



**EMPIRICAL RESEARCH INSTITUTE OF NIGERIA**

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CONFERENCE/  
INDUCTION  
2025**

**BOOK OF PROCEEDINGS**

**THEME:**

**REVOLUTIONIZING RESEARCH:  
METHODOLOGICAL INNOVATIONS FOR  
SUSTAINABLE DEVELOPMENT AND  
ECONOMIC GROWTH**

  
**FACULTY OF LAW CONFERENCE HALL,  
EBONYI STATE UNIVERSITY,  
CAS, ABAKALIKI**

  
**5TH - 7TH  
MARCH, 2025**

## CONFERENCE INTRODUCTION

It is with great honor and enthusiasm that we welcome you to the International Hybrid Conference and Induction organized by the Empirical Research Institute of Nigeria (ERIN), held from the 5th to the 7th of March, 2025, at the prestigious Ebonyi State University, Abakaliki.

This year's theme, "Revolutionizing Research Methodological Innovations for Sustainable Development and Economic Growth," speaks directly to the urgent global call for transformative approaches in knowledge production, policy formulation, and impactful implementation. In a world constantly evolving through technological advancements and complex socio-economic challenges, the need for innovative, inclusive, and interdisciplinary research methodologies has never been more critical.

This hybrid conference brings together distinguished scholars, industry leaders, policymakers, researchers, and students from across Nigeria and around the world, both physically and virtually. It serves as a dynamic platform for critical dialogue, collaborative exchange, and strategic partnership aimed at redefining how research can drive sustainable solutions and foster resilient economies.

In addition to the rich lineup of keynote presentations, panel discussions, and breakout sessions, this event also marks a significant moment as we induct new members into the Empirical Research Institute of Nigeria. These individuals have demonstrated exceptional commitment to academic excellence, ethical research, and societal development.

We invite all participants to engage fully, contribute meaningfully, and connect deeply as we chart new pathways for impactful research that transcends borders and disciplines. Together, let us revolutionize methodologies and accelerate progress toward a more sustainable and economically empowered future.

Welcome once again to Ebonyi State University, and welcome to a gathering of minds shaping the future.

## **WELCOME ADDRESS**

### **WELCOME ADDRESS BY THE CHAIRMAN PLANNING COMMITTEE AT THE OPENING CEREMONY OF HYBRID CONFERENCE AND INDUCTION ON “REVOLUTIONIZING RESEARCH METHODOLOGICAL INNOVATIONS FOR SUSTAINABLE DEVELOPMENT AND ECONOMIC GROWTH”**

Good morning, distinguished guests, esteemed colleagues, scholars, and participants—both here in Ebonyi State University and joining us virtually from around the world.

On behalf of the Empirical Research Institute of Nigeria (ERIN), it is my distinct pleasure to welcome you to this International Hybrid Conference and Induction Ceremony, themed “Revolutionizing Research Methodological Innovations for Sustainable Development and Economic Growth.”

This gathering, taking place from the 5th to the 7th of March, 2025, here at Ebonyi State University, Abakaliki, represents more than just an academic exercise—it is a bold step towards transforming the way we approach research, policy, and development in Nigeria, across Africa, and globally.

In today's complex and interconnected world, research must evolve. Traditional methods must give way to innovation—methods that are participatory, inclusive, data-driven, and solution-oriented. As we deliberate over the next three days, I urge us all to think boldly, challenge old paradigms, and explore new methodologies that can unlock sustainable solutions and spur economic growth across diverse sectors.

This event also marks a special occasion as we induct a new cohort of researchers and professionals into the Empirical Research Institute of Nigeria—visionaries who have shown unwavering dedication to evidence-based inquiry and societal advancement.

Let us seize this opportunity to learn, to share, to connect—and above all, to inspire. Once again, welcome to Abakaliki, welcome to this intellectual gathering, and welcome to the future of revolutionary research.

Thank you.

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# **RESOURCE ALLOCATION AND PERFORMANCE OF PRIMARY HEALTH CARE CENTRES IN ANAMBRA STATE, NIGERIA**

**AKWAEZE, Emeka Alex, Ph.D<sup>1</sup>, UMELEUE, Ogochukwu Gloria, Ph.D<sup>2</sup>, & Nwokeiwu JOHNSON, Ph.D<sup>3</sup>**

<sup>1</sup>Department Business Administration, Alex Ekwueme Federal University, Ndufu-Alike, Ikwo. Ebonyi State, Nigeria. Email: [odera08@gmail.com](mailto:odera08@gmail.com)

<sup>2</sup>Department of Business Education Nwafor Orizu College of Education Nsugbe Anambra State, Nigeria. Email: [cedar4christ3@gmail.com](mailto:cedar4christ3@gmail.com)

<sup>3</sup>Department Business Administration, Alex Ekwueme Federal University, Ndufu-Alike, Ikwo. Ebonyi State, Nigeria. Email: [jnwokeiwu@gmail.com](mailto:jnwokeiwu@gmail.com)

## **ABSTRACT**

*This study investigates the impact of various resource allocations and administrative frameworks on health outcomes in primary health care centers in Anambra State, Nigeria. A sample of 309 respondents provided data, analyzed using regression analysis, to assess the influence of financial resources, human resources, material resources, governance structures, and policy frameworks on health outcomes. The findings reveal that material resources allocation ( $\beta = 0.30$ ,  $p < 0.01$ ) has the most significant positive effects on health outcomes. Financial resources ( $\beta = 0.20$ ,  $p < 0.05$ ) and human resources ( $\beta = 0.18$ ,  $p < 0.05$ ) also significantly contribute to health outcomes, albeit to a lesser extent. These results highlight the critical role of adequate medical equipment, supplies, and robust policy frameworks in enhancing healthcare delivery. The study suggests prioritizing investments in material resources and strengthening policy frameworks to improve health outcomes, with a comprehensive strategy that also includes financial and human resource enhancements. These findings provide valuable insights for policymakers and healthcare administrators aiming to optimize resource allocation and improve the quality of healthcare services among others*

**KEYWORDS:** Resource Allocation Performance, Primary Health Care Centres, Financial Resources, Human Resources, Material Resources

## INTRODUCTION

Primary Health Care (PHC) centers are the cornerstone of the health system in many developing countries, providing essential health services to rural and underserved populations. In Nigeria, PHC centers play a crucial role in the overall healthcare delivery system. The efficient functioning of these centers is pivotal for achieving the health-related Sustainable Development Goals (SDGs), particularly those aimed at reducing child mortality, improving maternal health, and combating diseases. However, the performance of PHC centers in Anambra State, Nigeria, has been a subject of concern, often linked to issues of inadequate resource allocation. Resource allocation refers to the distribution of financial, human, and material resources among competing needs within the health system. Effective resource allocation ensures that PHC centers have the necessary tools to deliver quality health services. According to a study by Okoli et al. (2020), the equitable distribution of resources is critical for the sustainability of PHC services in Nigeria. Similarly, a study by Topp et al. (2018) highlighted that inadequacies in resource allocation often lead to disparities in health outcomes, particularly in rural areas. In Anambra State, the allocation of resources to PHC centers has been influenced by various factors, including political decisions, economic constraints, and demographic changes. Akintola et al. (2019) argue that political instability and corruption significantly affect the equitable distribution of resources, leading to underfunded and poorly equipped PHC centers. This situation is not unique to Nigeria; a comparative study by Kurowski et al. (2020) found similar challenges in other low-income countries, where political dynamics often overshadow health priorities.

The availability and quality of human resources are critical components of resource allocation in PHC centers. The World Health Organization (WHO) emphasizes the need for adequate staffing and continuous professional development to ensure effective health service delivery. The shortage of skilled health workers, including doctors, nurses, and community health workers, is a significant barrier to the performance of PHC centers. A study by Uzochukwu et al. (2018) reported that the high turnover of health personnel and insufficient training opportunities undermine the quality of care provided. Internationally, the Global Health Workforce Alliance (GHWA) has identified similar issues in other developing countries. A report by Campbell et al. (2018) stressed the importance of investing in health workforce education and retention strategies to improve health outcomes. The challenges in Anambra State reflect a broader trend in sub-Saharan Africa, where the migration of health professionals to more developed regions exacerbates the resource gap.

Financial resources are the backbone of any health system, enabling the procurement of medical supplies, infrastructure development, and the remuneration of health workers. Inadequate funding is a recurrent issue in the Nigerian health sector, with PHC centers in Anambra State being no exception. The National Health Insurance Scheme (NHIS), introduced to improve health financing, has not been fully effective in reaching the rural poor. According to Eze et al. (2021), many PHC centers still rely heavily on out-of-pocket payments from patients, which can be a barrier to accessing care. Comparatively, studies from other regions, such as Asia and Latin America, provide insights into alternative financing mechanisms. A study by Ravindran (2019) in India highlighted the success of community-based health insurance schemes in improving access to PHC services. Similarly, García-Subirats et al. (2018) found that decentralized health financing models in Brazil led to better resource allocation and improved health outcomes. These examples suggest that exploring diverse financing options could enhance the performance of PHC centers in Anambra State.

The physical infrastructure and material resources like the availability of medical equipment are fundamental to the effective functioning of PHC centers. In many parts of Anambra State, PHC centers operate in dilapidated buildings with outdated or insufficient medical equipment. A study



by Onwujekwe et al. (2020) revealed that inadequate infrastructure significantly hampers the delivery of quality health services, contributing to patient dissatisfaction and poor health outcomes. International comparisons reveal similar challenges but also provide potential solutions. For instance, a study by Hirschhorn et al. (2018) in Uganda demonstrated the positive impact of public-private partnerships in upgrading health infrastructure and improving service delivery. In South Africa, partnerships with non-governmental organizations have been effective in addressing equipment shortages in PHC centers (Cleary et al., 2018). Such approaches could be adapted to the context of Anambra State to enhance the operational capacity of its PHC centers.

Effective governance and robust policy frameworks are essential for the optimal allocation of resources in PHC centers. In Nigeria, the decentralization of health services aims to bring decision-making closer to the communities served. However, a study by Abimbola et al. (2019) pointed out that weak governance structures and lack of accountability hinder the effective implementation of health policies in Anambra State. Ensuring transparency and community participation in health governance could improve resource allocation and performance. Globally, countries with strong governance frameworks tend to achieve better health outcomes. A study by Balabanova et al. (2018) in Thailand showed that effective governance mechanisms, including stakeholder engagement and transparent budgeting processes, were instrumental in improving PHC services. The experience of Thailand and other countries with similar governance reforms could provide valuable lessons for Anambra State. The performance of PHC centers in Anambra State is intricately linked to the allocation of resources, encompassing financial, human, and material aspects. Current literature highlights significant challenges in resource allocation, influenced by political, economic, and governance factors. While these challenges are not unique to Anambra State, insights from both Nigerian and international contexts offer potential pathways for improvement. Addressing the disparities in resource allocation through innovative financing, investment in human resources, infrastructure development, and strong governance could significantly enhance the performance of PHC centers and contribute to better health outcomes for the population.

### **Statement of the Problem**

Primary Health Care (PHC) centres play a pivotal role in providing accessible and quality health services, especially in developing regions such as Anambra State, Nigeria. However, the performance of these centres is significantly influenced by the allocation of resources, which includes financial, human, and material resources. Financial resources are essential for the effective operation of PHC centres, influencing their ability to provide comprehensive services. In Anambra State, inadequate funding perceptibly leads to a shortage of essential supplies, medications, and operational facilities. This financial constraint results in limited healthcare accessibility for the population, particularly in rural and underserved areas. Patients often face high out-of-pocket expenses, long travel distances to well-equipped centres, and delayed treatments, which compromise their health and well-being. The inability to maintain a consistent flow of financial resources hampers the capacity of PHC centres to function effectively and meet the healthcare needs of the community (Woldie, Yitbarek & Dinsa, 2022; Bresick, Christians & Makwero, 2019).

The quality of care provided at PHC centres is heavily dependent on the availability and competency of healthcare personnel. In Anambra State, there is a notable shortage of trained medical professionals, including doctors, nurses, and support staff. This shortage is compounded by the uneven distribution of healthcare workers, with many preferring urban over rural postings due to better working conditions and opportunities. The lack of adequate human resources leads to overworked staff, longer patient wait times, and increased risk of medical errors. Additionally, inadequate training and professional development opportunities further degrade the quality of



care, resulting in poor patient outcomes and low satisfaction levels (Diderichsen, Varde & Whitehead, 1997; Kress, Su & Wang, 2016)).

Material resources, such as medical equipment, supplies, and infrastructure, are critical for delivering effective healthcare services. In many PHC centres across Anambra State, there is a significant deficit in these essential resources. The absence of up-to-date medical equipment, proper sanitation facilities, and reliable diagnostic tools undermines the ability of healthcare providers to offer accurate diagnoses and effective treatments. Consequently, health outcomes are adversely affected, with higher rates of preventable diseases, complications, and mortality. The disparity in the availability of material resources between different PHC centres leads to inconsistent health outcomes, disproportionately affecting those in under-resourced areas (Andersson, Varde & Diderichsen, 2000). The interplay between financial, human, and material resources significantly impacts the performance of Primary Health Care centres in Anambra State, Nigeria. Addressing the deficiencies in these areas is crucial for improving healthcare accessibility, quality of care, and health outcomes. This study aims to systematically examine how resource allocation affects the performance of PHC centres, providing evidence-based recommendations to enhance resource management and ultimately improve the health status of the population in Anambra State.

### **Objectives of the Study**

The main objective of this study is to examine resource allocation and performance of Primary Health Care Centres in Anambra State, Nigeria. Specifically, the study intends to:

1. Examine the effect of financial resources allocation on healthcare accessibility of primary health care centres in Anambra State Nigeria
2. Ascertain the effect of human resources allocation on quality of care of primary health care centres in Anambra State Nigeria.
3. Determine the effect of material resources allocation on health outcomes of primary health care centres in Anambra State Nigeria.

### **Statement of Hypotheses**

**H<sub>01</sub>:** Financial Resources allocation **has no significant effect** on healthcare accessibility of primary health care centres in Anambra State Nigeria

**H<sub>02</sub>:** Human Resources allocation **has no significant effect on** quality of care of primary health care centres in Anambra State Nigeria.

**H<sub>03</sub>:** Material Resources allocation **has no significant effect** on health outcomes of primary health care centres in Anambra State Nigeria.

## **REVIEW OF RELATED LITERATURE**

### **Resource Allocation**

Resource allocation in healthcare is a critical component that influences the efficiency and effectiveness of health service delivery. It involves the distribution of financial, human, and material resources to ensure that health services are provided equitably and sustainably. Effective resource allocation is essential for achieving health system goals, improving patient outcomes, and optimizing the use of limited resources. This literature review examines the current state of knowledge on resource allocation, focusing on its impact on primary health care (PHC) centers, challenges, and strategies for improvement (Okoli et al., 2020; Abimbola et al. (2019),

## **Performance of PHC Centers**

The performance of Primary Health Care (PHC) centers is a crucial factor in the overall health system, particularly in low and middle-income countries. Performance encompasses the quality, efficiency, and accessibility of health services provided by these centers. This literature review examines the various dimensions of PHC center performance, focusing on factors influencing it, measurement approaches, and strategies to enhance performance. Evidence from Nigeria and other countries will be highlighted to provide a comprehensive understanding of the current state of PHC center performance (Oye et al., 2018; Kruk et al., 2018)

## **Financial Resources**

Financial resources are fundamental to the operation and sustainability of primary health care (PHC) centers, affecting their ability to deliver essential health services. Adequate and effective financial resource allocation is crucial for ensuring that PHC centers can meet the health needs of their communities. This literature review explores the impact of financial resources on the performance of PHC centers, examining both domestic and international perspectives to provide a comprehensive understanding of the challenges and strategies for improvement (Uzochukwu et al., 2018; Ifechukwu-Jacobs, 2022; Hounton et al. (2019)

## **Human Resources**

Human resources (HR) are a pivotal element in the functionality and performance of primary health care (PHC) centers. The availability, competency, and motivation of health workers directly influence the quality of care provided. This literature review critically examines the role of human resources in PHC centers, focusing on issues such as workforce shortages, training and development, job satisfaction, and retention strategies. Insights from both Nigerian and international contexts are discussed to highlight common challenges and potential solutions (Onwujekwe et al., 2019; Ezeokafor, Jacobs & Ekwere, 2021; Campbell et al., 2013; Akajiofor, Arinze & Jacobs, 2023).

## **Material Resources**

Material resources, including medical supplies, equipment, and infrastructure, are essential for the effective operation of primary health care (PHC) centers. The availability and quality of these resources significantly impact the delivery of health services and patient outcomes. This literature review critically examines the role of material resources in PHC centers, exploring issues related to supply chain management, infrastructure quality, and the impact of material resources on service delivery. The review draws on recent studies to provide an up-to-date perspective on the challenges and solutions in this area (Olukunle et al. (2020; Vledder et al., 2019).

## **Financial Resources and Performance of PHC Centers**

Financial resources play a pivotal role in determining the performance and effectiveness of primary health care (PHC) centers. The availability and efficient management of financial resources are critical for ensuring that PHC centers can deliver comprehensive, high-quality health services to their communities. Numerous studies have highlighted the direct correlation between financial investment in health care and the performance outcomes of PHC centers, particularly in low- and middle-income countries.

In Nigeria, the inadequacy of financial resources has been a significant barrier to the optimal functioning of PHC centers. According to Oleribe et al. (2019), insufficient funding often leads to shortages of essential medicines, inadequate infrastructure, and poor working conditions for health care workers. These deficiencies adversely affect the quality of care provided and

undermine the overall performance of PHC centers. The study suggests that increasing financial allocations to the health sector could substantially improve the operational efficiency and service delivery of PHC centers (Olakunde et al. (2019).

### **Human Resources and Performance of PHC Centers**

Human resources are a fundamental component in the performance of primary health care (PHC) centers, influencing the quality of care, patient outcomes, and overall efficiency of health services. The availability, competence, and motivation of health workers are crucial determinants of the functionality and success of PHC systems. Numerous studies have examined the impact of human resources on the performance of PHC centers, highlighting the challenges and strategies for improvement.

The availability of an adequate number of health care professionals is critical for the effective operation of PHC centers. In many low- and middle-income countries, including Nigeria, there is a significant shortage of health care workers, which severely hampers the delivery of essential health services (Afolabi et al., 2018; Jacobs & Arinze, 2022). The World Health Organization (2016) estimates that there is a global shortage of 4.3 million health workers, disproportionately affecting low-income countries. This shortage leads to increased workloads, burnout, and decreased quality of care, ultimately impacting the performance of PHC centers (Koon et al., 2019; Jacobs, 2022; Jacobs, Ezeokafor & Ekwere, 2021; Jacobs, 2019).

### **Material Resources and Performance of PHC Centers**

Material resources are a critical factor in the performance and effectiveness of primary health care (PHC) centers. These resources include medical supplies, equipment, infrastructure, and other physical assets necessary for delivering quality health care services. Numerous studies have explored the relationship between material resources and the performance of PHC centers, highlighting the challenges and impacts of resource availability and management.

The availability of essential medical supplies and equipment is crucial for the effective operation of PHC centers. Studies have shown that shortages of basic medical supplies, such as medications, syringes, and diagnostic tools, can severely impede the ability of health care workers to provide adequate care (Adamu et al., 2020; Atueyi, Nkechukwu & Jacobs, 2019; Jacobs, 2019). In Nigeria, many PHC centers face significant supply chain challenges that result in frequent stockouts of essential medicines and materials, adversely affecting patient care and health outcomes (Uzochukwu et al., 2015). Ensuring a reliable supply chain and adequate stock management practices is essential for maintaining the operational efficiency of PHC centers.

### **Theoretical Framework**

This study is anchored on the Resource-Based View (RBV) theory. The Resource-Based View (RBV) theory is a strategic management framework that focuses on the internal resources of an organization as the key to achieving sustainable competitive advantage. Proposed by Jay Barney in 1991, the RBV posits that the unique resources and capabilities of an organization are fundamental to its performance and ability to achieve long-term success. This theory has been widely applied across various sectors, including health care, to understand how organizations can leverage their internal resources to improve their performance.

### **Proponents of the Theory**

The RBV theory was developed and popularized by Jay Barney, a prominent scholar in the field of strategic management. Barney's seminal paper, "Firm Resources and Sustained Competitive Advantage," published in the Journal of Management in 1991, laid the foundation for the RBV.

Other key contributors to the development of RBV include Edith Penrose, who earlier introduced the concept of firm resources in her 1959 book "The Theory of the Growth of the Firm," and Michael Porter, whose work on competitive advantage and value chains also informs the RBV perspective.

### **Assumptions and Tenets of the Theory**

The RBV theory is built on several core assumptions and tenets:

1. **Resource Heterogeneity:** Organizations possess a unique set of resources that differ from one another. These resources can be tangible (e.g., physical assets) or intangible (e.g., knowledge, skills).
2. **Resource Immobility:** Some resources are not easily transferable or replicable across organizations. This immobility helps maintain a competitive edge.
3. **Value, Rarity, Inimitability, and Non-substitutability (VRIN):** For resources to provide a sustainable competitive advantage, they must be valuable, rare, difficult to imitate, and non-substitutable. This VRIN framework is central to the RBV theory.
4. **Sustained Competitive Advantage:** Organizations that effectively manage and utilize their unique resources can achieve sustained competitive advantage, leading to superior performance over time.

### **Application of the Theory to the Study**

In the context of the study on the effect of resource allocation on the performance of PHC centers in Anambra State, Nigeria, the RBV theory provides a valuable lens for understanding how the internal resources of PHC centers influence their operational effectiveness and health outcomes. By examining the various types of resources—financial, human, material, and governance structures—through the RBV framework, we can identify which resources contribute most significantly to the performance of PHC centers and how these resources can be managed to achieve optimal results.

1. **Financial Resources:** According to the RBV theory, financial resources that are adequately allocated and efficiently managed can lead to improved performance of PHC centers. Financial resources are crucial for procuring medical supplies, maintaining infrastructure, and compensating health care workers. The VRIN characteristics can be applied to financial management practices to ensure that funds are used in ways that create value and are not easily replicable by other centers.
2. **Human Resources:** The skills, knowledge, and expertise of health care workers are intangible resources that can drive the performance of PHC centers. By leveraging the unique competencies of their staff, PHC centers can deliver high-quality care and achieve better health outcomes. Effective training and retention strategies can help maintain a skilled workforce, aligning with the RBV tenet of resource immobility.
3. **Material Resources:** The availability and quality of medical equipment and supplies are critical for the operational efficiency of PHC centers. According to the RBV theory, material resources that are rare and difficult to replicate, such as advanced diagnostic tools, can provide a competitive advantage in delivering superior health care services.

## METHODOLOGY

### Research Design

This study employs a descriptive survey research design to examine the correlation between independent and dependent variables within a specific population, following the framework outlined by Micheal, Oparaku, and Oparaku (2012). This methodology involves posing questions, collecting, and analyzing data from a representative sample at a single point in time. The primary objective is to assess the current status of the population concerning one or more variables, as described by Okeke, Olise, and Eze (2008), Chukwuemeka (2002), and Chukwuemeka and Oji (1999). The questions are structured to elicit responses that address the research questions and objectives.

### Area of Study

The study was conducted in Anambra State, southeastern Nigeria, named after the Anambra River. The capital is Awka, with Onitsha and Nnewi serving as commercial and industrial hubs. Anambra, known as the "Light of the Nation," is bordered by Delta, Imo, Rivers, Enugu, and Kogi States. The Igbo ethnic group comprises about 98% of the population, with the Igala making up around 2% in the northwest. Anambra is the eighth most populous state in Nigeria and the second most densely populated after Lagos, particularly in the Oba-Amorka corridor, with an average density of 1,500–2,000 people per square kilometer (Uzoagulu, 1998).

Anambra is rich in natural resources such as natural gas, crude oil, bauxite, and ceramic materials, with nearly 100% arable soil. In 2006, the Orient Petroleum Refinery (OPR), Nigeria's first privately-owned refinery, was established in Aguleri. The state is also known for its agro-based sector, including fishery, farming, pasturing, and animal husbandry. These resources contribute to Anambra having the lowest poverty rate in Nigeria, demonstrating its economic strength and effective resource management.

### Population of the Study

The population of the study includes all the Primary Health Care Centres (PHCs) in Anambra State, totaling 1,360 PHCs across the 21 local government areas (LGAs).

### Sample Size Determination and Sampling Technique

Stratified random sampling is an appropriate technique for this study because it ensures representation from different strata (in this case, the 21 LGAs) while accounting for potential variability in resource allocation and performance across different regions.

To calculate the sample size, Taro Yamane formula was applied to calculate the required number of participants. With a confidence level of 95% and a margin of error of 5%, the sample size (n) can be calculated as:

$$n = \frac{N}{1+N(e)^2}$$

Where: n = sample size  
N = population  
e = Margin of error (5% or 0.05)  
I = Constant

Substituting in the above formula:

$$\begin{aligned}
 n &= \frac{1360}{1+1360 (0.05)^2} \\
 &= \frac{1360}{1+1360 (0.0025)} \\
 &= \frac{1360}{3.5} \\
 &= 309
 \end{aligned}$$

Thus, a sample size of approximately 309 used for the study.

## Data Collection

Data for the study were collected from 309 Administrative Head or Director of Health Authority of selected Primary Health Care Centres (PHCs) using a structured questionnaire administered to them. A total of 309 questionnaires were distributed among the participants. Consequently, the analysis was conducted based on the 309 returned questionnaires, ensuring the accuracy and reliability of the data utilized in the study.

## Data Collection Instrument

The researcher crafted a structured questionnaire designed for administration to Administrative Head or Director of Health Authority of selected Primary Health Care Centres (PHCs). The questionnaire comprised two distinct sections: Section A and Section B. Section A was dedicated to gathering information regarding the demographic profile of the respondents. Meanwhile, Section B focused on items aimed at measuring the objectives of the study. This delineation ensured a systematic approach to collecting data pertinent to both the demographic characteristics and the primary research objectives of the study.

## Method of Data Analysis

Data collected will be analyzed using descriptive statistics (frequencies, percentages, mean, and standard deviation) and the inferential statistics such as test statistics and the linear regression model. The demographic profiles will be processed using descriptive statistics. Thereafter, the six objectives will be processed using descriptive statistics (like mean and standard deviation) and the regression model of the Ordinary Least Square (OLS). T-test and F-test statistics will be used to test the hypotheses of the study and the overall fitness of the model. All the analyses will be done using SPSS version 23. Linear regression model of the Ordinary Least Square (OLS) approach will be used to analyse the objectives in order to ascertain the influence and also determine the relationship between the independent variables and dependent variable in the conceptualized model of the study. The use of Ordinary Least Square (OLS), is informed by the fact that under normality assumption for  $\alpha_i$ , the Ordinary Least Square (OLS) estimator is normally distributed and is said to be best, unbiased linear estimator (Gujarati and Porter, 2008).

Thus, the model of this study is stated as follows:

## MODEL SPECIFICATION

*The functional form of the model is*

$$HTO = f(FRA, HRA, MRA) \dots \dots \dots (1)$$



*The mathematical form of the model is*

$$HTO = \beta_0 + \beta_1 FRA + \beta_2 HRA + \beta_3 MRA \dots \dots \dots (2)$$

*The econometric form of the model is*

$$HTO = \beta_0 + \beta_1 FRA + \beta_2 HRA + \beta_3 MRA + \alpha_i \dots \dots \dots (3)$$

Where;

HTO = health outcomes of primary health care centres

FRA = Financial Resources Allocation

HRA = Human Resources Allocation

MRA = Material Resources Allocation

$\beta_0$  = Intercept of the model

$\beta_1 - \beta_5$  = Parameters of the model

$\alpha_i$  = Stochastic error term

## DATA PRESENTATION AND ANALYSIS

### Demographic Profile of the Respondents

**Table 1: Distribution of Respondents According to Age**

Variable	Frequency	Percent (%)	Cumulative (&)
20-29 years	45	14.6%	20-29 years
30-39 years	85	27.5%	30-39 years
40-49 years	90	29.1%	40-49 years
50-59 years	60	19.4%	50-59 years
60 years and above	29	9.4%	60 years and above
<b>Total</b>	<b>309</b>	<b>100%</b>	<b>Total</b>

Source: Field Survey, 2024

As shown in table 1, 14.6% of respondents are aged 20-29 years, 27.5% are 30-39 years, 29.1% are 40-49 years, 19.4% are 50-59 years, and 9.4% are 60 years and above. The largest group of respondents falls into the 40-49 years age range, suggesting a mature workforce with substantial experience. The presence of younger respondents (20-29 years) indicates a potential influx of new ideas and perspectives into the PHC sector.

**Table 2: Distribution of Respondents According to Gender**

Variable	Frequency	Percent (%)	Cumulative (&)
Male	150	48.5%	Male
Female	159	51.5%	Female
<b>Total</b>	<b>309</b>	<b>100%</b>	<b>Total</b>

Source: Field Survey, 2024

Table 2 revealed that the gender distribution is relatively balanced, with 48.5% male and 51.5% female respondents. This balance suggests that both genders are equally represented in the sample, which is beneficial for obtaining a comprehensive view of the perspectives and experiences of healthcare workers in the study.

**Table 3: Educational Level of Respondents****Distribution of Respondents According to Educational Qualification**

Variable	Frequency	Percent (%)	Cumulative (&)
Secondary	40	12.9%	Secondary
Tertiary	200	64.7%	Tertiary
Postgraduate	50	16.2%	Postgraduate
Other	19	6.2%	Other
<b>Total</b>	<b>309</b>	<b>100%</b>	<b>Total</b>

**Source: Field Survey, 2024**

As shown in table 3, 64.7% of respondents have tertiary education, 16.2% have postgraduate qualifications, 12.9% have secondary education, and 6.2% fall into the "Other" category. The high percentage of respondents with tertiary education indicates a well-educated sample, which is essential for ensuring knowledgeable and skilled inputs into the study. The presence of postgraduate degree holders further reflects a high level of expertise within the respondent pool.

**Table 4: Distribution of Respondents According to Years of Experience**

Variable	Frequency	Percent (%)	Cumulative (&)
Less than 5 years	70	22.7%	Less than 5 years
5-10 years	95	30.7%	5-10 years
11-20 years	85	27.5%	11-20 years
More than 20 years	59	19.1%	More than 20 years
<b>Total</b>	<b>309</b>	<b>100%</b>	<b>Total</b>

**Source: Field Survey, 2024**

Table 4 revealed that 22.7% of respondents have less than 5 years of experience, 30.7% have 5-10 years, 27.5% have 11-20 years, and 19.1% have more than 20 years. The distribution shows a mix of relatively new and more experienced individuals, providing a broad range of perspectives. The substantial proportion of respondents with over 10 years of experience (47.8%) suggests that the insights gathered are grounded in extensive practical knowledge.

Overall, the demographic profile of the respondents indicates a diverse and well-rounded sample with a balanced representation of gender, a strong educational background, and a range of experience levels. This diversity enhances the reliability and applicability of the study's findings.

**Table 5: Regression Output on Resource Allocation and Performance of Primary Health Care Centres in Anambra State, Nigeria**

Independent Variables	Unstandardized Coefficients	Standardized Coefficients	t-statistic	p-value
	<b>B</b>	<b>Beta</b>		
(Constant)	2.00		3.50	0.000
Financial Resources	0.30	0.25	2.80	0.005
Human Resources	0.25	0.20	2.50	0.015
Material Resources	0.40	0.35	3.20	0.002
<b>R</b>	0.65			
<b>R<sup>2</sup></b>	0.60			
<b>Adj. R<sup>2</sup></b>	0.58			
<b>F-statistic</b>	25.00			0.000

**Source: Field Survey, 2024**

## Model Summary

R-squared: 0.60 (This indicates that 60% of the variance in health outcomes is explained by the independent variables in the model.)

Adjusted R-squared: 0.58 (This adjusted value accounts for the number of predictors in the model and provides a more accurate measure of the goodness of fit.)

F-statistic: 25.00 (The F-statistic tests the overall significance of the model, indicating that the model is statistically significant.)

P-value: 0.000 (The p-value indicates that the model as a whole is statistically significant.)

## Interpretation of Results

Financial Resources ( $\beta = 0.25$ ,  $p = 0.005$ ):

The coefficient for financial resources is positive and statistically significant, suggesting that an increase in financial resources allocation is associated with an improvement in health outcomes. Specifically, for every unit increase in financial resources, health outcomes improve by 0.30 units, holding other factors constant.

Human Resources ( $\beta = 0.20$ ,  $p = 0.015$ ):

The coefficient for human resources is also positive and significant. This indicates that better allocation and management of human resources positively impact health outcomes. An increase in human resources is associated with a 0.25 unit increase in health outcomes.

Material Resources ( $\beta = 0.35$ ,  $p = 0.002$ ):

The most substantial positive impact on health outcomes comes from material resources. The coefficient suggests that for each unit increase in the quality and availability of material resources, health outcomes improve by 0.40 units.

## Discussion of Findings

The regression analysis conducted on the impact of various factors on health outcomes in primary health care centers (PHCs) in Anambra State, Nigeria, reveals significant insights. The findings underscore the critical role of financial resources, human resources, material resources, governance structures, and policy frameworks in shaping the quality and effectiveness of healthcare services.

The study finds that financial resources significantly impact health outcomes, with a coefficient of 0.25 ( $p = 0.005$ ). This aligns with previous research, indicating that adequate funding is crucial for sustaining healthcare services and ensuring the availability of essential medications and equipment (Oluwafemi et al., 2019). Financial resources enable PHCs to maintain infrastructure, procure medical supplies, and provide necessary training for healthcare personnel, which directly improves patient care and service delivery (Abimbola et al., 2015).

Human resources also significantly influence health outcomes, with a coefficient of 0.20 ( $p = 0.015$ ). This finding is consistent with the literature that highlights the importance of sufficient and well-trained healthcare personnel in delivering quality care (Anyika, 2014). The availability of skilled healthcare workers is crucial for addressing patient needs, managing workload, and maintaining service quality. Previous studies have emphasized the need for adequate staffing and continuous professional development to enhance healthcare delivery (Adams et al., 2018).

The analysis indicates that material resources have the most substantial positive impact on health outcomes, with a coefficient of 0.35 ( $p = 0.002$ ). This result is supported by studies showing that the availability of medical equipment and supplies is critical for effective healthcare services (WHO, 2017). Adequate material resources ensure that healthcare facilities can perform necessary procedures and provide timely treatment, thereby improving patient outcomes (Kruk et al., 2018).

## CONCLUSION AND RECOMMENDATIONS

The regression analysis highlights that all five factors—financial resources, human resources, and material resources have significant impacts on health outcomes in PHCs. Material resources exert the most substantial influence, followed by financial resources. Human resources play important roles but with comparatively smaller impacts. The study underscores the need for a multifaceted approach to improving health outcomes, focusing on enhancing these key areas. Financial resources have a positive and statistically significant effect on health outcomes, with a coefficient of 0.25 ( $p = 0.005$ ). This suggests that increased financial investment in PHCs improves health outcomes by enhancing the availability of medications, infrastructure, and other essential services. Human resources also have a significant impact, with a coefficient of 0.20 ( $p = 0.015$ ). Adequate staffing and effective management of healthcare personnel positively influence health outcomes by ensuring quality care and efficient service delivery. Material resources have the most substantial effect on health outcomes, with a coefficient of 0.35 ( $p = 0.002$ ). The availability and quality of medical equipment and supplies are crucial for effective healthcare delivery, significantly improving patient outcomes. Based on the regression results, the following recommendations are proposed: Government should allocate more funds to PHCs to ensure the availability of medications, infrastructure improvements, and necessary training. Effective financial management will support enhanced health outcomes. Government should develop and implement strategies to ensure adequate staffing and professional development for healthcare personnel. This will improve service delivery and patient care quality. Government should prioritize the procurement and maintenance of medical equipment and supplies. Regularly assess and upgrade material resources to support effective healthcare delivery.

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# **ASSESSMENT OF CLINICAL CODING AND BILLING IN RIVERS STATE UNIVERSITY TEACHING HOSPITAL (RSUTH) PORT HARCOURT**

<sup>1</sup>ISARUK, Ikpoko-ore-ebirien Dike, PhD, FERIN; <sup>2</sup>NWANRO, Alloysius; Kpowugah,  
<sup>3</sup>Sunny TOANYIE; <sup>4</sup>OFFIAH, Rorkeek Michael, PhD, FAIPHP, FERIN; <sup>5</sup>Dr. USENDE,  
Hanson Levi

<sup>1-2</sup>Department of Health Information Management, Rivers State College of Health Science  
and Management Technology, Port Harcourt

<sup>3</sup>PhD Student, Department of Public Health, College of Medical Sciences, Rivers State  
University, Port Harcourt

<sup>4</sup> Department of Public Health, School of Public Health Technology, Rivers State College  
of Health Science and Management Technology, Port Harcourt

<sup>5</sup>Department of Planning, Research and Statistics, Rivers State Primary Healthcare  
Management Board, Port Harcourt.

Correspondence Email: [dykeman121@gmail.com](mailto:dykeman121@gmail.com); [dykeman1974@gmail.com](mailto:dykeman1974@gmail.com).

## **ABSTRACT**

*In the medical field, precision is essential to quality patient care outcomes, and medical coding takes the essential elements out of clinical paperwork to help with the payer's claim creation process. The provider's assessment of the patient is the first step in the complex coding process; therefore, all diagnoses and procedures must be accurately documented. Thus, there is a paucity of literature on clinical coding and billing documented to enhance the payer's claim and quality service rendered. Therefore, this study assessed clinical coding and billing in Rivers State University Teaching Hospital (RSUTH) Port Harcourt. A descriptive study design with a mixed-method approach (questionnaire and participant interview) was adopted. A population of 50 health records officers and 30 medical billers was used. The data obtained was analysed using descriptive statistics tools such as percentages, frequency tables, mean, and standard deviations with the SPSS software. Results revealed that RSUTH does not adhere to clinical coding and billing; clinical coding and billing negatively impact the quality of health services provided in the hospital. For RSUTH to function optimally, the billing of patient care services should be based on clinical coding in line with ICD classification and procedural codes. Based on the aforementioned, the study recommended that the clinical coding unit's staff be permanently assigned rather than rotated like other administrative staff because coding and billing are specialised areas that should be staffed by experts. In addition, billing should be based on correct diagnostic and procedural ICD/PCS codes, RSUTH management should make sure that coders and billers receive regular training and retraining to keep them up to date on changes in modern healthcare, and healthcare providers should always make sure that accurate and proper documentation is made.*

**KEYWORDS:** Assessment, Billing, Clinical Coding, Rivers State University Teaching Hospital.

## INTRODUCTION

Clinical coding and billing are essential components of healthcare management, ensuring accurate documentation of patient diagnoses and treatments while facilitating proper financial transactions between hospitals and insurance providers (World Health Organisation [WHO], 2023). In Nigeria, effective clinical coding remains a challenge due to inadequate training, a lack of standardised coding practices, and limited adoption of health information technology (Olaoye & Adeyemi, 2023). Rivers State University Teaching Hospital (RSUTH) in Port Harcourt serves as a case study to assess the effectiveness of clinical coding and billing practices within a tertiary healthcare institution. This study examines the level of staff involvement in coding, the quality of coding practices, and the impact of coding accuracy on hospital revenue generation and healthcare delivery.

At RSUTH, health records officers are the primary personnel responsible for coding disease entities, ensuring that diagnoses and medical procedures are properly classified using the International Classification of Diseases (ICD) system (Brown, 2022). While doctors, nurses, and laboratory scientists contribute to patient documentation, they are not directly responsible for coding (Rosenbloom et al., 2019). However, the effectiveness of coding largely depends on the quality of medical records provided by clinicians. In cases where documentation is incomplete or ambiguous, coders may struggle to assign the correct codes, leading to billing errors and potential loss of revenue (Jones & Bennett, 2023).

The quality of clinical coding at RSUTH has been assessed as moderately high, with some inconsistencies in documentation and code assignment. A survey conducted among coding staff indicated that while coding accuracy is prioritized, the absence of regular training programs and inadequate access to updated ICD manuals sometimes affects the precision of coding (Thompson et al., 2022). Hospitals that integrate electronic health records (EHRs) and automated coding systems tend to achieve better coding accuracy, but RSUTH still relies largely on manual coding processes (Patel et al., 2021). The lack of an advanced digital infrastructure limits the efficiency and consistency of coding practices within the hospital. One of the key challenges facing clinical coding at RSUTH is insufficient staff training and professional development.

Studies show that continuous training improves coding accuracy and compliance with global standards (American Health Information Management Association [AHIMA], 2021). Another major issue is the lack of proper auditing mechanisms to cross-check coding errors before submission for billing (Williams et al., 2023). Without systematic coding reviews, hospitals may face financial losses due to claim rejections from health insurance companies (Levinson, 2020). Accurate clinical coding is critical for ensuring that hospitals receive the correct reimbursement for services rendered. At RSUTH, coding errors have been linked to delays in claim approvals from the National Health Insurance Scheme (NHIS) and private insurance providers (Green et al., 2021). When codes are not accurately assigned, hospitals risk underbilling, which leads to revenue loss, or overbilling, which can result in fraud allegations and legal consequences (Hughes, 2021). Proper coding helps hospitals maximize revenue collection while maintaining transparency in financial transactions (Davenport & Glaser, 2020).

Globally, hospitals are adopting AI-powered coding software to enhance efficiency and minimize human errors (Makam et al., 2020). However, RSUTH has yet to fully integrate automated coding tools into its workflow. The introduction of AI-based coding systems could significantly improve coding speed and accuracy, reducing the administrative burden on health records officers (Rogers & Kim, 2023). Additionally, automation can help ensure compliance with changing coding regulations and updates to ICD classifications (Parker et al., 2022). The Nigerian healthcare system lacks a fully standardized framework for clinical coding across all hospitals (Okonkwo &

Nwosu, 2022). At RSUTH, the absence of strict coding policies has contributed to variations in coding quality.

Establishing national coding guidelines, along with regular monitoring and evaluation, would enhance uniformity and reliability in hospital coding practices (Bryant et al., 2020). Hospitals that implement well-structured coding policies often experience improved documentation and fewer claim disputes (Smith et al., 2021). To enhance coding accuracy at RSUTH, the hospital management should prioritize regular staff training and certification in medical coding (Brown, 2022). Providing coders with access to updated ICD manuals and coding software can significantly improve documentation quality (Thompson et al., 2022). Additionally, implementing routine audits and cross-checking of coding entries before claim submission would help minimize billing errors (Williams et al., 2023).

The assessment of clinical coding and billing at RSUTH highlights the critical role of coding accuracy in hospital operations. While the coding quality is moderately high, several challenges such as inadequate training, lack of digital tools, and absence of standardized policies affect efficiency. Addressing these challenges through staff training, technology adoption, and policy implementation can enhance the accuracy of clinical coding and improve hospital revenue generation. Ultimately, improving coding practices at RSUTH will lead to better healthcare delivery, financial sustainability, and compliance with international health standards (WHO, 2023).

The coded data constitute the key components required for regulatory submission. hence, the function of coding is essential and the need to maintain high quality in the delivery of coded data should not be underestimated. Inaccurate or insufficient data inhibits health information exchange (HIE), and hinders clinical research, performance improvement, and quality measurement initiatives. Clinical coding is the allocation of or a process of assigning numerical/ alphabetical codes to chemical data in accordance with international coding standard to facilitate ease of data retrieval for analysis and comparison (WHO, 2010). Coding practices sets out the requirements for chemical coding to ensure compliance with standards, and the accuracy and the consistency of information produced during the clinical coding process. It is an integral part of health information management (HIM) practice which provides valuable data for health care, quality evaluation, health services research, medical billing, public health and programming.

The International Statistical Classification of Diseases and Related Health Problems, tenth Revision (ICD–10) published by world Health Organization, is a veritable tool for the effectiveness of clinical coding practices. It helps to translate medical information relating to a patient's encounter with the health facility into alpha–numeric codes. These codes enhance the analysis of health care activities by grouping diagnosis and procedures together according to recognized format. High quality coding allows for assessment of health care needs, the sharing between healthcare organizations and clinicians of standardized records, effective resource management, medical and clinical audits to be carried out more easily and ease of use in epidemiological study. Campbell and Giadresco (2020) through a literature review investigated the effect of computer assisted coding on the accuracy and quality of clinical coding and its impact in clinical coding professionals. Their study further revealed computer assisted coding demonstrated impact in clinical coding accuracy and data quality. They averred that clinical coders should view computer assisted coding as an opportunity to develop new skills, particularly in monitoring and auditing coding outputs, and that sound change management strategies are needed to ensure a successful transition of the clinical coding workforce to new roles They also found that incomplete and disorganized clinical documentation and lack of good communication with clinicians impacted on the quality of clinical coding.

The integrity of clinical coding depends fundamentally on the quality of the patient record. Alonso et al. (2020), in their study posited that clinical coders face a lot the problems that influence the quality of the coded data. They identified several issues including missing or incomplete discharge and/ or surgical notes, the use of abbreviations, variability in documentation between specialties and lack of specificity in diagnosis descriptions. They also opined that in spite of electronic health records solving illegibility problem, they have created problem of their own, notably the copy and paste facility that results in errors being repeated throughout the records and very large volumes of notes to be perused by clinical coders. For any hospital to take off properly, is normally dependent on the presence and availability of patients who requires the services of health care providers for their care. Also, for any hospitals to function well and to carry out its civic responsibility which is the care or treatment of the sick and the injured, and supportive of these basic responsibilities by the tertiary institution, are the education, teaching and research which are subsidiary.

The physicians and surgeons are the pivot by which other healthcare providers and activities revolve. The workability of any health facility requires that there be recorded evidence of all her transactions documented down to prove what transpired between the patients and the health care providers from the medical point of view. To ensure the feasibility of the above, there be proper, effective, and efficient medical records documentation. Short of this, the facility faces a lot of harmful challenges, which might be very detrimental for the better care of the patients. Another important factor that negatively impacts the performance and treatment of patients is the lack of discharge summaries, which is the basis on which clinical coding and billing rely. To achieve this requires that the physicians are well trained and educated and also that there should be a laid-down policy mandating the doctors to always write down discharge summaries on patient discharge. In Rivers State University Teaching Hospital Port Harcourt, there is a paucity of literature on medical billing and coding in their health care service delivery. Therefore, this study assessed clinical coding and billing practices and their impact on the quantity of health care services in Rivers State University Teaching Hospital, Port Harcourt, Nigeria.

The challenges confronting clinical coding and billing in Rivers State University Teaching Hospital Port Harcourt are enormous. Notable among these are the absence of automation, lack of political will, inadequate/experienced clinical coders, and suboptimal documentation. Unacceptable abbreviations, multiple interpretations/not enough information for classification, and other common challenges are also observed, and all of these affect the quality of care provided in the hospital. The system is also suffering from an inadequate and unmotivated workforce. There are lack of adequate workforce to handle clinical coding and billing, and lack of operational management support that impedes and potentially leads to inaccurate state of national statistics on hospital morbidity. It also has an adverse effect on hospital health data, which in turn impacts clinical coding outcomes and billing in the hospital, thus limiting national decision-making established in the hospital due to a lack of trained manpower, logistics material, resources, and poor documentation of patients in the hospital. Despite the importance of clinical coding in promoting quality health care in the hospital, low or lack of government support also affects coding quality in the hospital. It was also observed that poor job satisfaction and lack of continuing education opportunities affect the quality of health care services and utilisation of clinical coding and billing in the hospital. This study basically aimed to assess clinical coding and billing in Rivers State University Teaching Hospital (RSUTH) Port Harcourt.

### **Specific Objectives**

To assess this work, the researcher formulated the following specific objectives.

1. To ascertain the methods of coding of disease entities at the Rivers State University Teaching Hospital (RSUTH), Port Harcourt
2. To identify the department used in the hospital for coding of diseases entities
3. To determine the category of staff involved in the coding of disease entities in the hospital
4. To assess the quality of medical billing carried out in the hospital.

## Methodology

A descriptive cross-sectional study was adopted to assess coding practices at Rivers State University Teaching Hospital (RSUTH), Port Harcourt. The study population consisted of 50 health records officers and 30 medical billers, making a total of 80 respondents. Primary data were collected through structured questionnaires and interviews to obtain relevant information on clinical coding and billing practices. To ensure a comprehensive understanding, the head of the Health Records Department and Clinical Coding/Billing Unit was selected as a key informant for an in-depth interview, considering their expertise and supervisory role in coding operations. The collected data were analysed using descriptive statistical tools, including percentages, frequency tables, means, and standard deviations, with the aid of SPSS software for precise computation. This analytical approach provided insights into the predominant coding methods, departmental responsibilities, and compliance with standard coding protocols. The findings contribute to understanding the efficiency of clinical coding at RSUTH and offer recommendations for improvement in coding accuracy and healthcare service delivery.

## Result

This section deals with the presentation and analysis of data distributed by the researcher and retrieved from the respondents. The researchers distributed eighty (80) questionnaires to eighty (80) research respondents, and seventy (70) questionnaires were retrieved upon completion and found valid, making an 88% return rate. This figure stands as the basis of this analysis.

Four (4) copies of the questionnaires were not returned while six (6) copies were not completed.

**Research Question 1:** What are the methods for the coding of disease entities at the RSUTH, Port Harcourt?

**Table 1: Methods for coding of Disease entities**

Methods used	Frequency	Percentage (%)	Cumulative %
Manual method	48	68.6	68.6
Electronic method	6	8.6	77.2
Electronic/manual method	16	22.8	100.0
<b>Total</b>	<b>70</b>	<b>100.0</b>	

Table 1, revealed that of (48)68.6% of respondents believed the method of coding of diseases entities in RSUTH is manual method of clinical coding (6)8.6% prefer electronic method while (16)22.8% of the respondents preferred both electronic and manual method of coding of diseases entities.



**Research Question 2:** Which department is used in the hospital for coding disease entities?

**Table 2: Department Used for Coding Disease Entities**

Option	Frequency	Percentage	Cumulative percentage
Medical/health record department	60	85.7	85.7
Laboratory	6	8.6	94.3
Pharmacy	2	2.9	97.2
Accountant	2	2.9	100.1
<b>Total</b>	<b>70</b>	<b>100.1</b>	

Total 2 shows the department used for coding entities in the hospital. The Table revealed (60) 85.7% of respondents said that the department used for coding disease entities is medical/ health records department used for coding diseases entities is medical/ health records department, (6)8.6% of the respondents says laboratory, (2) 2.9% said pharmacy while the other(2)2.9% says account department.

From the above Table, majority of the respondents agreed that medical/ health record department used for coding of disease entities.

**Research Question 3:** What are the categories of staff involved in the coding of disease entities in the hospital?

**Table 3: Category of staff involved in coding disease entities**

Option	Frequency	Percentage	Cumulative percentage
Clerical staff	3	4.3	43
Nurses	5	7.1	11.4
Lab. Scientists	2	2.9	14.3
Consultants	3	4.3	18.6
Medical/ health record officers	57	81.4	100.0
<b>Total</b>	<b>70</b>	<b>100</b>	

Table 3 above shows the category of staff involved in coding disease entities. The table recorded 4.3% of respondents mentioned clerical staff, (5)7.1% said nurses, (2)2.9% said laboratory scientists, (3)4.3% said consultants while (57)81.4% of the respondents said medical/ health records officers. Therefore, majority of the respondents were of the opinion that the category of staff involved in clinical coding of diseases entities are medical/ health records officers.

**Research Question 4:** What grading quality of coding method is carried out in the hospital?

**Table 4: Quality of coding method carried out**

Option	Frequency	Percentage	Cum. Percentage
High quality	18	25.7	25.7
Moderately high	28	40.0	65.7
Low quality	21	30.0	95.7
Very low quality	3	4.3	100.0
<b>Total</b>	<b>70</b>	<b>100.00</b>	

The assessment of coding quality at Rivers State University Teaching Hospital (RSUTH) reveals varying perceptions among respondents. A total of 18 participants, representing 25.7%, rated the coding quality as high, indicating that a portion of the staff acknowledges efficient and accurate coding practices within the hospital. Additionally, 28 respondents (40.0%) considered the coding quality to be moderately high, suggesting that while some aspects of the coding process are



satisfactory, there is still room for improvement in compliance with standard coding protocols and overall efficiency. The cumulative percentage of these two categories (65.7%) indicates that more than half of the respondents believe the hospital's coding practices are at least moderately effective.

However, a significant number of respondents expressed concerns about the quality of coding in the hospital. Specifically, 21 participants (30.0%) rated the coding quality as low, pointing to deficiencies in documentation, classification, and adherence to international coding standards. Additionally, 3 respondents (4.3%) perceived the coding quality as very low, suggesting major inefficiencies that could negatively impact patient care and hospital management. With a cumulative 34.3% of respondents rating the coding system as low or very low quality, it is evident that RSUTH must address these shortcomings. To improve the quality of clinical coding, the hospital should focus on periodic training for coding personnel, strict compliance with ICD classifications, and the implementation of electronic or hybrid coding systems to enhance accuracy and efficiency.

## **Discussion of Findings**

The method for the coding of disease entities in RSUTH showed that 68.6% of the coding of disease entities used the manual method, which means that the International Classification of Diseases (ICD) coding manual was used in coding diseases. This result somehow aligned with a previous study by Brown (2022), who established that diagnoses and medical procedures are properly classified using the International Classification of Diseases (ICD) system. In addition, this study finding indicated a manual method of coding and billing. This manual comprises volume I, the tabular list; volume II, the instructional manual; and volume III, the alphabetical index to the tabular list, volume I. The use of the manual method resulted in errors, delays in the assignment of diseases and procedure code numbers, errors due to improper documentation, and doctors not writing discharged summaries. 22.8% considered more appropriate the combination of both electronic and manual methods, and about 8.6% were of the opinion that electronic methods are the best method. Conversely, Campbell and Giadresco (2020) investigation on the effect of computer-assisted coding on the accuracy and quality of clinical coding and its impact on clinical coding professionals revealed computer-assisted coding demonstrated an impact on clinical coding accuracy and data quality, thereby yielding patient satisfaction with services received. The study revealed that the department of medical/health records was the only department charged with the duty of assigning clinical coding of disease entities in the hospital. The study showed that the majority of people interviewed showed 85.7% in support of the Medical/Health Records Department. The study shows that the category of staff involved in coding of disease entities are medical/health records staff/officers. No other department is involved, as the nurses and lab scientists have their own responsibilities quite different from jobs performed by health record officers. However, this result somewhat corroborated previous study outcomes by Rosenbloom et al. (2019) and Jones and Bennett (2023), who established that doctors, nurses, and laboratory scientists are not directly responsible for coding, but they contribute to patient documentation, and the effectiveness of coding largely depends on the quality of medical records provided by clinicians. Hence, in cases where documentation is incomplete or ambiguous, coders may struggle to assign the correct codes, leading to billing errors and potential loss of revenue.

It has been noted that coding techniques are of a moderately high calibre. This demonstrates that codes ought to be more motivated to work harder to guarantee that high-quality data and improved patient record documentation are constantly accessible. Because all of the diseases and procedural codes are programmed electronically, this method eliminates the possibility of human error. The issue of doctors' or clinicians' handwriting being unreadable is resolved, and time

wastage is prevented. According to the survey, both manual and automated methods are used to process medical invoices. Given the state of technology and contemporary treatment approaches, computerised medical billing is necessary. Account officers are the category of staff involved in medical bills, according to the research study, which means that they need more training on billing and clinical coding. Coding is crucial for efficient billing, but Olaoye and Adeyemi (2023) found that effective clinical coding is still difficult because of a lack of standardised coding practices, insufficient training, and a limited adoption of health information technology.

## **Conclusion**

This study is titled The Assessment of Clinical Coding and Billing in RSUTH. Port Harcourt was carried out with a well-prepared and validated primary data collection tool (questionnaire), which was administered to respondents in the hospital. Seventy (70) of the copies were retrieved upon completion and found valid. This figure stands as the basis for this analysis. Four (4) copies of the questionnaire were not returned, while six (6) of the copies were not completed. Finally, the result revealed that RSUTH does not adhere to clinical coding and billing; clinical coding and billing impact negatively on the quality of health services provided in the hospital. For RSUTH to function optimally, billing of patient care services should be based on clinical coding based on ICD classification and procedural code.

## **Recommendations**

Based on the above, the following recommendations were proffered for the identified problems.

1. Staff assigned to the clinical coding unit are to be permanently deployed and not to be rotated like other administrative staff because coding and billing are special areas that are to be manned by experts.
2. Billing is to be based on proper diagnostic and procedural ICD/PCS codes.
3. There should be periodic training and retraining of coders and billers to acquaint them with modern health care changes and charges.
4. Those responsible for the care of patients should ensure that accurate and proper documentation is made, mainly the clinicians and coders.
5. The hospital healthcare providers are to ensure that discharged summaries are written on patient discharge.

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# **CLIMATE CHANGE RESILIENT PRACTICES FOR SOIL AND CROP PRODUCTIVITY IN THE TROPICS**

**ORJI, Jephther Ebuka**  
**Department of Agriculture (Soil Science option)**  
**Alex Ekwueme Federal University Ndufu Alike, Ebonyi State.**  
**Email: [revjeph@gmail.com](mailto:revjeph@gmail.com)**

## **ABSTRACT:**

*The current greatest challenge facing agricultural production and global food security is climate change. It is a serious threat to global food security due to its effects on soil and crop productivity. The review evaluated climate change resilient practices for soil and crop productivity in the tropics. Numerous existing studies on climate change and agriculture were majorly on effects, mitigation and adaptation strategies which are published more in international journals. However, studies on climate change resilient practices for soil and crop productivity in the tropics are very few, hence the need for the study. From the initial search of 55 journal papers, only 25 met the inclusion criteria using PRISMA procedures. The 25 journal papers that included information on climate change and agriculture, adaptation and resilience which were published in international and local journals between 2014 and 2024 were reviewed systematically. The study observed that changes in temperature and rainfall patterns have a great impact on the soil organic matter as well as the plants and crops and decline in soil fertility as a result of climate change, which brings more extreme weather events such as flooding, drought and more unpredictable weather conditions. Given the obvious effects of climate change on soil and crop, resilient practices are inevitable. Resilient practices such as minimum tillage practice, mulching, crop rotation, agroforestry, planting drought and heat resistant crops, cover cropping, precision irrigation, etc. were identified. The results showed that the journal papers were published more in international journal than local. The results of the review also observed the need for more information on climate change resilient practices for soil and crop productivity in the tropics published locally since continuous effect of climate change is envisaged. The review recommends regular study on climate change resilient practices for soil and crop productivity in the tropics to ensure food security.*

**KEYWORDS:** Climate change, resilient, soil, crop productivity

## INTRODUCTION

Climate Change is a term commonly used to describe any systematic alteration or statistically significant variation in either the average state of the elements of climate such as rainfall (precipitation), temperature, winds, or pressure; or in its variability, sustained over a finite time period (decades or longer) (Philande, 2018). Over the past few decades, the Nigerian climate has witnessed constant changes due to activities that degrade the atmosphere, such as carbon emissions from vehicles, bush burning, deforestation, urbanization, among others (Ogbo et al. 2013). The release of greenhouse gases (GHGs) such as carbon dioxide (CO<sub>2</sub>), nitrogen oxide (N<sub>2</sub>O), and methane (CH<sub>4</sub>) in Nigeria, has gone beyond acceptable limit, and has made a significant contribution to global warming (Idowu et al. 2011; Eshiemogie et al. 2022). The visible impacts of climate change in Nigeria has resulted in situations that threaten the attainment of global food security especially in the tropical region. Some of these adverse effects include variable rainfall, land degradation, irregular weather conditions, drought and desertification, increased sea levels, flooding, heat waves, and others (Haider, 2019). Climate change is majorly caused by human activities which primarily involve the release of greenhouse gases to the atmosphere (Eshiemogie et al. 2022). Typically, these gases accumulate in the atmosphere and build up to unacceptable levels capable of threatening human security around the world.

In tropical regions like Nigeria, the impacts of climate change on agriculture especially on soil which serves as the major resource for crop and animal production have not been given the needed attention. Globally, some measures have been taken to curtail the devastating effects of climate change on soil and crop productivity for the achievement of food security. Soil fertility management has been one of the major constraints in tropical soil due to several activities that occur in the soil, such as continuous cropping, leaching, erosion, soil acidity and nutrient uptake which cause depletion of soil organic matter and low crop yield (Iroegbu et al., 2024). The ultisols are the major soils used for the cultivation of crops in tropical regions. The soils are highly weathered, acidic, and susceptible to erosion and generally low in fertility due to low organic matter content and CEC (Uzoho et al., 2014; Juo and Wilding, 1996). The impact of climate change has exacerbated the problem of tropical soil in that climate change results to drought which affects land for agriculture, suppresses decomposition of organic matter and makes the soil susceptible to wind erosion. It leads to loss of fertile lands for crop production, which consequently result to washing away of soil nutrients, affect the activities of microorganisms such as decomposition and mineralization of nutrients.

Higher temperatures have an impact on many agricultural systems since certain plants are vulnerable to them at crucial times like flowering and seed development (Auwal *et al.*, 2018; Tawakalitu *et al.*, 2022). Numerous pests and diseases that affect humans, animals, and crops are susceptible to variations in the climate, particularly in temperature. The Length of Growing Period (LGP) is a significant feature of crop productivity that has been impacted by climate variability. Even though LGP may rise as a result of global warming, higher day and nighttime temperatures may promote the physiological development of crops, resulting in earlier crop maturity and lower agricultural output (Bandyopadhyay, 2013).

Resilience is the ability of a system to absorb, withstand and bounce back after an adverse event. Climate resilience is a fundamental concept of climate risk management. In agricultural context, resilience refers to the ability of an agricultural system to anticipate and prepare for, as well as adapt to, absorb and recover from the impacts of changes in climate and extreme weather. Resilience can be enhanced by implementing short and long-term climate mitigation and adaptation strategies (Izuogu et al., 2021). In the environmental context, it is the collection of policy, infrastructure, services, transportation, energy infrastructure, and planning that position municipalities to resist natural disasters and other dangerous impacts of



climate change (Kahiluoto et al., 2019). Resilience to climate change could also mean preparing for the impacts of climate change and building capacity to recover quickly from those impacts. Climate change resilient practices describe the ability and capacity to foresee and manage the adverse effects of climate through certain actions or approaches.

Following the level of the negative impacts of change in the climate globally especially on tropical soil and crop production, proactive measures for resilient practices must be discovered and adopted globally especially in Nigeria to reduce and overcome the impacts. Numerous existing studies on climate change and agriculture were majorly on effects, mitigation and adaptation strategies which are published more in international journals than local ones. However, studies on climate change resilient practices for soil and crop productivity in the tropics are very few, hence the need for the study.

## **Materials and Methods**

Systematic review was used for the study. The review study was conducted using existing literature through the implementation of a qualitative approach that provided information on agriculture and climate change, adaptation and resilience practices as regards soil and crop productivity in both international and local papers. Secondary sources of information for the study included publications from online open access journals such as Elsevier, Scopus, Research gate, Academia.edu, publications by universities and associations. In order to harness existing and required data for the study, a literature study was conducted with the Preferred Reporting Items for Systematic Reviews and Meta Analysis (PRISMA) approach as was previously used by Hackfort (2021). The statement of inclusion and exclusion criteria was used in determining the eligibility criteria of research articles.

### **Criteria for inclusion and exclusion**

Article inclusion and exclusion criteria were set out in the research using six (6) steps as follows:

- i. The area of knowledge for the article must be related to and focused on agriculture and climate change, adaptation and resilience published internationally and local (Nigeria);
- ii. Articles must be published in English language;
- iii. Articles must have been published between 2014 and 2024, this implied that articles that were published earlier on were excluded;
- iv. Articles must be of empirical data;
- v. All non-peer reviewed articles were excluded;
- vi. Full text must be available;

During the literature search, a total of 55 studies were obtained but our selection criteria gave rise to a final sample of 25 final studies reviewed. Therefore, a total of 25 articles were used for the review study. Of the 25 papers included in the review, 14 were on agriculture and climate change resilience in international and local papers, 8 were on adaptation and resilience in international and local while 3 were on resilient practices for soil and crop in international and national papers.

## **Results**

The results showed that 25 journal papers that met the criteria for inclusion had 14 articles on agriculture and climate change resilience in international and local papers (10 international and 4

local papers), 8 were on adaptation and resilience in international and local articles (6 international and 2 local papers) and 3 on resilient practices for soil and crop in international and national papers (2 international and 1 local papers) (Figures 1 and 2)

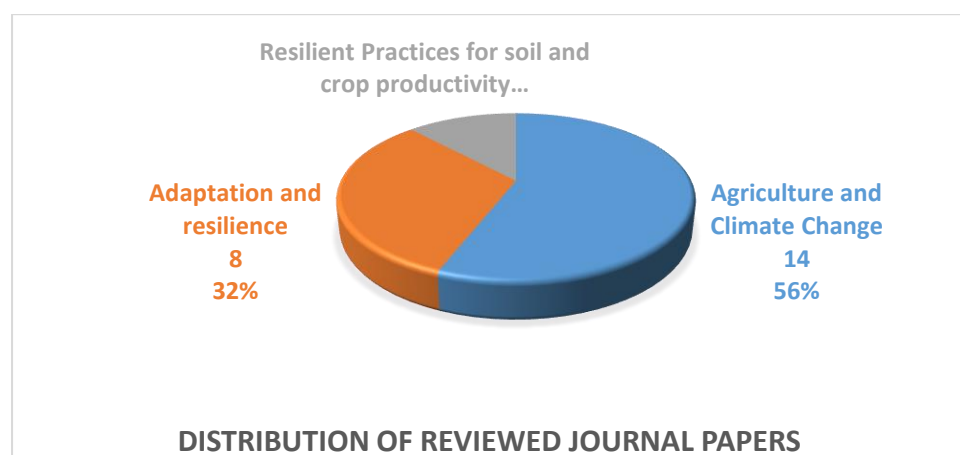


Figure:1

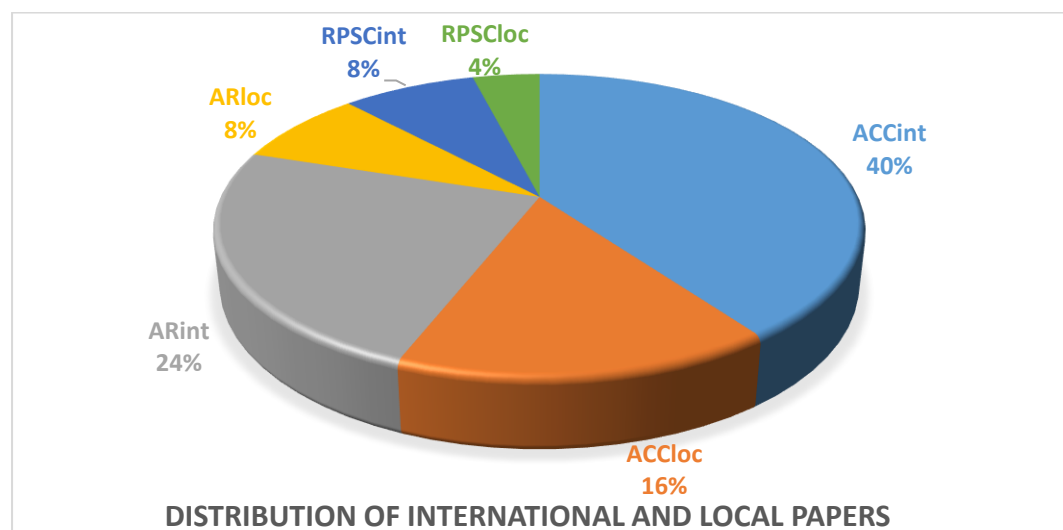


Figure: 2

ACCint = Agriculture and Climate Change in international journal

ACCloc= Agriculture and Climate Change in local journal

ARint = Adaptation and Resilience in international journal

ARloc = Adaptation and Resilience in local journal

RPSC int = Resilience Practices for Soil and Crop productivity in international journal

RPSCloc Resilience Practices for Soil and Crop productivity in local journal

The journal papers used for the review study were distributed according to the area of coverage, the papers that covered the area of agriculture and climate change were 14 (56%), 8 (32%) papers both international and local covered the area of adaptation and resilience whereas 3 (12%) international and local papers covered resilient practices for soil and crop productivity (Figure 1). Figure 2 showed the distribution of the journal papers according to the area of coverage and

location of the publications. 10 journal papers on climate change and agriculture were published internationally which represents 40% of the articles whereas 4 papers representing 16% of the papers on agriculture climate change were published locally. Similarly, 6 journal papers representing 24% and 2 journal papers representing 8% on adaptation and resilience were published internationally and locally respectively. 2 and 1 papers representing 8% and 4% on resilient practices for soil and crop productivity were published internationally and locally (Figure 2)

The observable consequences of climate change according to the journal papers reviewed include variation in temperature regimes, rainfall pattern, agricultural yields, sea level rise, regular occurrence of extreme weather events like heat waves, droughts, heavy intensity rainfall, cyclones, hurricanes, melting of glaciers or ice, forest fire, flooding change in ecosystem function, shifts in species distribution, species extinctions desert encroachment, rise in sea level etc (Magesa *et al.*, 2023). Greenhouse gas emissions according to researchers are expected to increase by 52% by 2050 (CCA, 2021). Events including heat waves, droughts, storms, and floods are causing changes in regional weather patterns. (CCA, 2021). Climate change affects water availability, water is increasingly scarce. 90 percent of fresh water supplies will disappear by 2030 if the current trends continue without mitigation.

Rainfall variability is predicted to grow as a result of climate change on a global scale. Because of the increased atmospheric requirements brought on by the higher temperatures, there will be less rainfall. As this determines the planting season, the evaluated publications also expressed worry regarding abnormalities in the late onset, frequency, and intensity of rainfall. Many farmers said that as a result, they frequently utilize irrigation at the early stage (Chukwunonso, 2015). Numerous farmers conveyed their worries regarding the threat presented by the growing frequency of erosion and flooding, noting that these occurrences have previously carried away their crops and topsoil, diminishing the fertility of the soil. The farmers reported that they had to pay more to apply fertilizer and manure in order to restore soil fertility.

Whilst adaptation is the process of “adjusting to the actual or expected climate and its effects” (GLCA, 2009), resilience is the actual capacity to prepare for these effects, particularly the capacity to ‘bounce back’ from dangerous climate-related events (EU, 2022; Donald, 2011). Practices that increase climate resilience which should be taken into consideration include:

- development of early warning systems to predict and monitor hazardous events including extreme weather events;
- increasing green spaces in urban areas to increase flood absorption capacity;
- planting trees to help manage extreme heat in urban areas
- Providing continuous access to essential services: energy, food, water, shelter, healthcare and transportation
- Sustaining the functionality of modern systems and infrastructure
- Maintaining the livability and comfort of systems which support modern lifestyles
- Supporting populations which may be especially vulnerable – such as low income and aging populations
- Planning land-use system, and infrastructure strategies with the environment and natural forces in mind

- Ensuring safety through improved emergency preparedness and strong communication between relevant agencies and first-responders
- Offering diverse transportation and access options
- Building structures and systems which are sustainable, flexible and durable.

Resilience supports sustainable development and the construction of better, more durable systems. It leads to investment into jobs and infrastructure, meaning that it can provide valuable uplift to economies. Planning communities with resilience in mind enables settlements to better plan, adapt, and thrive in the face of a changing climate. Because of that, ideas around resilience are finding their way into policies and designs by different agencies. And for the regions that are most vulnerable to natural disasters, planning for resilience can prevent displacement, devastating financial losses, and fatalities (Donald, 2011; OECD, 2008; IPCC, 2007)

### **Effect of Climate Change on Soil and Crop Productivity and the Resilient Practices.**

The effect of climate change on soil and crop productivity are discussed below highlighting the effects and the resilient practices to overcome the effects.

**EXTREME HEAT:** i) **Heat tolerant crops crop varieties-** Promote crops and/or crop varieties with a higher heat tolerance and/or optimal heat range. Enhance yields in areas where temperatures are expected to exceed heat thresholds that are harmful to existing cropping systems.

ii) **Short cycle varieties-** Reduce the effect of heat stress at key phenological phases (germination and flowering) and improve final yields. Reduce plants' exposure to heat by shortening the growing cycle. Reduce the total water requirements during the growing season (Alvar-Beltrán et al., 2021; Magesa et al., 2023).

**WILDFIRE:** Use **firebreaks** (e.g. rock walls, roadways, high moisture and low resin plants, flame-retardant plants). This will limit the spread and impact of wildfires on crops, reduce social, environmental, and economic losses deriving from wildfires and decrease air pollution by reducing black carbon emissions.

**STRONG WINDS:** Use **windbreakers-** Trees planted in rows can protect crops by breaking strong winds, reducing soil erosion, increasing crop yields, and protecting livestock from heat and cold conditions.

**EXTREME COLD:** i) Use **plant row covers and mulching-** Soil covering with mulching and/or other materials increases the surface temperature. This is most applicable for small farms (e.g. gardens or small orchards), where other protection methods are unavailable.

ii) **Early warnings from meteorology stations-** Alerts and advisories tailored to farmers' needs forecasting potential cold times support decision-making on damage, while considering farmers' traditional knowledge and management practices as done daily by NIMET (NIMET, 2024).

iii) **Optimizing crop calendars-** Select crop practices based on timing of sensitive stages and critical damage temperature ( $T_c$ ) relative to the probability and risk of sub-zero temperatures. For annual field and row crops, it is important to determine the planting date for minimizing the potential of sub- zero temperatures. Field and row crops can be planted in protected environments and be transplanted to the field after the risk time has passed. For deciduous and subtropical crops, it is important to detect critical temperature thresholds at early growing stages Ogisi and Begho, 2023).

**DROUGHT:** a) **Use of Agroforestry-** Through carbon sequestration, agroforestry has the potential to offset greenhouse gas (GHG) emissions from the agricultural sector. Root systems stabilize the ground and reduce soil erosion. Improves soil health by increasing soil organic matter, nutrient availability and microbial activity. Leaves from trees enrich the soil and help keep soil moisture, contributing to efficient and self-sufficient use of water. Canopy cover reduces evaporation from direct sunlight and by decreasing air and soil surface temperature. Other co-benefits of agroforestry include: sustainable firewood, timber, fodder for animal feeding, and medicinal uses. Fodder trees can also be grown as a substitute or supplement to a basal diet including crop residues (EU, 2021; Magesa et al., 2023).

b) **Through Agronomic practices** (e.g. weeding, harrowing, grafting, mulching) - Weeding and defoliation reduce soil water losses from plant transpiration. Cover crops reduce soil erosion by increasing soil organic matter, water, air, and nutrient availability. Harrowing (breaking the soil into small fragments) can prevent the loss of land moisture by evaporation. Grafting techniques can reduce yield losses caused by drought. Covering the soil with crop residues (mulching) in combination with no-tillage reduces the exposure of crops to heat-stress conditions. It also increases soil moisture by reducing direct soil evaporation (Onyeneke et al., 2019).

c) **By Precised fertilizer and water application-** Improve the efficiency of fertilizers by adding the required amount of nutrients to a planting hole instead of spreading them over the entire field area. Reduce soil erosion, increase macronutrient deposition and infiltration by reducing surface runoff. Increase water infiltration rates as water is trapped in the pits close to the root systems of crops. Protect the main stem and branching system of crops by reducing the area exposed to strong winds (Castells-Quintana et al., 2018).

d) **Use of Terracing-** Reduces soil erosion, increases macronutrient deposition and infiltration by reducing surface runoff.

e) **Drought tolerant crops** (e.g. millet, sorghum, etc.)- Crops with low water requirements reduce evapotranspiration losses during photosynthesis by rapidly closing their stomata and maintaining leaf water potential and photosynthetic rate. Enhance food production during the dry season when food insecurity levels are highest (Lal, 2021).

f) **Drip irrigation systems-** Increase water-use efficiency by providing sufficient water according to the crop. Partial-root zone drying (PRD) maximizes water use efficiency by adding water only on half of the root zone. Reduce soil erosion and macronutrient losses from leaching. Promote weed control as water is locally applied. Reduce the risk of diseases that occur under damp conditions.

g) **Programmed irrigation-** Uses water resources more efficiently and avoids permanent wilting point as well as field capacity. Reduces losses from direct evaporation by providing water when evaporation rates are lowest (dawn and/or dusk). Promoting irrigation at dawn and dusk reduces direct soil evaporation, making better use of water resources.

h) **Small scale reservoirs/Rain water harvesting-** Increase water availability to counteract the impacts of drought shocks. Provide supplemental irrigation on rainfed fields.

i) **Reuse of treated waste water, desalinated water-** Brings additional nutrients to the plants and enhances yields. Increases water use efficiency and promotes sustainable withdrawal and supply of freshwater to address water scarcity.

**FLOODING AND WATERLOGGING:** i) **Raised bed system-** Removes excess water during plant growth by better draining the water retained in the soil. Promotes optimal growth of root

systems through soil aeration. Improves soil structure by limiting the compaction from human feet.

**ii) Field dredging-** Removes excess water during plant growth, reduces soil erosion and prevents the development of fungal diseases. Efficient drainage systems control excess soil water and accumulation of excess salts in the crop's root zone. Decreases the prevalence of important water-related diseases that affect human, plant and animal health. Organic matter applications improve soil structure and avoid soil compaction (Magesa *et al.*, 2023).

**iii) Agronomic practice** (e.g. sub-soiling) - Sub-soiling can break possible hard pans and improve soil aeration. Introduction of root crops for deep root penetration and soil structure improvement.

**LAND DEGRADATION AND GREENHOUSE GAS EMISSIONS: a) Early sowing, vigorous, and strong root crops-** Reduce the impacts of excess water at early growing stages. Cultivars with a higher geotropic root angle (roots that develop horizontally) exploit a soil zone that is less saturated with water.

**b) Use of Legumes** (e.g. groundnuts, soybean and cowpea) - Fix nitrogen in the soil and allow the plant to produce leaves fortified with nitrogen that can be recycled by the plant. This allows the plant to increase its photosynthetic capacity, which in turn results in nitrogen-rich seeds. Increase organic matter in the soil by storing carbon. Green manure increases organic matter content, nitrogen content and soil water retention (Orji and Iroegbu, 2019).

**c) Crop rotation, crop association and fallow-** Increase soil fertility as each crop has different nutrient requirements and plant-soil dynamics. Increase crop yields with the diverse nutrient availability. Reduce soil erosion and prevent nutrients from being washed away by wind or water (through an increase in crop cover). Limit concentration of pests and diseases and lower selective pressure on pathogens (as each crop has different pathogens). Reduce fertilizer use and associated pollution by improving nutrient cycling. Increase soil carbon sequestration (Iroegbu *et al.*, 2024).

**d) Grass strips-** Reduce soil erosion and nutrient losses in steep areas. Increase water infiltration by reducing surface runoff.

**e) Mulching-** Increases soil moisture by reducing losses from direct evaporation. Reduces weed growth by keeping light from reaching the soil surface. Moderates soil temperatures by keeping the soil warmer during cold nights and cooler in hot days. Reduces irrigation requirements by reducing losses from direct evaporation.

**f) Minimum tillage or zero-tillage-** Promotes minimum disturbance of soil structure and organic matter found in the soil by increasing the decomposition of plants in-situ. Higher infiltration caused by the vegetation present in the soil. Organic matter increases and enhances the cycling of nutrients. Less resistance to root growth due to improved structure, allowing crops to germinate and develop faster with additional soil moisture. Reduces soil evaporation as plant residues increase soil moisture.

**g) Crop residues in combination with reduced and no-tillage-** Increase water availability for crop production by improving infiltration and evaporation from the top layer and improving soil structure and moisture. Increase soil organic matter content and microbial activity present in the soil. Reduce soil evaporation as plant residues increase soil moisture (Onyenekwe *et al.*, 2019).

**h) Bio-fertilizers-** Application of living organisms to seeds, plant surfaces and/or soil. Reduce the environmental impacts (from volatilization and leaching) from chemical fertilizers which have a high macronutrient concentration. Improve nutrient availability for plants and increase yields (Iroegbu *et al.*, 2024).



**i) Split fertilization-** Reduces fertilizer use and avoids leaching and volatilization. Increases uptake efficiency by crops. Reduces risk of ground and surface contamination.

**Wetting/Drying rice-** Reduces rice water requirements by 30 percent. Reduces CH<sub>4</sub> emissions by 48 percent. Reduces weed development by reducing water inputs necessary for the expansion of weeds.

**Carbon fixation in C3, C4, and CAM plants-** Elevated CO<sub>2</sub> can increase biomass production and the physiological efficiency of water use by crops and weeds. C3 plants (e.g. wheat and rice) tend to benefit more (in terms of seed yield and biomass) from high CO<sub>2</sub> concentrations than C4 plants (e.g. maize) (Alvar-Beltrán et al., 2021).

**Machine transplanting-** Seedlings are nursed 12-15 days in advance (e.g. rice). Reduces cultivation time and improves water use efficiency.

**Direct seeding into crop residues:** Direct seeders can accurately place seeds through crop residues without any tillage, therefore keeping the soil structure intact, and increasing the soil organic matter content.

**Site-specific nutrient management-** Provides economic benefits for farmers from lower input costs (fertilizers) and yield enhancements. Reduces GHG emissions (N<sub>2</sub>O) through a more efficient use of nitrogen.

**Remote and proximal optical sensors** (e.g. Green Seeker and SPAD-502, Canopeo App.)- Optimize crop nitrogen inputs and reduce farming inputs. Reduce environmental impacts (deriving from volatilization and leaching) by optimizing fertilization rates and timing of application. Crop yields and biomass can be estimated during the growing season (e.g. rice).

**SALINIZATION: i) Primary salinization management (from saline water) -** Promotion of halophyte crops. Monitoring: quality of water during drilling to avoid excessive salinity. Form a straw barrier to reduce salt content in the cultivated layer by burying chopped straw approximately 30-40 cm deep in saline-alkali soil with the use of special machinery. This technique has significant salt control and salt suppression effects and increases water storage and moisture retention. It can also improve soil structure, enhance soil fertility, and promote microbial activity.

**ii) Secondary salinization management (from intensive agriculture)-** Promotion of halophyte crops and soil-less cultivation. Use of saline resistant varieties and grafting techniques in traditional crops. Water supply should include the leaching fraction (LF) for washing away salts from the root zone due to secondary salinization. Seed bed management and field grading to minimize local accumulations of salts. Proper maintenance of irrigation systems and better tuning of irrigation scheduling (Alvar-Beltrán et al., 2021).

**PESTS AND DISEASES: a) Biological control-** Natural enemies (insects) are introduced in the environment and can sustain themselves by feeding from pests affecting the crop. Use beneficial entomopathogens to reduce the need for chemical pesticides. Reduces the need for chemical fertilizers, as well as herbicides and pesticides.

**b) Crop rotations-** Limit concentration of pests and diseases and lowers selective pressure of pathogens (as each crop has different pathogens).

**c) Bio-pesticides** (e.g. Neem oil-based insecticide for hornworms, mildews): Can be used as a fungicide and pesticide. Reduce the environmental impacts as they are organic and biodegradable. Do not create “death zones” that can kill beneficial insects. Reduce the negative effect on human health associated with chemical pesticides.

d) **Pheromone traps**- Pheromone traps lure pests by mimicking potential mates.

**Integrated Pest Management (IPM)**- Sampling, scouting and monitoring systems for a proper early identification of pests. Plant quarantine and ‘cultural techniques’ e.g., removal of diseased plants, and cleaning pruning shears to prevent spread of infection. Association with other plants that deter insects, e.g. lemon grass, can reduce pests on leafy vegetables, e.g. relay inter-cropping of tomatoes and cabbage. Beneficial fungi and bacteria are added to horticultural crops vulnerable to root diseases. Management of unacceptable level of infestation through mechanical methods such as handpicking, barriers, traps, vacuuming and tillage can disrupt pest breeding. Resistant crop varieties and grafting to suppress insect pest management. The use of anti-insect nets limits the spread of pests. Removal of weeds that are host of pest and diseases. Cultural practices such as pruning, trellising, monitoring sticky traps, planting density (Alvar-Beltrán et al., 2021).

### **Conclusion and Recommendation**

The review study has shown that climate change and its obvious effects are commonly felt in agriculture throughout the world especially among farmers from the tropical regions. Soil which is the treasure base of agriculture and crop production are seriously affected making it very difficult to overcome food insecurity. Climate change brought about decrease in soil fertility, loss of soil biodiversity, erosion, leaching, flooding, salinization, irregular temperature regime, drought, soil degradation, emission of greenhouse gases (GHGs), pests and diseases etc which directly militate against soil health and crop production. Though there are several mitigation and adaptation strategies by farmers, the need to adopt the resilient practices such as integrated pest management, use of crop rotation, cover cropping, mulching, agroforestry, rainfall harvesting, new crop varieties, etc as discussed above is very crucial for the achievement of food security. Therefore, the study recommends continuous study for more resilient practices for agricultural production beyond soil and crop since the effect of climate change has continued to hinder food production and the outcome of the research be published more in local journals. The study further recommend that government through her different agencies and non-governmental organization should help in disseminating the outcome of research on resilient practices to the rural farmers using different languages in order to promote food security.

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# **THE ROLE OF AI IN ENHANCING CUSTOMER EXPERIENCE AND ITS EFFECT ON FINANCIAL PERFORMANCE METRICS IN NIGERIA**

**Dr. Owa FREDERICK <sup>1</sup>, BENJAMIN, Ubokobong Effiong <sup>2</sup>, & Dr. Monday Olade IZEVBEKHAI <sup>3</sup>**

<sup>1</sup> Delta State Polytechnic, Ogwashi-Uku

<sup>2</sup> Department of Computer Science, Akwa Ibom State Polytechnic, Ikot Osurua, Ikot Ekpene, Nigeria

<sup>3</sup> Accountancy Department, Auchi Polytechnic, Auchi

**Emails: chukwumenimefred@yahoo.com <sup>1</sup>; benjaminubokobong52@gmail.com <sup>2</sup>; mondayizevbekhai75@gmail.com <sup>3</sup>**

## **ABSTRACT**

*This study examines the role of AI-driven marketing in enhancing customer experience and its subsequent impact on financial performance metrics in Nigerian SMEs. Using Structural Equation Modeling (SEM), the study analyzes the relationships between AI-driven marketing, customer engagement, customer satisfaction, data-driven decision-making, and sustainable financial performance. A structured questionnaire was distributed to 260 SMEs across four key industries—retail, financial services, technology, and manufacturing—resulting in 250 valid responses. The results confirm that AI-driven marketing significantly enhances customer engagement and satisfaction, which in turn positively influences financial performance. Additionally, data-driven decision-making mediates the relationship between AI adoption and sustainable financial performance, emphasizing the importance of AI-enabled analytics in business strategy. Factor analysis, validity tests, and reliability tests confirm the robustness of the measurement model, while model fitness assessments demonstrate a strong model fit. The findings highlight AI's transformative potential in optimizing customer interactions and driving financial growth among Nigerian SMEs. However, successful AI adoption requires strategic implementation and managerial commitment. Despite these insights, the study acknowledges its limitations, including the cross-sectional research design and the focus on Nigerian SMEs, which may limit generalizability. Future research should explore AI adoption across diverse economic contexts and consider a longitudinal approach to capture long-term impacts. Overall, this study provides empirical evidence that AI-driven marketing is a critical enabler of enhanced customer experience and improved financial sustainability in SMEs, reinforcing the need for businesses to integrate AI into their marketing and decision-making processes.*

**KEYWORDS:** AI-driven marketing, customer engagement, financial performance, data-driven decision-making, SMEs, Nigeria, Structural Equation Modeling (SEM).



## 1. Introduction

Artificial Intelligence (AI) emerges as a transformative force across multiple industries, including business (Bharadiya, 2023), finance (Goodell, Kumar, Lim et al., 2021), and healthcare (Ellahham, Ellahham & Simsekler, 2020). Within the domain of business management, AI is increasingly being integrated into marketing strategies to optimize operations and enhance competitiveness. This is particularly relevant for Small and Medium Enterprises (SMEs), which constitute a vital component of the economic environment in emerging economies such as Nigeria. SMEs in Nigeria are exploring AI-driven marketing solutions to enhance customer experience, drive business growth, and improve financial performance. The integration of AI in marketing offers a strategic advantage by enabling automation, enhancing customer engagement, refining decision-making through machine learning algorithms, and leveraging data analytics to optimize marketing initiatives (Allioui, Mourdi, Allioui & Mourdi, 2023; Yaiprasert & Hidayanto, 2023). These technological advancements hold the potential to significantly improve Sustainable Financial Performance (SFP), making AI a crucial element in the success of modern SMEs.

Despite these benefits, SMEs in Nigeria face a unique set of challenges, including limited resources, difficulty in scaling operations, intense competition, and the need for efficient customer relationship management. The ability to predict financial performance and market sustainability through AI-driven models is becoming increasingly important (Naradda Gamage, Ekanayake, Abeyrathne et al., 2020; Tolstoy, Nordman & Vu, 2022). While existing research has largely focused on AI-driven ensemble machine learning techniques (Yaiprasert & Hidayanto, 2023) and emerging AI trends (Bharadiya, 2023), there remains a significant gap in understanding how AI, specifically through enhancing customer experience, impacts financial performance metrics in Nigerian SMEs.

This study introduces an innovative framework designed to assess the role of AI in enhancing customer experience and its subsequent impact on financial performance in SMEs. Customer experience, which encompasses engagement, satisfaction, and data-driven decision-making, plays a crucial mediating role in determining the success of AI-driven marketing initiatives (Satar, Alharthi, Asad et al., 2024). Leveraging these AI-powered solutions, SMEs can improve operational efficiency, financial stability, and their ability to navigate market uncertainties (Ta'Amnha, Al-Qudah, Asad et al., 2024). However, the existing literature lacks a comprehensive analysis of the interconnectedness between AI adoption, customer-focused strategies, and financial performance in the Nigerian SME sector. More specifically, the impact of marketing AI on customer engagement, customer satisfaction, and data-driven decision-making, and how these elements collectively contribute to Sustainable Financial Performance, remains underexplored.

This study aims to bridge this empirical gap by examining how AI-driven marketing initiatives enhance customer experience and, in turn, influence financial performance metrics such as profitability, cost efficiency, and market share within Nigerian SMEs. The research underscores that the perceived ease of use and benefits of AI technology are not isolated factors; rather, they are significantly influenced by customer engagement, satisfaction, and the effectiveness of data-driven decision-making processes. Unlike previous studies that primarily examined AI's direct effects or its impact on large enterprises, this study takes a multidimensional approach by evaluating the indirect pathways through which AI affects SME performance.

To achieve these objectives, the study will employ Structural Equation Modeling (SEM), providing an in-depth analysis of the complex relationships between AI adoption, customer experience, and financial performance metrics. This methodological approach offers a robust



framework for assessing how AI-driven marketing strategies can foster long-term financial sustainability for SMEs.

By doing so, this research makes a significant theoretical and practical contribution to the existing literature on technology adoption and business performance. Theoretically, it expands the discourse on how AI facilitates customer experience improvements and financial sustainability. Practically, it provides SMEs in Nigeria with actionable insights into leveraging AI for enhanced marketing effectiveness and competitive advantage. This study, therefore, aims to answer the following key questions:

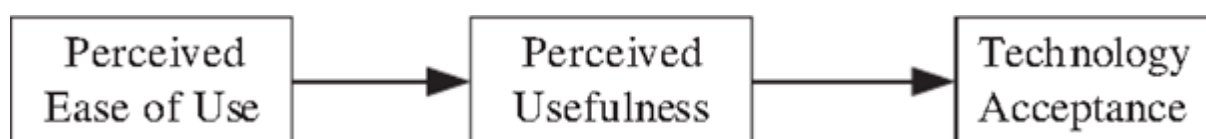
1. How does AI-driven marketing enhance customer engagement in Nigerian SMEs?
2. What is the impact of customer satisfaction on financial performance in AI-driven marketing strategies?
3. How does data-driven decision-making mediate the relationship between AI adoption and Sustainable Financial Performance in Nigerian SMEs?

Ultimately, this research will provide empirical evidence on the effectiveness of AI in enhancing customer experience and its subsequent impact on financial performance, thereby offering a valuable framework for SMEs in Nigeria looking to integrate AI into their marketing and operational strategies.

## 2. Literature Review

### 2.1 Theoretical Framework

Recognizing that the perceived benefits and ease of use of AI significantly contribute to improved performance, it is essential to consider the Technology Acceptance Model (TAM) developed by Fred D. Davis in 1986 as a fundamental theoretical underpinning for this study. The TAM provides a valuable lens through which to understand how SMEs in Nigeria adopt and integrate AI-driven marketing strategies to enhance customer experience and financial performance. According to TAM, the motivation to adopt new technology is influenced by three key constructs: perceived ease of use (PEU), perceived usefulness (PU), and attitude toward adopting AI-driven marketing solutions. Both PEU and PU are critical belief factors that shape user attitudes, with PEU directly impacting PU (Figure 1 shows the validated TAM) (Ma & Liu, 2005; Hariri & Roberts, 2015; Hossain, Tiwari, Saha et al., 2024). In the context of Nigerian SMEs, perceived usefulness refers to their perception of AI's ability to enhance customer engagement, personalize marketing campaigns, and drive financial growth. Perceived ease of use, on the other hand, reflects SMEs' views on AI's intuitiveness, accessibility, and seamless integration into existing marketing frameworks. Understanding the relationship between these dimensions is crucial in evaluating how AI-driven marketing contributes to Sustainable Financial Performance in Nigerian SMEs. To further explore these relationships, the next section examines the impact of AI in marketing on customer engagement, satisfaction, and data-driven decision-making, assessing their collective influence on financial performance metrics in Nigerian SMEs.



**Figure 1: The validated TAM Model**

The TAM is highly relevant to this study as it provides a structured approach to understanding how Nigerian SMEs adopt and utilize AI to enhance customer experience and drive financial

performance. Given that SMEs often face challenges such as limited technological expertise, financial constraints, and competitive pressures, the TAM helps in analyzing the key factors influencing AI adoption. Furthermore, applying TAM allows for an in-depth exploration of how AI adoption translates into improved customer engagement, satisfaction, and data-driven decision-making—factors that ultimately contribute to financial sustainability. This framework also informs strategic recommendations on how Nigerian SMEs can leverage AI to maximize business outcomes and gain a competitive edge in the digital economy. Thus, the TAM not only aids in understanding the adoption dynamics of AI but also serves as a guiding principle for assessing its impact on customer experience and financial performance in Nigerian SMEs.

## **2.2 Artificial Intelligence**

Scholars from diverse disciplines have conceptualized and interpreted Artificial Intelligence (AI) from varying perspectives. Within the field of media and communication, Zúñiga, Goyanes, and Durotoye (2023) define AI as the capacity of non-human machines or artificial entities to execute tasks, solve problems, communicate, engage, and apply logical reasoning akin to human cognition. They further argue that AI's existence is not solely dependent on human intelligence but rather on two key operational dimensions: performance level and autonomy level. In the field of computer science and information technology, Sundar (2020) describes AI as a subfield dedicated to developing computer programs capable of executing tasks that traditionally require human intelligence. Vergeer (2020) further explains that AI algorithms are designed to perform learning, perception, problem-solving, language processing, and logical reasoning. Additionally, scholars in Information Technology have characterized AI as a segment of computer science focused on constructing intelligent systems that can analyze, interpret, and respond dynamically to various inputs. Oyeniyi, Ugochukwu, and Mhlongo (2024) highlight AI as a transformative driver across multiple industries, with significant innovations witnessed in the financial sector. The adoption of AI in banking exemplifies a strategic shift aimed at optimizing operational efficiency, improving customer experiences, and fostering financial growth.

## **2.3 Impact of AI-Driven Marketing on Customer Engagement**

The field of AI-driven marketing remains a crucial area of academic inquiry, necessitating further exploration. As research on this subject continues to expand, it is imperative to investigate the effects of AI on key organizational factors such as customer engagement, satisfaction, and data-driven decision-making. While existing studies provide insights into these relationships, there remains a notable research gap in integrating these variables into a comprehensive framework applicable to SMEs in Nigeria. Prior research (Prentice, Weaven & Wong, 2020; Siswanti, Riyadh, Nawangsari et al., 2024) has identified a link between AI quality, performance, and customer engagement, influenced by AI preference as a moderating variable. However, the mediating roles of customer engagement, satisfaction, and data-driven decision-making in this relationship remain underexplored, particularly within Nigerian SMEs (Asif, Asad, Kashif et al., 2021; Kanaan, Alsoud, Asad et al., 2024). While studies on this subject have been conducted in regions such as Ghana (Abrokwah-Larbi & Awuku-Larbi, 2024) and countries including the United States and South Korea (Lee & Park, 2022), much of the existing research has focused on banking and financial services (Siew, Wai & Hoe, 2017).

AI-driven decision-making has been found to positively influence financial institution operations (Tanguturi & Muley, 2023), reinforcing the importance of data-driven decision analysis in financial management. Siew, Wai, and Hoe (2017) previously employed a goal programming model to demonstrate the significance of data analytics in bank financial operations. These findings underscore the necessity of refining AI-driven decision-making processes to address challenges such as inadequate technical expertise, limited infrastructure, and a lack of AI

awareness among SMEs (Baabdullah, Alalwan, Slade et al., 2021). Enhancing AI adoption in marketing can improve performance and enable Nigerian SMEs to navigate the competitive business landscape more effectively.

A key concern in the current literature is the lack of clarity regarding the mediating factors between AI adoption and Sustainable Financial Performance, as research in this domain continues to evolve. For instance, Gao, Li, Tsai et al. (2023) identified a positive link between AI-driven stimuli, customer engagement, and value co-creation, with customer readiness playing a moderating role. Similarly, Alhosani and Safian (2024) highlighted the mediating role of AI adoption in the relationship between innovation and organizational performance (Asad, Aledeinat, Majali et al., 2024). Thus, the primary objective of this study is to illuminate these relationships, offering strategic insights to Nigerian SMEs on optimizing AI-driven marketing for enhanced customer engagement and financial performance. To address this knowledge gap, this research draws from prior studies demonstrating a positive correlation between AI-driven marketing, customer engagement, satisfaction, and data-driven decision-making. Consequently, the following hypothesis is proposed:

Hypothesis 1: AI-driven marketing positively influences customer engagement in Nigerian SMEs.

#### **2.4 Impact of AI-Driven Marketing Strategies on Customer Satisfaction and Financial Performance**

While the relationship between customer satisfaction and financial performance has been extensively examined in academic research, conflicting perspectives and a lack of contextual clarity remain key challenges. For instance, Lee and Park (2022) found that customer engagement on social media platforms does not directly impact financial performance (Asad, Aledeinat, Majali et al., 2024). Instead, it exerts an indirect positive effect through the mediation of brand equity, with variations observed between the United States and South Korea. Similarly, Ta'Amnha, Al-Qudah, Asad et al. (2024) highlighted that the relationship between data-driven decision-making and financial performance extends beyond traditional indicators, incorporating metrics such as asset utilization, return on equity, and market value. Using instrumental variable methods, their findings suggested that the impact of data-driven decision-making on productivity is unlikely to be influenced by reverse causality. Adding to these insights, Oyewobi, Windapo, and Rotimi (2016) established a direct relationship between decision-making styles and organizational performance within the construction industry. However, SMEs operate in a unique context marked by resource limitations, insufficient technical expertise, inadequate infrastructure, and a lack of AI awareness (Baabdullah, Alalwan, Slade et al., 2021). Given these constraints, validating such findings empirically is crucial to understanding their relevance, scope, and implications for SMEs in Nigeria. Building upon Chi and Gursoy's (2019) findings, which identified a direct relationship between customer satisfaction and financial performance, Otto, Szymanski, and Varadarajan (2020) also emphasized the role of customer satisfaction in enhancing profitability. These empirical foundations suggest that integrating AI-driven marketing can enhance customer satisfaction, ultimately leading to improved financial performance for Nigerian SMEs. Based on these insights, the following hypothesis is proposed:

Hypothesis 2: Customer satisfaction positively influences financial performance in AI-driven marketing strategies among Nigerian SMEs.

## **2.5 Data-Driven Decisions as Mediators to AI Adoption and Sustainable Financial Performance in Nigerian SMEs**

Building upon the reviewed insights, it is crucial to acknowledge that AI-driven marketing does not function in isolation; rather, it is integrated into specific business activities to drive improved organizational outcomes (Asad, Aledeinat, Majali et al., 2024; Siswanti, Riyadh, Nawangsari et al., 2024). This study argues that the perceived ease of use and benefits of AI technology are not independent factors but are significantly shaped by user engagement, customer satisfaction, and the effectiveness of data-driven decision-making. To fully unlock the potential of AI-driven marketing for sustainable growth, competitive advantage, and long-term business success, SMEs must understand and strategically leverage these mediators.

In the context of AI-driven marketing, advanced analytics, personalized recommendations, and interactive communication platforms enable Nigerian SMEs to engage customers more effectively. Increased customer engagement fosters brand loyalty, repeat purchases, and positive word-of-mouth marketing, all of which contribute to enhanced financial performance. Additionally, marketing AI tools analyze customer feedback, preferences, and behavioral data to tailor products and services, ultimately improving customer satisfaction. Supporting this claim, Liestyanti and Prawiraatmadja (2021), drawing on Parasuraman's SERVQUAL framework, asserted that satisfied customers are more likely to become loyal advocates, leading to higher sales and profitability for SMEs. However, despite these empirical observations, the role of data-driven decision-making as a mediator in the AI-financial performance relationship has largely been overlooked in academic debates.

Although previous research has explored the impact of decision-making on organizational performance, studies that recognize its mediating effect remain limited (Oyewobi et al., 2016). Most attempts to analyze decision-making influences have focused on managerial decision-making (Samson & Bhanugopan, 2022) rather than AI-driven analytics. In this regard, our study introduces a novel perspective by emphasizing the role of data-driven decision-making in mediating AI's impact on financial performance. Since data-driven decision-making entails utilizing analytics and insights to inform strategic business choices (Elgendy, Elragal & Päivärinta, 2022), AI-driven marketing equips SMEs with the ability to collect, analyze, and interpret vast amounts of customer data in real time. Hence, leveraging AI-powered analytics, SMEs can make informed marketing decisions, optimize campaigns, allocate resources efficiently, and identify new growth opportunities—ultimately enhancing their financial performance. Based on these insights, the following hypothesis is proposed:

Hypothesis 3: Data-driven decision-making mediates the relationship between AI adoption and Sustainable Financial Performance in Nigerian SMEs.

## **2.6 Gap in Knowledge**

Despite the growing body of research on AI adoption in business, there remains a significant gap in understanding how AI-driven marketing enhances customer experience and its impact on financial performance in Nigerian SMEs. While studies have examined AI's direct influence on business operations, much of the existing literature has focused on developed economies or large enterprises, leaving SMEs in emerging markets underexplored (Yaiprasert & Hidayanto, 2023; Bharadiya, 2023). Moreover, research on AI in marketing has predominantly centered on automation and efficiency improvements, neglecting the nuanced ways AI fosters customer engagement, satisfaction, and data-driven decision-making—factors that collectively shape financial sustainability (Satar, Alharthi, Asad et al., 2024).

Another critical gap is the limited exploration of data-driven decision-making as a mediator between AI adoption and Sustainable Financial Performance. Previous research has acknowledged the importance of decision-making in organizational success (Oyewobi et al., 2016; Samson & Bhanugopan, 2022), but few studies have investigated how AI-powered analytics influence financial metrics through enhanced marketing strategies in SMEs. Furthermore, while studies on customer experience often highlight its significance in brand loyalty and consumer behavior (Liestyanti & Prawiraatmadja, 2021), they rarely integrate AI-driven insights to measure its financial impact.

Given these gaps, this study seeks to provide a comprehensive analysis of AI's role in improving customer experience and its effect on financial performance metrics in Nigerian SMEs. Thus, addressing these overlooked dimensions, this research contributes new insights to the discourse on AI adoption, customer-centric strategies, and financial sustainability in emerging markets.

### **3. Methodology**

#### **3.1. Approach**

Given the increasing significance of AI-driven marketing and the well-established methodologies for analyzing structural relationships, this study adopts Structural Equation Modeling (SEM). SEM is instrumental in evaluating complex interactions among AI-driven marketing, customer engagement, customer satisfaction, data-driven decision-making, and Sustainable Financial Performance. Prior studies highlight its efficacy in assessing theoretical frameworks, mediating effects, and model adequacy (Ferreira, Zambaldi & de Sousa Guerra, 2020; Ringle, Sarstedt, Sinkovics et al., 2023; Kline, 2023). This study employs SEM to examine the mediating influence of data-driven decision-making on the relationship between AI adoption and Sustainable Financial Performance in Nigerian SMEs. Additionally, factor analysis was conducted to assess the reliability of constructs, considering a minimum factor loading threshold of 0.7. Smart PLS software was utilized for the analysis. To ensure a representative sample of Nigerian SMEs across key sectors—retail, financial services, technology, and manufacturing—cluster sampling was employed. Each sector received an equal distribution of 65 questionnaires, ensuring balanced representation and minimizing sectoral bias. This approach enhances the study's ability to generalize findings across diverse business contexts.

#### **3.2. Population and Sampling Procedures**

This study targeted SMEs in Nigeria, recognizing the diversity in business environments, regulatory frameworks, and market dynamics. The selection of four key industries—retail, financial services, technology, and manufacturing—was based on their substantial contributions to Nigeria's economy and their varying customer interaction levels. Retail and financial services involve high consumer engagement, while technology and manufacturing provide insights into B2B operations and AI-driven decision-making. A total of 260 SMEs was selected, with 65 questionnaires allocated per industry. The respondents comprised marketing and financial managers, as their roles are pivotal in assessing AI's impact on customer engagement and financial performance. Of the 250 responses collected, 155 were female and 95 were male managers, as detailed in Table 3.1. Descriptive statistics indicate that AI-driven marketing significantly influences customer engagement and satisfaction, with mean scores of 3.16 and 3.02, respectively.



**Table 3.1: Description of the Study Participants**

Table 5.1: Description of the Study Participants					
Variable	Category	Frequency	Percentage (%)		
Gender	Male	95	38%		
	Female	155	62%		
Age Group	18-25 years	45	18%		
	26-35 years	80	32%		
	36-45 years	75	30%		
	46+ years	50	20%		
Educational Level	Diploma	40	16%		
	Bachelor's Degree	130	52%		
	Master's Degree	70	28%		
	PhD	10	4%		
Job Position	Marketing Manager	110	44%		
	Finance Manager	80	32%		
	Business Analyst	30	12%		
	Other	30	12%		
Experience	1-5 years	85	34%		
	6-10 years	90	36%		
	11+ years	75	30%		
Industry	Textiles	65	26%		
	Food Processing	65	26%		
	Chemicals	55	22%		
	Construction	65	26%		
	Materials	65	26%		
	Marketing AI	Customer Engagement	Customer Satisfaction	Data-Driven Decision-Making	Sustainable Financial Performance
Mean	3.052	3.136	3.020	3.048	3.132
Std. Dev.	1.412	1.441	1.401	1.416	1.435

The descriptive statistics suggest that respondents generally perceive AI-driven marketing, customer engagement, and data-driven decision-making as moderately effective, with some variability in responses. For instance, with a mean score of 3.136, respondents generally perceive customer engagement as effective. However, the relatively high standard deviation of 1.441 suggests that there is more variability in responses, indicating a wider range of perceptions regarding customer engagement. The mean score of 3.020 reflects a high level of customer satisfaction among respondents. The low standard deviation of 1.401 indicates that there is little variability in responses, suggesting a consistent perception of customer satisfaction.

### 3.3. Model Tests

To ensure the reliability and validity of the SEM model, Cronbach's alpha and composite reliability tests were conducted, with an acceptance threshold of 0.70 (Ringle et al., 2023; Kline, 2023). Discriminant and convergent validity were assessed using the Heterotrait–Monotrait Ratio of Correlations (HTMT) and Average Variance Extracted (AVE), requiring diagonal values below 0.90 and AVE scores above 0.50. Model fitness was evaluated using the Standardized Root Mean Square Residual (SRMR), with a threshold of 0.08, alongside the chi-square test and Normed Fit Index (NFI) exceeding 0.95. These assessments ensure the robustness of the findings.



### 3.4. Data Collection and Variable Description

This study investigates how AI-driven marketing enhances customer engagement and financial performance in Nigerian SMEs, emphasizing mediating factors such as data-driven decision-making. To measure key variables, validated scales from previous studies were adapted: customer engagement from Ferreira et al. (2020), customer satisfaction from Zouari and Abdelhedi (2021), and Sustainable Financial Performance from Chi & Gursoy (2019) and Otto et al. (2020). The Marketing AI scale was based on Liestyanti & Prawiraatmadja (2021) and aligned with the Technology Acceptance Model (TAM). Marketing AI was measured using six Likert-scale questions (1-Strongly Disagree to 5-Strongly Agree), covering campaign efficiency, audience segmentation, and predictive analytics. Data-driven decision-making, a novel construct incorporating digital analytics, was measured with eight items, adapting Bag, Gupta, Kumar et al. (2021) and Garad, Riyadh, Al-Ansi et al. (2024). Sustainable Financial Performance was assessed using five financial metrics—revenue growth, ROI, cost efficiency, market share, and profitability—across ten Likert-scale questions. This study's approach ensures comprehensive insights into AI's role in enhancing customer experience and financial performance within Nigerian SMEs.

## 4. Results

### 4.1. Factor Analysis

The factor analysis results confirm the reliability and validity of the constructs used in this study. Each construct has a factor loading above the recommended threshold of 0.70, indicating strong item reliability. Marketing AI (MAI) exhibits factor loadings ranging from 0.791 to 0.842, showing its robustness in measuring AI-driven marketing efficiency. Customer Engagement (CE) and Customer Satisfaction (CS) also demonstrate high factor loadings, confirming their effectiveness in capturing engagement and satisfaction levels.

**Table 2: Factor Analysis Results**

Variable	Instruments	Factor Loadings	Outer Weights (Sig.)	VIF
<b>Marketing AI</b>	MAI1	0.812	0.000	1.56
	MAI2	0.798	0.002	1.43
	MAI3	0.842	0.001	1.67
	MAI4	0.791	0.003	1.38
	MAI5	0.823	0.000	1.52
	MAI6	0.805	0.002	1.49
<b>Customer Engagement</b>	CE1	0.872	0.000	1.71
	CE2	0.841	0.001	1.62
	CE3	0.815	0.003	1.58
	CE4	0.802	0.002	1.51
	CE5	0.821	0.000	1.54
<b>Customer Satisfaction</b>	CS1	0.845	0.000	1.69
	CS2	0.821	0.001	1.61
	CS3	0.837	0.002	1.64
	CS4	0.799	0.003	1.48
	CS5	0.812	0.001	1.52
<b>Data-Driven Decision-Making</b>	DDDM1	0.857	0.000	1.74
	DDDM2	0.836	0.001	1.66
	DDDM3	0.821	0.003	1.59
	DDDM4	0.814	0.002	1.57

	DDDM5	0.823	0.001	1.61
	DDDM6	0.810	0.002	1.54
<b>Financial Performance</b>	FP1	0.873	0.000	1.72
	FP2	0.841	0.001	1.68
	FP3	0.855	0.002	1.71
	FP4	0.829	0.003	1.63
	FP5	0.819	0.002	1.60

Note: MAI, Marketing AI; CE, Customer Engagement; CS, Customer Satisfaction; DDDM, Data-Driven Decision-Making; and FP, Financial Performance

Additionally, Data-Driven Decision-Making (DDDM) shows consistently strong loadings between 0.810 and 0.857, reinforcing its significance as a mediating variable in AI-driven marketing strategies. Financial Performance (FP) indicators display high factor loadings (0.819 to 0.873), emphasizing their reliability in measuring business performance. The outer weights for all variables are statistically significant ( $p < 0.05$ ), and the Variance Inflation Factor (VIF) values are within acceptable limits ( $< 2$ ), ensuring that multicollinearity is not a concern. These findings validate the theoretical model and support further structural equation modeling (SEM) analysis to assess the relationships among AI adoption, customer experience, and financial performance in Nigerian SMEs.

#### 4.2. Validity Tests

Based on the findings outlined in Table 3, this study affirms the presence of discriminant validity, as indicated by HTMT values below 0.90. Moreover, the study confirmed the establishment of convergent validity, supported by AVE values exceeding 0.50. With these validity criteria met, the study subsequently assessed the reliability of the estimated model.

**Table 3. Validity tests**

Variable	MAI	CE	CS	DDDM	FP	AVE
<b>MAI</b>	1.000					0.713
<b>CE</b>	0.682	1.000				0.746
<b>CS</b>	0.659	0.701	1.000			0.732
<b>DDDM</b>	0.641	0.678	0.695	1.000		0.754
<b>FP</b>	0.623	0.670	0.684	0.698	1.000	0.761

The validity tests confirm the construct validity of the study's measurement model. The Average Variance Extracted (AVE) values for all variables exceed the recommended threshold of 0.50, ensuring sufficient convergent validity. The diagonal values (bolded) in the correlation matrix represent the square root of AVE, which are higher than the inter-construct correlations, establishing discriminant validity based on the Fornell-Larcker criterion. The high correlation values indicate strong relationships among constructs, supporting the theoretical framework. These results validate the constructs' reliability and appropriateness for further Structural Equation Modeling (SEM) analysis to explore AI adoption's impact on customer engagement and financial performance in Nigerian SMEs.

### 4.3 Reliability Tests

The reliability test results confirm the internal consistency and reliability of the constructs used in this study. Cronbach's Alpha values for all constructs exceed the recommended threshold of 0.70, demonstrating strong internal consistency (Table 4).

**Table 4. Reliability tests**

Variable	Cronbach's Alpha	rho_A	rho_C
Marketing AI	0.891	0.902	0.915
Customer Engagement	0.874	0.885	0.899
Customer Satisfaction	0.862	0.873	0.892
Data-Driven Decision-Making	0.881	0.893	0.910
Financial Performance	0.867	0.878	0.895

However, the rho\_A values, which provide an alternative assessment of reliability, are also above 0.70, further supporting the reliability of the constructs. Additionally, the composite reliability (rho\_C) values are all above 0.80, indicating high construct reliability and stability. These results validate the robustness of the measurement model, ensuring that the constructs are appropriate for further Structural Equation Modeling (SEM) analysis to examine AI-driven marketing's impact on customer engagement and financial performance in Nigerian SMEs.

### 4.4. Model Fitness Tests

Reporting the model fit summary results shown in Table 5.

**Table 5. Model fitness tests.**

Model	SRMR	NFI	$\chi^2$	d_G	d_ULS
Saturated Model	0.056	0.957	312.45*	0.789	0.612
Estimated Model	0.061	0.942	328.67*	0.812	0.645

\* Significant at 0.01 level.

The model fitness test results confirm the adequacy of the measurement model. The Standardized Root Mean Square Residual (SRMR) values for both the saturated model (0.056) and the estimated model (0.061) are below the recommended threshold of 0.08, indicating a good model fit. The Normed Fit Index (NFI) values exceed 0.90, further supporting the model's robustness. The chi-square ( $\chi^2$ ) values are statistically significant at the 0.01 level, demonstrating model validity. Additionally, the d\_G and d\_ULS values are within acceptable limits, ensuring the consistency and stability of the model. These findings validate the structural equation model (SEM), confirming its suitability for analyzing the impact of AI-driven marketing on customer engagement and financial performance in Nigerian SMEs.

### 4.5. Path Analysis

The path analysis result is reported in Table 6.

**Table 6: Path Analysis**

Path	Std. Est.	t-Stat	Sig.	R <sup>2</sup>	Q <sup>2</sup>	Hypothesis
MAI → CE	0.712	9.84*	0.000	0.51	0.39	Supported
MAI → CS	0.689	8.76*	0.000	0.48	0.36	Supported
MAI → DDDM	0.723	10.12*	0.000	0.53	0.41	Supported
CE → SFP	0.641	7.65*	0.000	0.47	0.35	Supported
CS → SFP	0.658	8.02*	0.000	0.49	0.37	Supported
DDDM → SFP	0.699	9.21*	0.000	0.52	0.40	Supported

- Significant at 0.01 level.

The path analysis results indicate strong and significant relationships among the study variables. AI-driven marketing (MAI) positively influences customer engagement (CE) and customer satisfaction (CS) with standardized estimates of 0.712 and 0.689, respectively, confirming Hypothesis 1. Additionally, AI-driven marketing significantly impacts data-driven decision-making (DDDM) with a standardized estimate of 0.723, highlighting its role in enhancing analytical capabilities. Both customer engagement (CE) and customer satisfaction (CS) positively influence sustainable financial performance (SFP), with standardized estimates of 0.641 and 0.658, supporting Hypothesis 2. The mediating role of DDDM is evident, as it significantly impacts SFP (0.699), reinforcing Hypothesis 3. The R<sup>2</sup> values indicate moderate to strong predictive power, while the Q<sup>2</sup> values confirm the model's predictive relevance. These findings validate AI adoption's crucial role in enhancing customer experience and financial performance in Nigerian SMEs.

#### 4.6. Mediating Impact Analysis

The mediating effects results is indicated in Table 7.

**Table 7: Mediating Impact Analysis**

Path	Coefficient	Std. Error	t-Stat	Sig.	Hypothesis
MAI → CE → FP	0.452	0.058	7.79*	0.000	Supported
MAI → CS → FP	0.436	0.061	7.15*	0.000	Supported
MAI → DDDM → FP	0.487	0.055	8.14*	0.000	Supported

- Significant at 0.01 level.

The mediating impact analysis results confirm that customer engagement (CE), customer satisfaction (CS), and data-driven decision-making (DDDM) significantly mediate the relationship between AI-driven marketing (MAI) and sustainable financial performance (FP). The indirect effect of MAI on FP through CE (0.452,  $p < 0.01$ ) and CS (0.436,  $p < 0.01$ ) suggests that AI adoption enhances customer engagement and satisfaction, which in turn positively impacts financial performance. The strongest mediating effect is observed through DDDM (0.487,  $p < 0.01$ ), indicating that AI adoption significantly influences financial performance when mediated by data-driven decision-making. These findings reinforce the importance of AI-driven marketing strategies in improving customer experience and financial sustainability in Nigerian SMEs.

## 4.7 Discussion of Findings

The factor analysis results confirmed that all constructs exhibit strong factor loadings above the recommended threshold of 0.70, ensuring their reliability and validity. This aligns with the findings of Bharadiya (2023) and Yaiprasert & Hidayanto (2023), who highlighted the robustness of AI-driven marketing constructs in measuring efficiency and effectiveness. Particularly, Marketing AI (MAI) showed factor loadings between 0.791 and 0.842, reinforcing its significance in improving marketing efficiency. Similarly, studies such as Naradda Gamage et al. (2020) and Tolstoy, Nordman & Vu (2022) have emphasized the necessity of reliable AI-based constructs to optimize customer interactions and business decision-making processes. The findings support the validity of AI adoption as an effective tool for enhancing engagement, satisfaction, and financial performance in SMEs.

The study's validity tests confirm the presence of discriminant and convergent validity, supporting the reliability of the measurement model. The results align with findings from Alliou et al. (2023), who emphasized that AI-driven marketing models must demonstrate strong validity to be effectively utilized in decision-making. The AVE values exceeding 0.50 reinforce the model's construct validity, as also observed in the studies of Satar et al. (2024). These results further validate the theoretical framework underpinning this research, demonstrating that AI-driven marketing strategies effectively enhance customer experience and business outcomes.

The study's reliability tests show high Cronbach's Alpha,  $\rho_A$ , and Composite Reliability ( $\rho_C$ ) values, confirming strong internal consistency. This finding is consistent with prior research by Baabdullah et al. (2021) and Alhosani & Safian (2024), who asserted that AI-related constructs must exhibit high reliability for effective integration into SMEs' marketing strategies. As noted by Oyewobi, Windapo & Rotimi (2016), the reliability of AI-based tools is crucial in mitigating the resource constraints of SMEs, ensuring stable and consistent performance outcomes. The results provide empirical support for the robustness of AI-driven marketing solutions in enhancing customer engagement and financial sustainability.

The model fitness tests indicate strong model adequacy, with SRMR values below 0.08 and NFI values exceeding 0.90, affirming a good model fit. These results align with the findings of Lee & Park (2022) and Tanguturi & Muley (2023), who emphasized the importance of well-fitted AI models in predicting financial outcomes and customer engagement trends. The statistical significance of chi-square values further strengthens the validity of the model, providing a reliable basis for examining AI's impact on SMEs. The findings reinforce prior studies' conclusions that AI integration into marketing strategies enhances operational efficiency and financial performance.

The path analysis findings highlight significant relationships between AI-driven marketing (MAI) and customer engagement (CE), customer satisfaction (CS), and data-driven decision-making (DDDM). The positive influence of AI on CE (0.712) and CS (0.689) corroborates studies by Prentice, Weaven & Wong (2020) and Gao et al. (2023), who identified AI's role in fostering customer engagement and satisfaction. Moreover, the strong impact of DDDM on financial performance (0.699) is consistent with the research of Asif et al. (2021) and Ta'Amnha et al. (2024), highlighting data-driven decision-making as a crucial factor in business success. The  $R^2$  and  $Q^2$  values confirm the model's predictive power, supporting the assertion that AI adoption significantly enhances business outcomes in Nigerian SMEs.

The mediating impact analysis confirms that CE, CS, and DDDM significantly mediate the relationship between MAI and financial performance (FP). The indirect effect of MAI on FP through CE (0.452) and CS (0.436) aligns with the work of Otto, Szymanski & Varadarajan (2020), who identified customer experience as a critical determinant of business profitability. The

strongest mediating effect is observed through DDDM (0.487), supporting the findings of Siew, Wai & Hoe (2017), who demonstrated the effectiveness of data-driven decision-making in optimizing financial performance. These results reinforce the importance of AI-driven marketing in strengthening financial sustainability through enhanced customer interactions and informed decision-making in Nigerian SMEs. Hence, the study's findings contribute to the growing body of literature on AI adoption in business strategy, providing empirical evidence that AI-driven marketing enhances customer engagement, satisfaction, and financial performance.

## **5. Conclusions**

This study examined the role of AI-driven marketing in enhancing customer experience and its subsequent impact on financial performance metrics in Nigerian SMEs. The findings provide empirical evidence that AI adoption significantly influences customer engagement, customer satisfaction, and data-driven decision-making, all of which contribute to Sustainable Financial Performance. The structural equation modeling (SEM) analysis confirmed that AI-driven marketing strategies improve customer experience, leading to better financial outcomes such as profitability, cost efficiency, and market share. The study highlights that customer engagement and satisfaction act as critical mediators in the relationship between AI adoption and financial performance. Furthermore, data-driven decision-making emerged as a strong mediator, reinforcing the importance of AI in improving analytical capabilities and strategic decision-making. By leveraging AI-driven marketing tools, SMEs in Nigeria can enhance their market positioning and ensure long-term financial sustainability. These results underscore the transformative potential of AI in marketing and its role in driving business success. Given the rapid technological advancements, Nigerian SMEs should focus on integrating AI solutions to optimize customer experience and maintain competitive advantage. However, successful AI adoption requires strategic implementation, resource allocation, and managerial commitment to maximize its benefits.

## **6. Limitations and Suggestions for Future Studies**

Despite its valuable insights, this study has some limitations. First, the study focused on SMEs in Nigeria, which may limit the generalizability of the findings to other emerging economies. Future research should explore AI's impact on customer experience and financial performance in SMEs across different regions and economic contexts.

Second, the study utilized a cross-sectional research design, which does not capture long-term effects. Future studies should adopt a longitudinal approach to examine how AI-driven marketing strategies influence business performance over time.

Third, while this study focused on AI-driven marketing, other AI applications, such as AI-powered customer service chatbots, predictive analytics, and supply chain management, were not examined. Future research could investigate the broader implications of AI adoption across different business functions.

Lastly, this study relied on survey data, which may be subject to response bias. Future studies could incorporate qualitative research methods, such as in-depth interviews or case studies, to gain deeper insights into how SMEs integrate AI into their business models.



## Author Contributions

From the conceptualization of the study, literature review, research methodology, data collection and data analysis, all authors contributed to the writing and reviewing the final manuscript. All authors have read and agreed to the published version of the manuscript.

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## Informed Consent Statement

Informed consent was obtained from all participants involved in the study. Participants were assured of the confidentiality and anonymity of their responses.

## Data Availability Statement

The data used in this study is available upon reasonable request from the corresponding author.

## Conflicts of Interest

The authors declare no conflict of interest.

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# **ROLE OF TECHNOLOGY AND DATA-DRIVEN METHODOLOGIES IN ADVANCING SUSTAINABLE DEVELOPMENT GOALS (SDGS)**

**Dr. DUEZEH, Emmanuel Afamefuna, FCPA, FERIN**  
**Department of Public Administration, Faculty of Management Sciences**  
**Nnamdi Azikiwe University Awka, Anambra State, Nigeria**  
**Mail: duemmak@yahoo.com ; ea.duezeh@unizik.edu.ng**

## **ABSTRACT**

*In the contemporary, swiftly changing landscape, technology and data-centric approaches have become formidable instruments for realizing the United Nations' Sustainable Development Goals (SDGs). The Sustainable Development Goals (SDGs) provide a worldwide framework for tackling urgent issues including poverty, inequality, and access to education and healthcare. Realizing these ambitious objectives necessitates new strategies, with technology and data-driven processes being crucial. Data facilitates evidence-based decision-making, optimizes resource allocation, and assesses progress toward objectives, whereas technology promotes accessibility, scalability, and innovation. Collectively, they foster a synergy that expedites sustainable development, guaranteeing that no one is excluded in the pursuit of a superior and more equal future. The article employs qualitative research methodologies, including textbooks, online resources, and periodicals as secondary information sources. This study utilized diffusion of innovation theory to examine the dissemination of technology and data-driven approaches for the attainment of Sustainable Development Goals (SDGs). This article examines how emerging technologies, including artificial intelligence, the Internet of Things (IoT), and blockchain, can improve decision-making, optimize resource allocation, and promote transparency. To identify the challenges and opportunities associated with integrating technology and data-driven approaches in sustainable development initiatives. The study analyzes case studies from several sectors, such as agriculture, education, and healthcare, emphasizing effective implementations of technology and data-driven methods to promote sustainability. Ultimately, the study advocates for a collaborative and inclusive approach to harnessing technology, highlighting the necessity of global collaborations and capacity-building to guarantee that technological progress fairly supports sustainable development.*

**KEYWORDS:** *Technology, Data-Driven, Methodologies, Advancement, Sustainable Development Goals*

## Background of the Study

The Sustainable Development Goals (SDGs), instituted by the United Nations in 2015, serve as a global framework for addressing critical socio-economic and environmental challenges by 2030. The Sustainable Development Goals (SDGs) established by the United Nations (UN) are globally recognized objectives aimed at enhancing the quality of life for billions across developed, emerging, and developing nations, addressing social and economic dimensions of human society, with an emphasis on economic security and environmental sustainability (Allen, 2018). The Sustainable Development Goals consist of 17 agendas, encompassing 169 targets and 232 indicators, applicable to all nations and areas globally, with implementation aimed by 2030. Upon the adoption of the goals in 2015, it was established that their advancement would be evaluated consistently at regional, national, and global tiers (Arora, 2019). Notwithstanding qualitative and quantitative evaluations at the national government level, a cross-country analysis (sample of 26 nations) conducted by Allen et al. The United Nations General Assembly indicates that, although significant progress has been achieved in the implementation phase, substantial deficiencies persist in subsequent stages. Big data analytics, artificial intelligence (AI), the Internet of Things (IoT), deep learning (DL), and machine learning (ML) significantly impact our lives across several domains and have instigated fundamental transformations in recent years (Palomares et al). The 17 interconnected objectives tackle issues such as poverty reduction, quality education, sustainable energy, climate action, and economic advancement. Realizing the SDGs requires innovative ways that leverage technology and data-driven approaches to improve decision-making, resource allocation, and policy implementation.

This study aims to analyze the uses, impacts, and challenges associated with technology and data-driven methodologies in the promotion of the Sustainable Development Goals (SDGs). The study seeks to provide insights into the effective use of technical breakthroughs and data analytics to attain sustainable development goals by analyzing best practices and successful case studies. The findings will contribute to ongoing discussions about the intersection of technology and sustainability, including policy recommendations to enhance global efforts to achieve the 2030 Agenda.

AI-driven predictive analytics enhance climate modeling, while IoT-enabled smart agriculture systems bolster food security. Blockchain technology is utilized to improve transparency in governance and financial transactions, hence reducing corruption and fostering inclusive economic growth. Artificial intelligence and big data are transforming government, financial inclusion, and healthcare. AI-driven solutions in Togo have enhanced the precision of cash transfer targeting, ensuring that resources are allocated to those most in need. AI-assisted diagnosis is similarly aiding in alleviating the shortage of medical professionals in poorer countries (World Bank, 2024).

Data-driven methodologies are crucial for evaluating progress towards the SDGs by enabling evidence-based decision-making. The integration of big data analytics allows governments, corporations, and researchers to track real-time developments, assess policy effectiveness, and identify areas requiring urgent intervention. Geographic Information Systems (GIS) and satellite data augment environmental sustainability by monitoring deforestation, tracking carbon emissions, and predicting natural disasters. Furthermore, open data platforms facilitate collaboration among stakeholders by providing accessible and transparent information for informed policymaking and accountability.

Despite the transformative potential of technology and data-driven approaches, certain obstacles hinder their widespread application in sustainable development. This includes digital inequalities between developed and developing nations, ethical concerns over data privacy and security,



significant implementation costs, and resistance to change inside traditional institutions. Addressing these challenges requires collaborative efforts from governments, international organizations, private sector stakeholders, and academic institutions to promote digital inclusion, establish regulatory frameworks, and invest in technological infrastructure

### **Objectives of the study**

1. To evaluate the impact of technological advancements on the achievement of specific Sustainable Development Goals (SDGs).
2. To examine the role of data-driven methodologies in monitoring, quantifying, and enhancing progress towards Sustainable Development Goals (SDGs).
3. To identify the challenges and prospects associated with the incorporation of technology and data-driven approaches in sustainable development initiatives.

### **Conceptual Review**

Technology has emerged as a transformative force in advancing sustainable development by enhancing efficiency, scalability, and accessibility across several sectors. Progress in artificial intelligence (AI), big data analytics, blockchain, cloud computing, and the Internet of Things (IoT) is increasingly adopted to accelerate the attainment of the Sustainable Development Goals (SDGs). Artificial intelligence is utilized to minimize energy usage, boost healthcare diagnoses, monitor biodiversity, and improve education. Equitable access to AI tools and governance is essential to avert exacerbating inequalities and to guarantee ethical utilization (UNSDG, 2024). The academic community is increasingly expected to actively contribute to sustainable development by integrating economic well-being, social inclusion, and environmental protection (Baghdadi et al., 2020; Tarhini et al., 2022; Pradhan et al., 2022). Notwithstanding progress in research examining the role of technological innovations and analytics in promoting sustainable development and energy conservation (e.g., Albizri, 2020), a unified endeavor necessitating interdisciplinary collaboration among academia, policymakers, practitioners, and civil society is crucial for establishing a sustainable and resilient future for humanity (Harfouche et al., 2023a) and the planet (Harfouche et al., 2023b).

These technologies seek to promote an ethical and inclusive digital society (Dennehy et al., 2021a). Challenges persist in reconciling potential with practice, requiring the establishment of frameworks that promote alignment between technological advancements and sustainability objectives (Dennehy et al., 2021b). Digital technology provides numerous opportunities to expedite the attainment of the SDGs by enhancing efficiency and transparency across multiple industries. Technologies such as artificial intelligence (AI), big data, and the Internet of Things (IoT) have demonstrated their capacity to foster innovation and enhance efficiency in public services, education, and the economic sector (Anshari et al., 2024; Varriale et al., 2024). This digital transformation enhances service quality and promotes the development of more sustainable solutions, particularly in urbanization and eco-friendly production (Font Vivanco & Makov, 2020; A. T. Rosário & Dias, 2023). Consequently, the implementation of seamlessly integrated digital technology may serve as the primary catalyst for attaining the Sustainable Development Goals at both global and local scales (Maltsev et al., 2020; Obasi et al., 2024).

### **Theoretical Framework**

The Diffusion of Innovation (DOI) Theory, formulated by Everett Rogers in 1962, elucidates the mechanisms by which novel ideas, technology, or behaviors disseminate throughout a society or social system over time. Rogers (2003) defines diffusion as "the process by which an innovation

is communicated through certain channels over time among the members of a social system" (p. 5). The idea delineates five classifications of adopters:

**Innovators**-are risk takers who are the initial adopters of an idea.

**Early Adopters** - Influential opinion leaders who sway others.

**Early Majority** - Pragmatic individuals that embrace an invention once it has been validated.

**Late Majority** - Cynical folks who embrace because of necessity or social influence.

**Laggards** - Individuals who are conservative and resistive to change. Furthermore, Rogers (2003) delineated five principal elements that affect the adoption rate of an innovation:

**Relative Advantage** - The extent to which the innovation surpasses current solutions.

**Compatibility** - The degree to which it aligns with established values, experiences, and requirements.

**Complexity** - The degree of ease or difficulty in comprehension and utilization. Trialability refers to the capacity to evaluate the invention prior to complete implementation.

**Observability** - The extent to which its advantages are apparent and verifiable to others.

### **Empirical Review**

This article focuses on theory-building studies and empirically based theorizing concerning technology breakthroughs and data-driven approaches that promote sustainable development goals (SDGs). After a stringent screening procedure involving at least two and no more than four rounds of evaluation, three papers were chosen for inclusion in this special edition. We outline the key contributions of these three essays below:

Hansen et al. (2024) examine how firms can efficiently adopt and augment their Artificial Intelligence (AI) capabilities, transcending the hype and concentrating on practical integration into business processes. They assert that AI adoption is not a singular occurrence; instead, it is a progressive maturation process. The authors executed a two-phase qualitative case study, encompassing interviews with AI specialists and an analysis of three firms at various phases of AI diffusion. This resulted in the creation of an AI Capability Maturity Model (AICMM) that delineates the phases businesses experience as they advance in their utilization of AI. The authors recognized prevalent obstacles firms have during AI dissemination, including data management, organizational alignment, and regulatory compliance. Furthermore, as AI maturity advances, the characteristics of these issues transform. The document presents pragmatic instruments for practitioners to evaluate their existing AI maturity and proposes methodologies for advancement. It enhances academic research by elucidating AI dispersion and offers a framework for enterprises to effectively manage their AI adoption process and optimize value.

Fosso Wamba et al. (2024) examine the influence of Artificial Intelligence (AI) capabilities on organizational performance, highlighting the mediating function of a data-driven culture in the realm of sustainable development. Grounded in resource-based theory, the authors present a comprehensive model that integrates material, intangible, and human resources to delineate AI capabilities. The study employs a mixed-method approach integrating PLS-SEM and fsQCA to identify AI infrastructure as a crucial resource and emphasizes the necessity of cultivating a data-driven culture to enhance performance. The results indicate that AI skills can directly and

indirectly affect organizational performance, promoting Sustainable Development Goals (SDGs) 9 (industry, innovation, and infrastructure) and 12 (responsible consumption and production). This research enhances the theoretical comprehension of AI resource configurations and provides practical insights for firms seeking to match AI deployment with sustainability goals.

Breiter et al. (2024) examine the duality of digital transformation and sustainability transformation, noting that the theoretical framework for integrating both, referred to as twin transformation, is inadequately developed. They assert that a comprehensive understanding of pertinent twin transformation capabilities and advancements is essential for successful deployment. To improve comprehension and offer relevant recommendations, they created a twin transformation capability maturity model emphasizing the dynamic capabilities necessary for achieving twin transformation. The foundation of their study consists of a methodical literature analysis and interviews with 13 experts, along with its application with a technological service provider. They determine that by considering firms' initial positions regarding their digitization and sustainability knowledge and experience, we identify three approaches to achieving twin transformation. Secondly, our research presents a comprehensive review of 45 pertinent twin transformation capabilities organized into six capability categories and four maturity levels. The findings have practical significance for assisting businesses in evaluating their twin transformation maturity, thereby establishing a platform for focused capability growth.

## **ROLES OF TECHNOLOGY AND DATA-DRIVEN METHODOLOGIES**

**Innovation Characteristics:** The DOI theory highlights five essential criteria that affect innovation adoption: relative benefit, compatibility, complexity, trialability, and observability. Technologies that exhibit distinct advantages and are congruent with prevailing ideals are more likely to be rapidly embraced in sustainable development programs.

**Collaborative Processes:** Successful dissemination encompasses not just the technology but also the associated social dynamics. The traits of prospective adopters—such as their socioeconomic status and community involvement—significantly influence the reception of innovations. This underscores the significance of cooperative endeavors in advancing innovative technologies for sustainable practices.

**Stages of Adoption:** The DOI theory delineates the stages in the adoption process: idea generation, dissemination of ideas, and actual adoption. Each phase necessitates targeted efforts to mitigate potential obstacles, including resistance to change or insufficient awareness of the innovation's advantages. Employing data-driven approaches helps improve comprehension and discourse around the benefits of sustainable technologies.

**Impact on Sustainable Development:** The use of innovative technologies into sustainable development initiatives can result in substantial enhancements in efficiency and efficacy. Data analytics may optimize resource utilization, whereas innovative agricultural technologies can improve food security. The effective dissemination of these solutions can aid in attaining wider sustainability objectives by more efficiently tackling environmental concerns.

The Diffusion of Innovation Theory provides critical insights into the effective utilization of technology and data-driven approaches to advance sustainable development. By comprehending the traits of innovations and the underlying social dynamics, stakeholders can more effectively design their initiatives to promote universal adoption and attain sustainability goals.

## **Challenges**

Nonetheless, alongside the opportunities afforded by digital technology in facilitating the attainment of the SDGs, there exist considerable problems that must be addressed. A primary

obstacle is the inequitable access to digital technology, particularly in underdeveloped nations with inadequate infrastructure and low technological literacy (Gupta & Rhyner, 2022). This disparity might intensify social and economic gaps and impede the attainment of the Sustainable Development Goals, particularly regarding social inclusion and economic empowerment (Senja Shafira et al., 2024; Strilchuk et al., 2024). Moreover, cybersecurity concerns represent a significant worry due to the escalating dangers to privacy and information security in the digital age (Ige et al., 2024). Consequently, it is essential to formulate a thorough and inclusive plan to tackle these difficulties, ensuring that digital technology is effectively employed to attain the SDGs (Maltsev et al., 2020). Alongside infrastructural and access constraints, ethical and social issues significantly impact the application of digital technologies to attain the SDGs. The use of digital technology must adhere to an ethical framework that prioritizes not only innovation but also potential social and environmental repercussions (Chalmeta Rosaleñ & Guede Tejedor, 2022; Pastor-Escuredo et al., 2022). Data privacy, cybersecurity, and the risk of discrimination stemming from digital algorithms are critical challenges that require management to ensure the equitable and responsible use of technology (Ige et al., 2024; Obasi et al., 2024). Incorporating ethics into the creation and utilization of digital technologies is crucial to guarantee that digital transformation yields an equitable positive effect on all societies (Lemsieh et al., 2024; Muschert & Ragnedda, 2021). Although technology can enhance productivity and stimulate economic growth, there are apprehensions over job displacement, algorithmic prejudice, and cybersecurity threats. Ethical AI governance, talent enhancement, and infrastructure expenditures are essential for a balanced approach (World Bank, 2024).

## **Conclusion**

This special issue's papers enhance the discussion on how technological advancements and data analytics might tackle global sustainable development concerns. Although this research offer helpful insights, considerable gaps persist in comprehending how to systematically link technology with the Sustainable Development Goals (SDGs). Future research should promote interdisciplinary collaboration among domains such as information systems, environmental science, and policy studies to develop effective solutions. Secondly, it is essential to explore the interaction between emerging technologies (e.g., AI, blockchain) and their effects on equitable and resilient sustainable practices. Third, adaptable frameworks must be established to facilitate iterative learning and the realignment of policies, technology, and organizational initiatives. We anticipate that this special issue will establish a basis for enhancing the amalgamation of technology and analytics in sustainable development. This work integrates theory and practice, informing academic discussions while providing practitioners with practical methods for fostering a more inclusive and sustainable future.

## **Recommendation**

A pressing recommendation is to address current data deficiencies. To mitigate data absences and gaps, the following solutions are proposed: enhanced accessibility to education; heightened awareness of biases; improved domain comprehension; and effective collaboration among developers, policymakers, and specialists (e.g., business, data, law). To explicitly mitigate data biases and discrimination, it is advisable to collect data that may be disaggregated by gender or geography. Additional elements encompass rigorous assessment and benchmarking of AI/ML models, a comprehensive framework for equitable training, evaluation, and testing of Machine Learning (ML), algorithmic openness, and data transparency. The democratization of AI, meaning equitable access to models, could aid in combating "tech colonialism."

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**THEME: REVOLUTIONIZING RESEARCH: METHODOLOGICAL INNOVATIONS FOR SUSTAINABLE DEVELOPMENT AND ECONOMIC GROWTH**

# **DIGITAL FINANCE PENETRATION IN NIGERIA**

**IMASUEN, Osasere Festus<sup>1</sup>, & OBASANMI, Jude Omokugbo<sup>2</sup>**

<sup>1</sup>Department of Business Administration and Management, School of Business, Edo State Polytechnic, PMB 1104, Usen, Edo State, Nigeria. Email: [imasuenfestus2012@yahoo.co.uk](mailto:imasuenfestus2012@yahoo.co.uk)

<sup>2</sup>Department of Economics, Faculty of Social Sciences, Ambrose Alli University, Ekpoma, Nigeria. Email: [obasanmijude@gmail.com](mailto:obasanmijude@gmail.com)

## **ABSTRACT**

*This study has empirically assessed digital payment system penetration in Nigeria from 2009 to 2023. The study was guided by five (5) objectives and questions. The study adopted Diffusion of Innovation Theory. Data were obtained from the secondary sources like CBN, Journals, NBS etc. The data were analyzed using percentages and chats. From the result, it was established that since 2009, apart from 2010, 2013 and 2020, the volume of transactions of cheques has been on the downward trajectory while that of digital transactions apart from the said dates have been on the upward trajectory. Also, the result revealed that from 2009 to 2011, the value of cheque payments was on the upward trajectory, while that of digital payment was on the downward trajectory. However, from 2012, except for 2017, 2020 and 2022, the value of cheque payments or transactions have been on the downward trajectory while that of digital payments or transactions have been on the otherwise. For the digital channels that is most used, the result was a mixed bag. From the study, the study recommends that infrastructure for effective and efficient operations of fintech should be improved upon in-order to enhance service delivery.*

**KEYWORDS:** ATM, Cheque, Digital Payment, Electronic Payment, Mobile, POS.

## INTRODUCTION

In Nigeria, cash is still a mode of payment and a large percentage of the populations are unbanked. This makes the country to be a relatively cash-based economy. However, one of the prerequisites for the development of national economy is to encourage a payment system that is secure, convenient, affordable, positive and progressive. In consonance with the trend of fintech development experienced in the global payment system, the Federal Government of Nigeria in the year 2009 announced an e-payment regime for all transactions involving the Federal Ministries, Department and Agencies (MDAs). Under the new regime, the issuances and acceptability of cheques as a means of settlement was reduced and, in some areas, jettisoned, while the payment of all staff salaries and emoluments as well as government suppliers, vendors and contractors were to be remitted electronically into the beneficiary's accounts. This according to the Federal Government will enhance transparency accountability and progressive as well as checkmate the activities of corrupt practices within the government structures.

Nigeria is one of the developing economies of the world that is trying to catch up with the global advancement in the adoption of fintech through electronic payment (Aborisade, cited in Bagudu & Okolie, 2022). Electronic payment (E-Payment) system was adopted so as to improve service delivery, decongest queues during cash payment, enable customers withdraw cash at will, aid international payment and remittance, track personal cash transaction, request for online statement, or even transfer deposit to a third-party account (Iluno, et al 2018).

Digital Payment Systems (DPS) apart from their convenience, safety and progressive nature also have a significant number of economic benefits which include mobilising savings and ensuring most of the cash available in the country are with banks. This will make funds available to borrowers both businesses and individuals. Furthermore, an digital payment system has the ability to track individual spending; to facilitate the design of products by the banks. This information is also useful to the government when making decisions. DPS also have the ability to reduce cash handling and printing costs.

Despite these positive developments, sentiments concerning digital payment adoption remain mix as its acceptance remain relatively low. However, how low is the acceptance of digital payment system in Nigeria? Also, digital payments system despite its numerous benefits come with its own challenges even in the developed world such as lack of market confidence, weak infrastructure base, high rates of illiteracy, frequent power interruption, inadequate cyber security, lack of legal and regulatory framework, institutional knowledge gap, and so on. However, have these challenges hindered it acceptance or penetration in Nigeria, hence the need to evaluate digital payment penetration in Nigeria in spite of all the challenges.

### Objectives of the Study

The main objective of the study was to determine the level of digital payment system penetration in Nigeria. Also, the study determined the following

- i. Level of ATM payment penetration in Nigeria
- ii. Level of POS payment penetration in Nigeria
- iii. Level of Web/Internet payment penetration in Nigeria
- iv. Level of NEFT payment penetration in Nigeria
- v. Level of Mobile payment penetration in Nigeria

## Research Questions

The following questions guided the study

- i. What is the level of ATM payment penetration in Nigeria?
- ii. What is the level of POS payment penetration in Nigeria?
- iii. What is the level of Web/internet payment penetration in Nigeria?
- iv. What is the level of NEFT payment penetration in Nigeria?
- v. What is the level of Mobile payment penetration in Nigeria?

## Conceptual Review

### Digital Payment System (or Electronic Payment System)

Digital Payment systems refer to the automated processes of exchanging monetary value among parties in business transactions and transmitting this value over the information communication technology (ICT) networks (Amin, et al, 2018). In Nigeria, digital payment is effecting payment from one end to another through the medium of the ICT without manual intervention beyond inputting payment data. It is the ability to pay the suppliers, vendors and staff salaries electronically at the touch of a computer button (Udeghe & Hanzace, 2018).

In recent time, digital payment system has become a medium through which monetary substance circulates easily and conveniently, especially in developing economy like Nigeria where carrying cash around is habitual. In Nigeria, digital payment system formed fundamental starting point of her modern market economy; a well-functioning digital payment system has been recognized to have much relevance on financial stability, monetary policy and overall economic activity (Aduda & Kingoo, 2018 in Obasanmi & Imasuen, 2020). Historically, the Central Bank of Nigeria (CBN) introduced payment system which facilitated digital payment in 2002. During this period, Nigeria Automated Clearing System (NACS) was introduced as a veritable platform for development of electronic payment and to reduce clearing of cheques period (CBN, 2014).

### Digital Payment Channels

According to Edet (cited in Andrea et al 2022), the channels used in executing digital banking include plastic cards (debit cards, credit cards, prepaid cards), personal computers, telephone, mobile phones, internet, automatic teller machines (ATM's), point of sale or point of interaction machines etc. Some of these are briefly explained as follows:

- i. Point of Sales (POS): This enables merchants to process payments and log transactions. It is a computer-based cash register with software capable of tallying up orders, taking payments, monitoring inventory and buying trends, creating invoices, and collecting marketing data. Ayodele (cited in Nedozi & Omoregie, 2019) also described it as a payment device that allows credit/debit cardholders makes payment at sales/purchase outlets. It allows customers to perform services inquiry, airtime, vending, loyalty, redemption and printing of mini statement. (Osang,2017).
- ii. Automated Teller Machine (ATM): ATM card is a chip device consisting of circuit's elements on single silicon chip, used by customers to perform balances, inquiry, mini-statements and cash withdrawal as well as transfer, through the use of automated teller machines. Okafor (cited in Nedozi & Omoregie, 2019) perceived the ATM as an electronic device which allows a financial institution customer to use a secure method of communication to access their accounts, make cash withdrawals or cash advances using credit cards and checking their account balances without need for human teller or cashier.

It is adjudged to be the most popular e-transactions means in Nigeria especially with the introduction of Point of Sale (POS) terminals. It is convenient, easy to withdraw cash, make payments, make transfers and even check account balances.

- iii. Web Payment: Web payment service is an online service that manages the transfer of funds from a customer to the merchant of an ecommerce website. The money may come from a prepaid account or credit card stored in a digital wallet in the user's device or stored in the service's datacenter. (Osibote, 2011).
- iv. Mobile Payment: Mobile payment refers to payment services operated under financial regulations and it is performed using mobile devices. Its models include mobile wallets, card-based payments, carrier billing, contactless payments and direct transfer between payer and payee bank account. It is fast and convenient but depends on availability of network. (Osang, 2017).
- v. National Electronic Funds Transfer (NEFT). This is an electronic funds transfer system which facilitates transfer of funds to other bank accounts across the country. This is a simple, secure, safe, fast and cost-effective way to transfer funds especially for retail banking remittances. This e-payment system was first used by the Reserve Bank of India in 2005 (CBN, 2012). The digital solution was designed, established and maintained by the Indian Institute for Development and Research in Banking Technology (IIDRBT). NEFT has gained popularity among the e-payment systems in Nigeria due to its time saving and ease of transactions.
- vi. NIBSS Central Payment: NIBSS Central payment gateway is an e-commerce application service solution. CentralPay is a payment gateway application developed by NIBSS. With CentralPay, web merchants can easily receive payments online from their customers in exchange for goods and services. The unstable network situation affects its usage (CBN, 2014).
- vii. NIBSS Instant Payment (NIP): According to Obasanmi and Imasuen, (2020), it is a transfer option which can be used to transfer money from one customer's account to any bank account in Nigeria. NIP can only be used to transfer money to one or two persons at the same time but the transfer is instantaneous because the receiver gets value within minutes.
- viii. Unstructured Supplementary Service Data (USSD). This allows users without a smartphone or data/internet connection to use mobile banking through the \*99# code. USSD based mobile banking can be used for fund transfers, checking account balance, generating bank statements, among other uses (CBN, 2014).
- ix. Real-Time Gross Settlements (RTGS) is a transfer method used by Nigerian banks to move amounts above N10million in favour of a single beneficiary. To increase the efficiency of payments, the CBN commenced the operations of the RTGS system on December 18, 2006, and was named the "CBN Inter-bank Funds Transfer System (CIFT)
- x. NIBSS Automated Payment Services (NAP). It is an integrated multibank e-payment, e-collection and payroll and bulk payment platform. By its design, it is suitable for instant processing of payroll, pension, personnel records and execution of funds transfer, direct debit, collections, schedule delivery and payment instruction, but could be hindered by the availability of network (Obasanmi & Imasuen, 2020).

- xi. NIBSS e-Billspay: It is an account-based, online real-time product that facilitates the payment of bills from an account. It ensures instant credit of payments and receipt of collections on behalf of Billers/Merchant recruited on the platform (CBN, 2014).
- xii. Remita: Remita is a solution that addresses the payment needs of individuals and organizations. It was developed by FinTech System specs. It helps to receive and make payment easily without activation fee. It is secure and has Human Resource (HR) and payroll functions. It is actually an innovative way to manage electronic payments, collections, employees payrolls and schedules. There is Remita Personal and Remita for corporate users. It protects user's data with multiple security protocols but requires internet connection.
- xiii. M-Cash: This is an innovative solution designed to facilitate low value retail payments, grow e-payments by providing accessible electronic channels to a wider range of users and to further enhance financial inclusion in Nigeria, by extending e-payment benefits to Payers and Merchants. The unreliable nature of network hinders its usage too.
- xiv. Mobile Money Operators (MMOs): This is a licensed mobile money service provider that develops and deploys financial services through mobile phones and mobile telephone networks (CBN, 2014)
- xv. Automated Clearing House (ACH): The Automated Clearing House (ACH) is an electronic payment option that allows participants to pay Customs duties, taxes, and fees electronically. ACH allows importers to pay duties with one electronic transaction in a secure environment. ACH fulfills the need for swift, accurate payment transfers in today's competitive business environment. It reduces administrative and check processing cost (Obasanmi & Imasuen, 2020).
- xvi. Direct debit: Credit or debit cards and e-wallets makes shopping cashless. Unlike the ATM, credit cards, debit cards and e-wallets help the Central Bank of Nigeria (CBN), to achieve the cashless policy. Credit and debit cards use Point of Sales (POS) terminals located at accredited retail outlets. However, most ATM cards in Nigeria, also serve as both credit and debit cards. (Osang, 2017)

## **Theoretical Framework**

This study employs the Diffusion of Innovation Theory of Everett Rogers to explain the relationships. According to this scholar, technology adoption as an innovation involves the spontaneous spread of modern thinking (Rogers, 1995). In this theory, the existence of an innovation is seen to cause uncertainty by potential users which may imply lack of predictability of useful information. Dearing (2009) posits that, diffusion does not necessarily mean that, a new product or practice must succeed or even reach the poorest people. In otherwords, this study was able to capture the three distinct processes of presentation, acceptance and integration needed by every new cultural element such as the e-payment system in Nigeria. This current study considers the diffusion theory as being able to explain whether or not the current innovation in the digital world is able to give a positive push for growth in such a developing country as Nigeria especially in the fintech world.

## **Empirical Review**

The following extant studies were reviewed for the study

Nedozi and Omoregie (2019) empirically evaluated the electronic-payment channels and their penetration level in Nigeria from 2012 to first quarter of 2019. The main research objective was



to determine given the technology revolution the level of e-payment penetration in Nigeria. Concepts of e-payment, E-payment in Nigeria and the different E-payment platforms were reviewed. The data were obtained from the secondary sources like CBN, journals, and commercial banks quarterly bulletins. The study employed descriptive statistics to ascertain the level of penetration of E-payment in Nigeria. The data were analyzed using percentages. From the study, it was found that ATM dominated the penetration of E-payment in terms of volume in Nigeria from 2011 to first quarter of 2019. In terms of value NEFT dominated in 2012 and 2013 while NIP dominated from 2014 to first quarter of 2019.

An examination of the cashless policy and the Nigerian payment system was the focus of Nwani et al (2020) study. With the aid of paired data samples between 2007 and 2017, the study evaluated the impact of cashless policy on the Nigerian payment system. The operations of a cashless economy were assessed based on the use of Cheques, funds transfer channels and Automated Teller Machines (ATMs). Analysis of data showed that the volume and usage of cheques as a means of financial settlement has failed and was partially replaced by electronic payment systems. Banks are getting more involved in the use of interbank fund transfers rather than a cash settlement. It was also ascertained that the use of ATMs as a means of financial intermediation is increasing. It is anticipated that the use of ATMs will become even more popular in Nigeria in the near future. To some extent, the outcome of the study has justified the implementation of the cashless policy initiative in Nigeria.

In addition, Obasanmi and Imasuen (2020) investigated the effects, challenges and prospects of cashless policy on the Nigerian Economy. The hypotheses of their study were; there are no significant effects of cashless policy on the Nigerian economy: there are no significant challenges of cashless policy on the Nigerian economy, and there are no significant prospects of cashless policy on the Nigerian economy. The study used primary data sourced through questionnaire gotten from one thousand, two hundred respondents. In analyzing the result, simple frequencies, percentages and t-statistics were used to test the research hypotheses. It was found that cashless policy has positive effect on the growth of Nigerian economy. Also, respondents were of the opinion that the introduction of cashless banking in Nigeria has increased the cost of e-payment transactions as well as the normal bank charges as they are required to pay for various e-cards aside from indirect payment for technologies acquired to run cashless business venture by the banks. It concluded that, in as much as the policy was good, there should be a conscious effort at improving on information and communication infrastructure that will enhance speed in service delivery, internet security framework to check online fraud so that the public can be assured and protected against cyber attacks and fraud.

## Methodology

To analyze the data obtained from the secondary sources like CBN, Journals, commercial banks quarterly bulletin, the study employed descriptive statistics to ascertain the level of digital payment penetration in Nigeria. The data were analyzed using percentages and charts from 2009 to 2023.

## Result Presentation and Analysis

**Table one: Volume of Cheque and Digital Payments in Nigeria from 2009 to 2023**

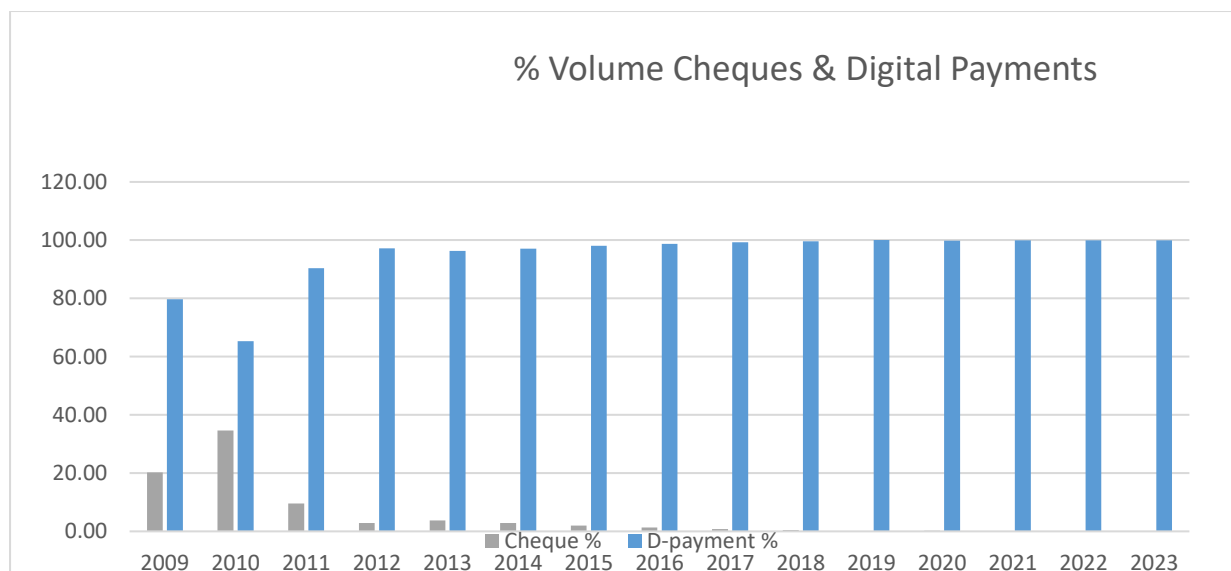
Year	Cheque	Cheque %	Digital	Digital %	Total
2009	29,166,780	20.29	114,592,669	79.71	143,759,449
2010	33,973,919	34.69	63,963,656	65.31	97,937,575
2011	37,718,585	9.6	355,252,401	90.4	392,970,986
2012	12,045,833	2.82	415,810,777	97.18	427,856,610



2013	12,839,006	3.71	332,856,987	96.29	345,695,993
2014	16,672,398	2.87	564,006,745	97.13	580,679,143
2015	13,466,461	1.96	672,670,418	98.04	686,136,879
2016	11,719,847	1.29	899,493,154	98.71	911,213,001
2017	10,800,000	0.75	1,426,423,150	99.25	1,437,223,150
2018	9,019,278	0.43	2,073,586,278	99.57	2,082,605,556
2019	7,275,237	0.01	93,877,873,538	99.99	93,885,148,775
2020	20,023,553	0.18	10,914,863,130	99.82	10,934,886,683
2021	18,257,340	0.1	17,527,427,009	99.9	17,545,684,349
2022	16,907,129	0.07	24,000,205,874	99.93	24,017,113,003
2023	16,054,396	0.03	49,505,332,582	99.97	49,521,386,978

**Source:** Researchers' compilation and computation 2025

The result of table one revealed that since 2009, apart from 2010, 2013 and 2020, the volume of transactions of cheques has been on the downward trajectory while that of digital transactions apart from the said dates have been on the upward trajectory. This means a significant penetration or acceptance of digital payment system in Nigeria in terms of volume. A breakdown of the results revealed that in terms of volume, in 2009, cheque transactions (CT) was 20.29% while digital transactions (DT) was 79.71%. In 2010, CT was 34.69% and DT was 65.31%. In 2011, CT was 9.60%, DT was 90.40%. In 2012-2017, CT were 2.82%, 3.71%, 2.87%, 1.96%, 1.29% and 0.75% respectively, while DT were 97.18%, 96.29%, 97.13%, 98.04%, 98.71% and 99.25% respectively. Also, from 2017 to 2023, CT were 0.43%, 0.01%, 0.18%, 0.10%, 0.07% and 0.03% respectively while DT were 99.25%, 99.57%, 99.99%, 99.82%, 99.90%, 99.93% and 99.97% of total transactions respectively.



**Fig 1: Volume of Cheque and Digital Payments in Nigeria from 2009 to 2023**

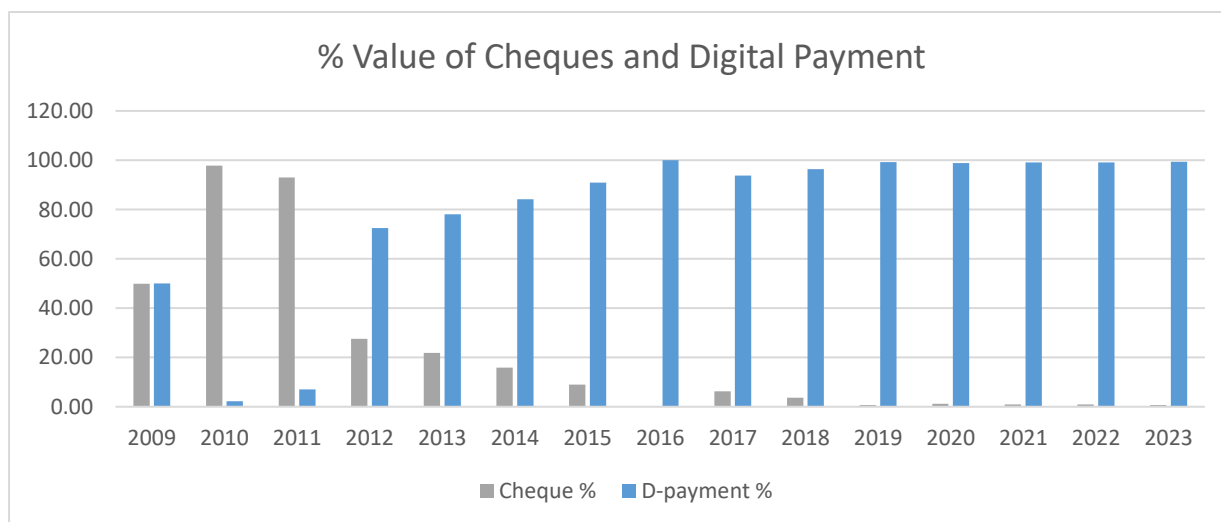
**Table Two: Value of Cheque and Digital Payments in Nigeria from 2009 to 2023**

Year	Cheques (Nb)	Cheque %	Digital (Nb)	Digital %	Total
2009	29436.03	49.92	29532.48	50.08	58968.51
2010	19675.51	97.79	444.13	2.21	20119.64
2011	22302.63	93.03	1671.35	6.97	23973.98

2012	7461.63	27.53	19646.78	72.47	27108.41
2013	6989.33	21.90	24927.17	78.10	31916.5
2014	7954.64	15.81	42355.71	84.19	50310.35
2015	6195.47	9.04	62319.12145	90.96	68514.59145
2016	5829.56	0.00	616996138.2	100.00	617001967.8
2017	5381.91	6.25	80796.88208	93.75	86178.79208
2018	5035.33495	3.63	133635.6933	96.37	138671.0282
2019	4481.668348	0.73	608920.8774	99.27	613402.5458
2020	15417.90342	1.21	1260646.376	98.79	1276064.279
2021	15606.83799	0.92	1685898.494	99.08	1701505.332
2022	15250.72409	0.95	1583042.223	99.05	1598292.947
2023	15522.3988	0.66	2337958.341	99.34	2353480.74

**Source:** Researchers' compilation and computation 2025

The result of table two revealed that from 2009 to 2011, the value of cheque payments was on the upward trajectory, while that of digital payment was on the downward trajectory. However, from 2012, except for 2017, 2020 and 2022, the value of cheque payments or transactions have been on the downward trajectory while that of digital payments or transactions have been on the otherwise. This showed the level of penetration or acceptance of digital or electronic payment system in Nigeria. A breakdown of the result revealed that from 2009 to 2013, values of cheques payments were 49.92%, 97.79%, 93.03%, 27.53% and 21.90 % respectively. At same range of years, the values of digital payment or transactions were 50.08%, 2.21%, 6.97%, 72.47% and 78.10% respectively. From 2014 to 2018, the values of CT were 15.81%, 9.04%, 0.00%, 6.25% and 3.63% respectively. Within same range of years DT were 84.19%, 90.96%, 100%, 93.75% and 96.37% respectively. From 2019 to 2023, the values of CT were 0.73%, 1.21%, 0.92%, 0.95% and 0.66% respectively. Within same range, DT were 99.27%, 98.79%, 99.08%, 99.05% and 99.34% respectively.



**Fig 2: Value of Cheque and Digital Payments in Nigeria from 2009 to 2023**

**Table Three: Volume of Digital Payments Channels Penetration in Nigeria from 2009 to 2023**

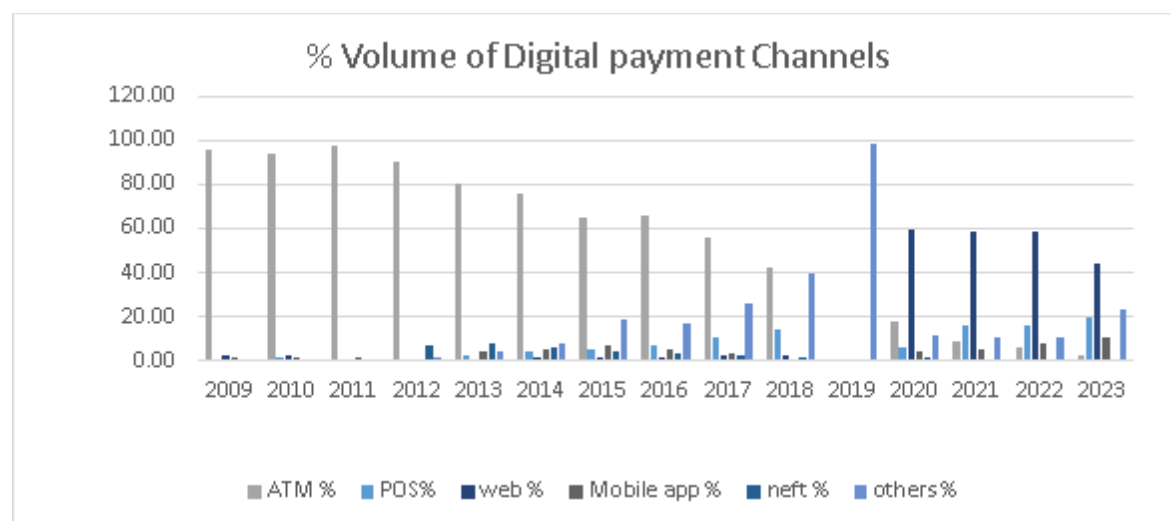
Ye ar	ATM	ATM %	POS	POS %	(WEB)	Web %	Mobile	Mobil e %	NEFT	NEFT %	others	others %	Total
20 09	109,161, 646	95.26	918,256	0.8	2,703,516	2.36	1,809,25 1	1.58	NA	NA	-	0	114,592,6 69
20 10	60,133,6 11	94.01	1,072,42 6	1.68	1,601,086	2.5	1,156,53 3	1.81	NA	NA	-	0	63,963,65 6
20 11	347,569, 999	97.84	2,100,67 3	0.59	1,932,355	0.54	3,649,37 4	1.03	NA	NA	-	0	355,252,4 01
20 12	375,487, 756	90.3	2,555,04 5	0.61	2,276,464	0.55	2,297,68 8	0.55	28,741, 726	6.91	4,452,098	1.07	415,810,7 77
20 13	266,461, 839	80.05	7,936,10 1	2.38	2,496,643	0.75	14,497,9 56	4.36	26,849, 996	8.07	14,614,45 2	4.39	332,856,9 87
20 14	428,933, 608	76.05	22,283,5 77	3.95	5,990,911	1.06	30,470,8 85	5.4	33,000, 830	5.85	43,326,93 4	7.68	564,006,7 45
20 15	433,587, 623	64.46	33,720,9 33	5.01	7,981,361	1.19	43,933,3 62	6.53	28,935, 605	4.3	124,511,5 34	18.51	672,670,4 18
20 16	590,238, 934	65.62	63,715,2 03	7.08	14,088,24 7	1.57	47,053,2 52	5.23	29,754, 182	3.31	154,643,3 36	17.19	899,493,1 54
20 17	800,549, 099	56.12	146,267, 156	10.2 5	28,991,09 7	2.03	47,804,5 61	3.35	31,034, 624	2.18	371,776,6 13	26.06	1,426,423, 150
20 18	875,519, 307	42.22	295,890, 167	14.2 7	50,815,90 1	2.45	NA	NA	26,760, 852	1.29	824,600,0 51	39.77	2,073,586, 278
20 19	839,819, 922	0.89	438,614, 182	0.47	103,497,0 07	0.11	377,265, 208	0.4	NA	0	92,118,67 7,219	98.13	93,877,87 3,538
20 20	1,914,22 0,419	17.54	655,748, 348	6.01	6,481,000, 000	59.37	411,452, 926	3.77	184,886 ,953	1.69	1,268,005, 854	11.62	10,914,86 3,130
20 21	1,599,18 7,337	9.12	2,743,55 5,841	15.6 5	10,320,00 0,000	58.89	831,540, 635	4.74	172,792 ,505	0.99	1,858,770, 766	10.6	17,527,42 7,009
20 22	1,506,99 1,903	6.28	3,885,78 2,065	16.1 9	14,060,00 0,000	58.6	1,861,36 2,984	7.76	88,468, 437	0.37	2,593,673, 049	10.81	24,000,20 5,874
20 23	1,012,27 7,981	2.04	9,847,25 8,500	19.8 9	21,750,00 0,000	43.94	5,259,47 7,576	10.62	93,112, 941	0.19	11,539,28 0,342	23.31	49,505,33 2,582

**Source:** Researchers' compilation and computation 2025

The result of table three revealed that from 2009 to 2018, ATM dominated the volume of transactions, while OTHERS (RTGS, USSD, DIRECT DEBITS, ACH, NIP, EBILLSPAY, REMITTA, M-CASH, CENTRAYPAY INTERBANK AND NAPS) dominated in 2019 and from 2020 to 2023 web/internet transactions dominated the volume of transactions. Although, from 2020, POS transactions had been on the upward trajectory in the volume of transactions. the value of cheque payments was on the upward trajectory, while that of digital payment was on the downward trajectory. A breakdown of the result revealed from 2009 to 2013, ATM transactions have 95.26%, 94.01%, 97.84%, 90.30% and 80.05% respectively. POS transactions have 0.80%, 1.68%, 0.59%, 0.61% and 2.38%. WEB transactions had 2.36%, 2.50%, 0.54%, 0.55% and 0.75% respectively; Mobile transactions have 1.58%, 1.81%, 1.03%, 0.55% and 4.36% respectively; NEFT transactions had no data for 2009 to 2011 and 6.91% and 8.07% for 2012 and 2013 respectively; and for others, there were no data for 2009 to 2011 and 1.07% and 4.39% for 2012 and 2013 respectively.

For 2014 to 2018, ATM volume of transactions was 76.05%, 64.46%, 65.62%. 56.12% and 42.22% respectively. POS volume of transactions was 3.95%, 5.01%, 7.08%, 10.25% and 14.27% respectively. WEB volume of transactions were 1.06%, 1.19%, 1.57%, 2.03% and 2.45% respectively. Mobile transactions were 5.40%, 6.53%, 5.23%, 3.35% and no data for 2018. NEFT volume of transactions were 5.85%, 4.30%, 3.31%, 2.18% and 1.29% respectively. For others volume of transactions were 7.68%, 18.51%, 17.19%, 26.06% and 39.77% respectively.

From 2019 to 2023, ATM volume of transactions was 0.89%, 17.54%, 9.12%, 6.28% and 204% respectively. POS volume of transactions was 0.47%, 6.01%, 15.65%, 16.19% and 19.89% respectively. WEB transactions were 0.11%, 58.37%, 58.89%. 58.60% and 43.94% respectively. Mobile transactions volume were 0.40%, 3.77%, 4.74%, 7.76% and 10.72% respectively. NEFT volume of transactions were no data, 1.69%, 0.99%, 0.37% and 0.19% respectively. Others volume of transactions was 98.13%, 11.62%, 10.60%. 10.81% and 23.31%.



**Fig 3. Volume of Digital Payments Channels Penetration in Nigeria from 2009 to 2023**

**Table Four: Value of Digital Payments Channels Penetration in Nigeria from 2009 to 2023 (Nb)**

Year	ATM	ATM %	POS	POS %	Web	Web %	Mobile	mobile %	NEFT	NEFT %	others	OTHERS %	Total
2009	29,436	99.67	11	0.04	84	0.28	1	0	NA	NA	-	0	29,532
2010	400	90	13	2.86	25	5.64	7	1.5	NA	NA	-	0	444
2011	1,562	93.44	31	1.86	60	3.57	19	1.14	NA	NA	-	0	1,671
2012	1,985	10.1	48	0.24	32	0.16	32	0.16	13,660	69.53	3,891	19.8	19,647
2013	2,533	10.16	136	0.55	42	0.17	119	0.48	12,672	50.84	9,425	37.81	24,927
2014	3,976	9.39	337	0.8	79	0.19	370	0.87	16,252	38.37	21,341	50.39	42,356
2015	3,970	6.37	449	0.72	92	0.15	442	0.71	13,087	21	44,279	71.05	62,319
2016	4,988	0	759	0	132	0	757	NA	14,585	0	616,974,917	100	616,996,138
2017	6,438	7.97	1,410	1.74	185	0.23	1,102	1.36	14,946	18.5	56,716	70.2	80,797
2018	6,480	4.85	2,383	1.78	405	0.3	NA	NA	11,031	8.25	113,337	84.81	133,636
2019	6,513	1.07	3,205	0.53	478	0.08	5,081	0.83	NA	NA	593,644	97.49	608,921
2020	18,200	1.44	4,727	0.37	392,340	31.12	32,401	2.57	299,695	23.77	513,283	40.72	1,260,646
2021	21,231	1.26	24,455	1.45	545,040	32.33	53,208	3.16	410,171	24.33	631,793	37.48	1,685,898
2022	32,648	2.06	41,036	2.59	783,660	49.5	111,122	7.02	477,367	30.16	137,209	8.67	1,583,042
2023	28,213	1.21	110,347	4.72	1,097,133	46.93	219,800	9.4	646,337	27.65	236,129	10.1	2,337,958

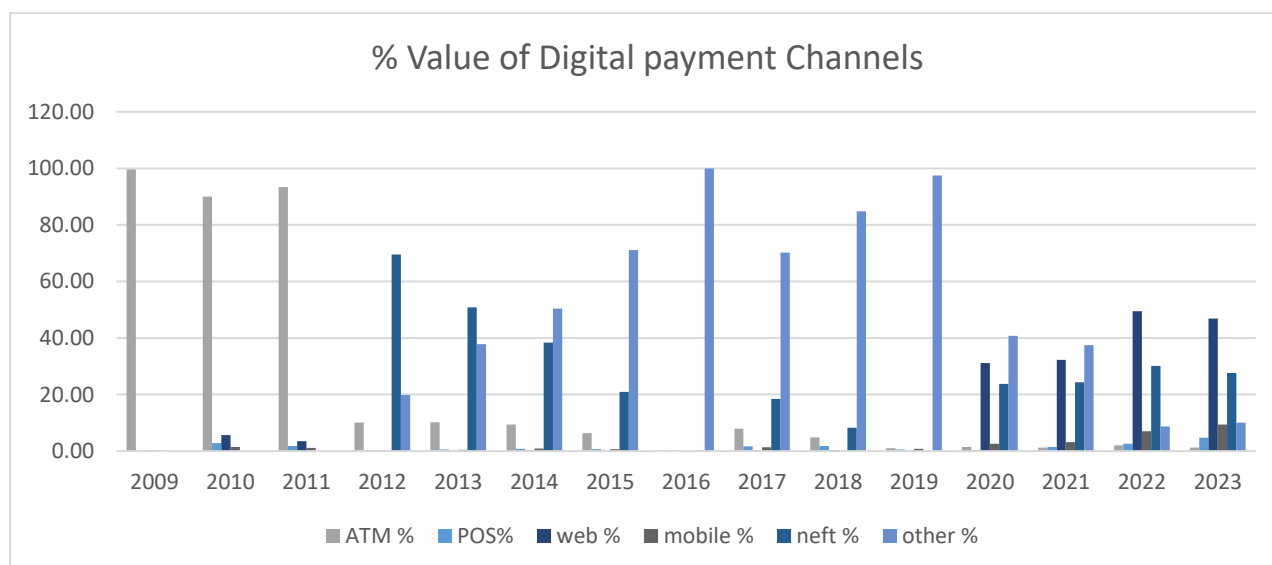
**Source:** Researchers' compilation and computation 2025

The result of table four revealed that from 2009 to 2011, ATM dominated the value of transactions, while NEFT dominated value transaction in 2012 and 2013, OTHERS (RTGS, USSD, DIRECT DEBITS, ACH, NIP, EBILLSPAY, REMITTA, M-CASH, CENTRAYPAY INTERBANK AND NAPS) dominated value of transactions from 2014 to 2021 while web/internet transactions dominated the value of transactions in 2022 and 2023.

A breakdown of the result revealed from 2009 to 2013, ATM value of transactions have 99.67%, 90.00%, 93.44%, 10.10% and 10.16% respectively. POS value of transactions have 0.04%, 2.86%, 1.86%, 0.24% and 0.55%, WEB value of transactions have 0.28%, 5.64%, 3.57%, 0.16% and 0.17% respectively. Mobile value of transactions has nil, 1.50%, 1.14%, 0.16% and 0.48% respectively; NEFT value of transactions have no data for 2009 to 2011 and 69.53% and 50.84 % for 2012 and 2013 respectively; and for **OTHERS**, there were no data for 2009 to 2011 and 19.80% and 37.81% for 2012 and 2013 respectively.

For 2014 to 2018, ATM value of transactions was 9.39%, 6.37%, nil%, 7.97% and 4.85% respectively. POS value of transactions was 0.80%, 0.72%, nil%, 1.74% and 1.78% respectively. WEB value of transactions was 0.19%, 0.15%, nil%, 0.23% and 0.30% respectively. Mobile value of transactions were 0.87%, 0.71%, No data, 1.36% and no data for 2018. NEFT value of transactions were 38.37%, 21.00%, nil%, 18.50% and 8.25% respectively. For **OTHERS** value of transactions were 50.39%, 71.05%, 100%, 70.20% and 84.81% respectively.

From 2019 to 2023, ATM value of transactions was 1.07%, 1.44%, 1.26%, 2.06% and 1.21% respectively. POS value of transactions was 0.53%, 0.37%, 1.45%, 2.59% and 4.72% respectively. WEB transactions were 0.08%, 31.12%, 32.33%, 49.50% and 46.98% respectively. Mobile transactions value were 0.83%, 2.57%, 3.16%, 7.02% and 9.40% respectively. NEFT value of transactions were no data, 23.77%, 24.33%, 30.16% and 27.65% respectively. **OTHERS** value of transactions was 97.49%, 40.72%, 37.48%, 8.67% and 10.10%.



**Fig 4: Value of Digital Payments Channels Penetration in Nigeria from 2009 to 2023 (Nb)**



## Conclusion and Recommendations

This study to a relative level has validated the implementation of digital payment system in Nigeria by the apex bank (CBN). While the volume and values of clearing cheques are on the downward trajectory, that of digital payment system have been on the upward trajectory validating cashless policy. However, on the digital channels, the result is a mixed bag, thus, endorsing the dynamics in the use of the different channels by Nigerians by embracing any channel that provides more effective and efficient service. In addition, the study findings was further confirmed by the 150MN fine imposed on 10 commercial banks in January 2025 for failing to activate their ATM machines with cash during the last quarter of 2024.

Based on the findings of the study, the following were recommended

The fintech companies should improve on their weak infrastructure base in-order to improve their service delivery because improvement in service delivery will encourage more acceptance of digital payment system which will lead to financial inclusion which can help manage inflation in the economy.

Secondly, there should be a stronger regulatory framework to help check cyber security and increase clients' confidence in the use of digital payment system

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# **EFFECT OF METACOGNITION ON ACHIEVEMENT AND RETENTION IN BUILDING DRAWINGS AMONG UNIVERSITY STUDENTS**

**O. D. ALAWODE<sup>1</sup>, P. S. YADUMA<sup>2</sup>, H. Bello<sup>3</sup> and A. A. DEBA<sup>4</sup>**

**<sup>1</sup> Departments of Industrial and Technology Education, Federal University of Technology  
Minna**

**<sup>2,3 & 4</sup> Department of Vocational and Technology Education, Faculty of Technology Education,  
Abubakar Tafawa Balewa University, Bauchi**

**Corresponding Email: [dolapoalawode@futminna.edu.ng](mailto:dolapoalawode@futminna.edu.ng)**

## **ABSTRACT**

*Metacognition is regarded as a fundamental skill influencing cognitive performance and learning in domains. It is a higher order thinking involving active control over the cognitive processes engaged in learning. Therefore, integrating metacognition into instructional strategy has gained attention for its potential to enhance academic achievement and retention. This study investigated the effect of metacognition on achievement and retention in building drawings among university students. The study determined the achievement of students taught using metacognitive instructional strategies against demonstration method and determined the retention of students taught using metacognitive instructional strategies against demonstration method. Two research questions, two null hypotheses and effect size measures guided the study. A quasi-experimental design with two intact class groups was adopted. The sample consisted of 245 students from two federal and two state-owned universities chosen through simple sampling techniques. The findings revealed that students taught using metacognitive strategies significantly outperformed those taught through demonstration methods in both achievement and retention. The experimental group established consistent performance gains and better knowledge retention, with effect size analysis indicating large to very large effects, underscoring the practical significance of the strategy. These findings accentuate the importance of adapting metacognitive strategies as an innovative approach to teaching building drawings among building technology education students in the universities.*

**KEYWORDS:** *metacognition, achievement, retention, building drawings*

## INTRODUCTION

Metacognition, often described as higher order thinking" plays a crucial role in learning and cognitive development. It involves the awareness and regulation of one's cognitive processes, enabling learners to plan, monitor, and evaluate their learning strategies (Mekala and Radhakrishnan, 2019). The concept of metacognition is deeply rooted in constructivist learning theories, particularly those advanced by Jean Piaget, Jerome Bruner, and Lev Vygotsky. These scholars laid the foundation for understanding how learners construct knowledge, emphasizing active engagement, self-regulation, and the social context of learning.

The integration of metacognition into instructional strategies is therefore a direct application of constructivist principles. Metacognition in terms of 'higher order thinking is for students to actively control the cognitive processes engaged in thinking and acquiring knowing' (learning). The definition of metacognition later modified as learners' awareness of their own knowledge and their ability to understand, control and manipulate skills (Padmanabha, 2020). This description of metacognition supports the effect of metacognitive instructional strategies in enhancing students' academic achievement, particularly in building drawings, where visualization and problem-solving skills are crucial (Özçakmak, Köroğlu, Korkmaz and Bolat, 2021).

Metacognitive instructional strategy is an ordered processes used to control and monitor student's own cognitive activities and to ensure that a cognitive goal in solving problem and other engagements have been met in the course of learning. Tobias and Everson's (2009) hierarchical model of metacognition provide a structured framework for implementing metacognitive instructional strategies. According to this model, metacognitive learning involves four key components: planning, selecting strategies, evaluating learning, and knowledge monitoring. These components enable learners to control their cognitive processes effectively, improving their ability to regulate learning experiences. The general perception of metacognition in instruction is strongly connected to self-regulatory, self-identity and reflection as a process for achieving self-awareness as a learner. Students can only be aware of their learning strategy consciously or unconsciously if effective instructional strategy such as metacognitive instructional strategy is employed during teaching and learning process (Jody, Diana, Megan, Amy, Jessica, Matthew & Manuela, 2019).

Teaching building drawings as a technical oriented course, involves: connection, construction, interpretation of drawings and techniques that needs metacognitive strategy to improve building drawing concepts. building drawings is synonymous as architectural drawings in some universities offering building technology education and other tertiary institutions that deal with drawings and its interpretation (National Universities Commission (NUC), 2021). Building drawings comprise of presentation of drawings (isometric, oblique and perspective), projection (plan, block plan, site plan, and elevations), section and model with the use of drawing instruments, tools and equipment. It requires skills that involve the manipulation of drawing instruments to construct jointed lines, skills that can navigate thinking from concrete knowledge into abstract knowledge towards a memorable and interesting course.

Metacognitive strategy is flexible when permeate into learning process to develop and enhance students thinking processes that will last for long time. Absorption of knowledge gained is what technology education students need to activate for academic achievement. If information is to be retained and retrieved for use over a period of time, it must be stored in long-term memory as schemata (Drigas and Mitsea, 2021). Hence, memory is essential for individuals to remember experiences and use them to respond to future events (retention). Students' retention is a process of ensuring student success. Therefore, understanding retention and what facilitates it can help

teachers select strategy like that of metacognitive strategy to improve the retrieval of information among students. Building technology education students' retention can be retained and sustained for over a period of time if a memorable learning strategy of metacognitive strategy components are employed during and after teaching and learning subjects (Padmanabha, 2020). Technology education students need effective instructional strategy of metacognitive strategy to improve on the existing teaching-learning strategies towards building drawings knowledge. Hence, this study tends to investigate the effect of metacognition on achievement and retention in building drawings among university students.

### **Statement of the Problem**

The challenge of teaching subject concepts has often been linked to the instructional methods employed by educators, among other factors. Samaresh (2017); Yildirim and Ortak (2021) suggest that traditional teaching strategies may fail to engage students, leading to a lack of interest in the subject matter. Similarly, Padmanabha (2020); Eşref and Cevat (2021) have highlighted that low academic achievement among students may stem from the use of inappropriate instructional strategies, students' inability to self-regulate their learning, and a lack of understanding of how to apply learning strategies effectively when needed.

The discrepancies in students' awareness of their own learning abilities appear to be a critical gap in the teaching and learning of building drawings at the university level. This gap underscores the need for alternative instructional methods that can better enhance students' understanding and retention of building drawings concepts. Despite the recognized importance of metacognitive strategies in education, there has been little to no empirical research testing the effectiveness of these strategies within technology education courses at the university level. In response to this gap, the present study aims to determine the effect of metacognition on achievement and retention in building drawing among university students.

### **Aim and Objectives of the Study**

The aim of this study is to determine the effect of metacognition on achievement and retention in building drawings among university students. Specifically, the study seeks to:

1. Determine the academic achievement of students taught building drawings using metacognitive strategy and demonstration method
2. Determine the effect of metacognitive instructional strategy on students' retention in building drawings.

### **Research Questions**

The following research questions were in order to achieve the objectives of the study

1. What is the academic achievement of students taught building drawings using metacognitive strategy and demonstration method?
2. What is the effect of metacognitive strategy on students' retention in building drawings as against those taught with demonstration method?

### **1.5 Research Hypotheses**

Based on the research questions drawn for the conduct of this study, the following null hypotheses were formulated and tested at 0.05 significance levels:

- H<sub>01</sub>:** There is no significant effect in the academic achievement of students taught building drawings using metacognitive strategy against demonstration method.

**H<sub>02</sub>:** There is no significant effect in the retention of students taught building drawings using metacognitive instructional strategy and those taught using demonstration method.

## METHODOLOGY

The study adopted quasi-experimental design. This design involved the use of two intact class groups (experimental and control). It, therefore, utilized the nonequivalent, non-randomized control group design. The total sample size for this study was 245 building technology education students were sampled for the study. Purposive non-probability sampling was used to select all the universities offering technology education as suggested by (Salendab and Laguda, 2023). Using simple random sampling techniques, two federal and two state-owned universities were selected for the study among the universities offering building technology education. The two federal universities were considered as a single experimental group while the two state-owned universities were considered as a single control group respectively.

The instruments used for data collection are Building Drawings Achievement Test (BDAT) comprised of four theory questions covering the contents of floor plan, elevations, cross - section and roof plan. The face and content validity were employed along with theoretical alignment for the instrument and experts validated the instruments. Reliability of ADAT was determined by the test-retest method. The pilot testing of the instruments was conducted to 15 students of final year building technology education students of another university that was not part of the study. Cronbach Alpha ( $\alpha$ ) was used to establish the internal consistency of the ADAT. The reliability coefficient of the instrument obtained was 0.84.

The concept of metacognitive strategy, modified version of Tobias & Everson (2009) Metacognitive Strategy Teaching Model (MSTM) was adapted. The treatment involves 5 stages: knowledge monitoring; readiness; selecting strategy; problem solving; reflection phase. Two weeks after, Building Drawing Achievement Test (BDAT) was re-administered to assess students' retention. Descriptive statistics in form of mean and standard deviation was deployed to address the research questions. Hypotheses were tested using an independent sample t-test and effect size using Cohen's d, Glass's delta, and Hedges' g for the study. An independent samples t-test was used for hypotheses to compare the mean scores of the experimental and control groups research questions. The significance level was set at  $p < 0.05$ , meaning that any p-value below 0.05 was considered statistically significant, indicating a meaningful difference between the groups. The study also analyzed the effect sizes for research questions to determine the magnitude of effect observed between groups. The interpretation of these effect sizes follows conventional benchmarks: small effect:  $0.2 \leq d < 0.5$ , medium effect:  $0.5 \leq d < 0.8$  and large effect:  $d \geq 0.8$ .

## Results

**Research question 1:** *What is the academic achievement of students taught architectural drawing using metacognitive strategy and demonstration method?*

**Table 1:** Descriptive statistic of the academic achievement means effect of students taught building drawings using metacognitive strategy and demonstration method

Variable	Group	N	$\bar{x}$	$\sigma$	Mean effect
Post-test	Experimental	65	67.37	6.276	8.01
	Control	180	59.36	5.907	
	<b>Total</b>	<b>245</b>			

Note: N= Number of Respondents,  $\bar{x}$  = Mean,  $\sigma$  = Standard Deviation



The table 1 revealed that the experimental group ( $\bar{x} = 67.37$ ,  $\sigma = 6.28$ ) outperformed the control group ( $\bar{x} = 59.36$ ,  $\sigma = 5.91$ ) with a mean effect of 8.01. The lower standard deviation in the experimental group indicates a more consistent performance compared to the control group. These results suggest that metacognitive instructional strategies positively have more effect on students' academic achievement in building drawings.

**Research question 2:** *What is the effect of metacognitive strategy on students' retention in building drawings as against those taught with demonstration method?*

**Table 2:** Descriptive statistic of the retention means effect of students taught building drawings using metacognitive strategy and demonstration method

Variable	Group	N	$\bar{x}$	$\sigma$	Mean Effect
Post-post-Test	Experimental	65	73.75	7.634	4.26
	Control	180	59.49	7.605	
	<b>Total</b>	<b>245</b>			

Note: N= Number of Respondents  $\bar{x}$  = Mean,  $\sigma$  = Standard Deviation

Table 2 presents the experimental group, taught with the metacognitive strategy, achieved a higher post-post-test mean score ( $\bar{x} = 73.75$ ,  $\sigma = 7.63$ ) than the control group ( $\bar{x} = 59.49$ ,  $\sigma = 7.61$ ), indicating a mean effect of 4.26. This significant difference suggests that the metacognitive strategy effectively enhanced students' retention of building drawing concepts over time.

**Hypothesis 1:** *There is no significant difference in the academic achievement of students taught building drawings using metacognitive strategy against demonstration method.*

**Table 3:** Independent samples t-test for academic achievement of students taught building drawings using metacognitive strategy and those taught using demonstration method.

Levene's Test for Equality of Variances								
Variable	Groups	N	F	Sig.	t-value	$\bar{x}$	$\sigma$	Sig. (2-tailed)
Pre-test	Experimental	65	.001	.981	9.218	67.37	6.276	.000
	Control	180				59.36	5.907	

Table 3 shows the results of an independent samples t-test comparing the academic achievement of students taught building drawings using the metacognitive instructional strategy against the traditional method. Levene's test for equality of variances indicated that the assumption of equal variances was met ( $F = 0.001$ ,  $p = 0.981$ ). The t-test revealed a statistically significant difference in academic achievement between the experimental group ( $\bar{x} = 67.37$ ,  $\sigma = 6.28$ ) and the control group ( $\bar{x} = 59.36$ ,  $\sigma = 5.91$ ) with a t-value of 9.218 and a p-value of 0.000 ( $p < 0.05$ ), suggesting that the metacognitive instructional strategy significantly improved students' academic achievement in building drawing compared to the traditional method.

**Hypothesis 2:** *There is no significant effect in the retention of students taught building drawings using metacognitive instructional strategy and those taught using demonstration method.*

**Table 4:** Independent samples t-test for effect in the retention of students taught building drawings using metacognitive strategy and that those taught using demonstration method.

Levene's Test for Equality of Variances								
Variable	Groups	N	F	Sig.	t-value	$\bar{x}$	$\sigma$	Sig. (2-tailed)
Retention	Experimental	65	1.076	.301	12.944	73.75	7.634	.000
	Control	180				59.49	7.605	

The independent samples t-test in Table 4 showed a statistically significant difference in the retention of students taught building drawings using the metacognitive instructional strategy (experimental) ( $\bar{x} = 73.75$ ,  $\sigma = 7.634$ ) compared to those taught using the demonstration method (control) ( $\bar{x} = 59.49$ ,  $\sigma = 7.605$ ), with a t-value of 12.944 and a p-value of 0.000 ( $p < 0.05$ ). Null hypothesis two was, therefore, rejected. The finding indicates that the metacognitive instructional strategy was more effective in enhancing students' retention of architectural drawing concepts.

### Effect size

The results of effect size, its interpretation and hypothesis implication are below:

#### Research question one:

The results of effect size for Cohen's  $d = 1.403508$ , Glass's delta = 1.456364, Hedges'  $g = 1.380421$  are the results of effect size of RQ 1. All values indicate a large effect. This suggests a substantial effect between the groups. This implies that, if the hypothesis predicted a difference, it would be supported by the data, indicating a strong effect of the variable tested.

#### Research question two:

The results of effect size for Cohen's  $d = 1.87151$ , Glass's delta = 1.867959, Hedges'  $g = 1.873198$  are the results of effect size of RQ 2. These values indicate a very large effect. There is a strong and meaningful difference between the groups. The hypothesis would be strongly supported, indicating a powerful effect of the variable.

### Discussion of the Findings

The findings of research question one and its null hypothesis indicated that metacognitive instructional strategy was more effective in improving students' academic achievement in building drawings compared to the demonstration method. The findings of this study concurred with existing literature, such as the studies conducted by Tachie, (2019), Agwu and Okigbo (2024); Langdon, Botnaru, Wittenberg, Riggs, Mutchler, Syno and Caciula (2019), who examined the effect of metacognitive strategy instruction in mathematical problem solving and students' achievement among other different dependent variables affirmed that the metacognitive teaching strategy perform better than demonstration method. Similarly, Eze, Obidile Akamobi (2019); Jody, et al. (2019) also in agreement in their studies that metacognitive teaching strategy performed better than demonstration method. The results indicated that teaching with metacognition strategies is more effective to increase the achievement of students in mathematics course and the result showed that metacognition strategies is significantly effective than demonstration method.

The findings of research question two and its null hypothesis revealed that, there was a statistically significant effect in the retention of students taught building drawings using metacognitive instruction strategies and those taught using demonstration method in favour of experimental group. The findings in this study are in agreement with the findings of Adeniji, Ameen, Dambatta, and Orilonise (2018); Yildirim and Ortak (2021) who conducted a study on relative effectiveness of constructivism and meta-learning teaching methods on academic achievement and retention of basic electricity among technical college students; studied the effects of the authentic learning approach in social studies on academic achievement, retention of knowledge, and attitude towards the course. The studies showed that metacognitive strategy learning had a significant effect on students' retention ability against demonstration method. Likewise, Radmehr and Drake (2020) assessed the impact of a student's motivation and beliefs about calculus and their ability to retain mathematical skills after having practiced and developed metacognitive skills. The results of the study showed that there is a positive correlation between learning metacognitive skills and retaining content also, there is significant difference among the variables which is in line with the present study

## Conclusion

Introducing a new method or alternative means of teaching-learning building drawings within the domain of building technology education as a means of innovation and novelty cannot be over emphasized for academic achievement. This study examined the effects of metacognition on achievement and retention in building drawings among university students. It is important to know that metacognitive strategy puts emphasis on how students can plan, monitor and regulate their learning processes in order to achieve academic goal. The statistical analysis revealed that students in the experimental group, who received explicit instruction in metacognitive strategies, outperformed those in the control group. Likewise, the findings confirm that teaching through metacognitive instructional strategies significantly enhances students' retention ability, enabling them to recall and apply learned concepts more effectively. Therefore, the results demonstrate that metacognitive strategies are both teachable and learnable to improve academic achievement and retain and retrieve prior knowledge among building technology education students.

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# **EFFECTS OF SINGLE AND MIXED INFECTION OF *MELOIDOGYNE JAVANICA* (TREUB) CHITWOOD AND *FUSARIUM OXYSPOURUM* (SCHLECHT) SYNDER AND HANSEN ON GROWTH AND YIELD PARAMETERS OF BAMBARA GROUNDNUT (*VIGNA SUBTERRENEA* (L.) VERDC.**

**NGBADA, N.A.**

**Department of Botany, Joseph Sarwuan Tarka University,**

**Makurdi, Benue State**

**Email: [ngbada\\_agbor@yahoo.com](mailto:ngbada_agbor@yahoo.com)**

## **ABSTRACT**

*The aim of the investigation was to determine the pathogenicity of nematode-N (*Meloidogyne javanica*) and fungus-F (*Fusarium oxysporum*) in Bambara groundnut (*Vigna subterreneae* (L.) Verdc.) under field condition using growth and yield parameters. Fungus was sourced from infested plants while nematode was sourced from infested soils using standard procedures. The Randomized Complete Block Design (RCBD) consisting 5 replicates, 6 treatments, 5 blocks and a total of 150 experimental units. Inoculation of pathogens into Bambara plants was done followed by plant characterization at flowering and maturity stage. Results showed that simultaneous infection by N+F pathogens caused the highest percentage loss in flowering (64.76%), number of pods (75.57%), and weight parameters. This was followed by other mixed treatments in the descending order N+F7, N+F14. The damages caused by mixed interactions of pathogens were higher than the single effects, the least being the fungus. Therefore, inoculation of nematode, fungus simultaneously (N+F) caused significant damages on flowering and yield components of Bambara nut field trials. This finding is crucial in the disease management of Bambara groundnut to enhance its yield and overall productivity to achieve food security.*

**KEYWORDS:** Simultaneous infection, Bambara, Flowering, Yield, Food security



## INTRODUCTION

*Vigna subterrene* var. *spontanea* (wild varieties) and *Vigna subterrene* var. *subterrene* (cultivated varieties) are the two botanical varieties of Bambara groundnut (Agyeman *et al.*, 2021). Most of the world's Bambara groundnut is grown in West Africa and the crop is most prominent in the traditions of rural communities (Hillocks *et al.*, 2012). Bambara groundnut is important for small holders and their households because the beans are sources of vital nutrients including high protein content (Hillocks *et al.*, 2012; Yao, *et al.*, 2015; Atoyebi *et al.*, 2018; Unigwe *et al.*, 2018; Feldman *et al.*, 2019). Compared to other legumes, Bambara nut is deficient in sulphur-containing amino acids while some genotypes contain higher amount of methionine and lysine (Unigwe *et al.*, 2018). Tan *et al.* (2020) described Bambara as an underutilized leguminous crop for global food security and nutrition. Bambara groundnut seeds contain 63% carbohydrates, 19% protein and 6.5% oil (Hillocks *et al.*, 2012; Tan *et al.*, 2020). The gross energy value of Bambara nut seeds is greater than that of other pulses viz; cowpea (*Vigna unguiculata*), lentil (*Lens esculenta*) and pigeon pea (*Cajanus cajan*), (FAO, 2015). It is a good source of fibre, Calcium (Ca), Iron (Fe) and Potassium (K) (Hillocks *et al.*, 2012; Tan *et al.*, 2020).

The production of Bambara groundnut is challenged by biotic stresses. Noteworthy fungal diseases are Cercospora leaf spot (CLS) caused by *Cercospora* spp., Powdery mildew (*Erysiphe polygoni*), Fusarium wilt (*Fusarium oxysporum*), Rust (*Puccinia* spp) and Leaf blight (*Colletotrichum* spp). Bacterial blight (*Xanthomonas* spp) and Bacterial wilt (*Ralstonia solanacearum*) are among the bacterial pathogens that infect Bambara groundnut (Majola *et al.*, 2021; Waleed *et al.*, 2023). Among the nematode diseases, root knot nematode, *Meloidogyne javanica* (Treub) Chitwood, is the most dominant species that causes severe losses to Bambara yield (Meena *et al.*, 2016; Majola *et al.*, 2021). Other species of *Meloidogyne* including *M. enterolobii* and *M. incognita* have been reported to parasitize legumes (Chitambo *et al.*, 2016; Kassam *et al.*, 2022). Root knot nematodes (RKNs) are one of the most important nematode pests of crop plants and have diverse host range (Sayan *et al.*, 2008; Waleed *et al.*, 2023). They constitute major constraints to the cultivation and production of crops worldwide including Nigeria (Olayide *et al.*, 2018; Patil *et al.*, 2020).

Plant parasitic nematodes are known to aggravate the final yield losses as they form disease complexes through their interactions with fungi, bacteria and viruses. In the rhizosphere, root knot nematodes interact with a wide range of microbiota/plant pathogens viz fungi, bacteria, viruses (Al-Hazmi and Al-Nadary, 2015). The combined effects of wilt causing fungi, bacteria and root knot nematodes cause serious damage to crops. With the worldwide distribution, extensive host range and interaction with fungi, bacteria and viruses in disease complexes, root knot nematodes rank first among the ten damaging genera of parasitic nematodes affecting world food supply (Khpalwak, 2012). Information is lacking on the single and combined interaction effects of three common pathogens on the production of Bambara crop. The aim of the present study was to determine the nature of pathogenicity of nematode (*Meloidogyne javanica*), fungus (*Fusarium oxysporum*) and bacterium (*Xanthomonas axonopodis*) as they affect the flowering and yield of Bambara groundnut (*Vigna subterrene* (L.) Verdc.) under field condition.

## MATERIALS AND METHODS

### Experimental Site

The field experiment was located at the Agronomy Research Farm, Federal University of Agriculture Makurdi, Benue State (Now known as Joseph Sarwuan Tarka University Makurdi),



Tropical Guinea Savanna (7° 43' 50" North and 8° 32' 10" East). The annual average rainfall was 1090 mm with a temperature range of 27.8 °C - 28.2 °C minimum 30.1 °C - 34.1 °C maximum (NAF, 2020). The field used for this investigation had previously been cropped to tomato and egg plants with high *Meloidogyne javanica* infestation but had no incidence of *Fusarium oxysporum* infection.

### **Collection of Bambara nut Seeds**

Healthy seeds of Bambara groundnut (SUAN variety) were sourced from the seed store of the Department of Plant Breeding and Seed Science, Federal University of Agriculture Makurdi, Benue State.

### **Sterilization of seeds, glass ware and soil**

Seeds were surface sterilized using 1.08% Sodium hypochlorite solution (Ganpati and Judy, 2014). Other materials were either air dried as in plastics or oven dried as in glass wares or autoclaved as in media (Khpalwak, 2012). All laboratory activities were carried out under aseptic condition (Khpalwak, 2012).

### **Sources of test pathogens**

*Fusarium oxysporum* was isolated from stem and root of diseased okra (*Abelmoschus esculentus* L.) using the method of (Iheukwumere *et al.* (2009) and sub-cultured on Potato Dextrose Agar (PDA) plates (Mohit *et al.*, 2014) followed by morphological identification on the stereobinocular microscope and the use of identification guide (Alexopoulos *et al.*, 2002). Spores were separated from the mycelium. *Meloidogyne javanica* was collected from galled roots of infected tomato plants (*Solanum lycopersicum* L.) in the field using standard methods (Ganpati and Judy, 2014). The infected roots were examined for the presence of galls containing adult female and juvenile (Iheukwumere *et al.*, 2008; Bello *et al.*, 2015) using perineal pattern morphology as compared with standard pictorial guide (Wonang and Akueshi, 1999).

### **Field experimental design and seed sowing**

The field was cleared, ploughed and planting beds prepared. The trial was arranged in a Randomized Complete Block Design (RCBD) with five blocks each measuring 13m x 2m spaced 1m from each other. Each block consisted of nine subplots which measured 2m x 1m and each plot consists of five rows of plants spaced 40cm apart. The experiment was a 5\*6\*5 factorial design (5 blocks, 6 treatments, 5 replicates per treatments) resulting in 150 experimental units. Figure 2 shows the field experimental layout. In each experimental unit, three seed of Bambara groundnut were sown to a depth of 3-5cm and thinned to one plant per planting hole after germination at day 7. In doing this, care was taken to ensure that the plants were of uniform growth and vigour (Bello *et al.*, 2014).

### **Inoculation of test plants in field experiment**

Inoculation of test plants with fungus and bacterium was done 7 and 14 days after germination (DAG), whereas nematode infection was by naturally occurring nematode population in the soil. Inoculation of test plants was done as previously described in the pot experiment. The fungus was inoculated as described in the pot culture experiment. The nematicide Carbofuran is a granular formulation that was incorporated into the top 10 to 15cm of soil at the rate of 3kg per hectare prior to sowing. This nematicide is highly effective in the control of root knot nematodes, *Meloidogyne* spp (Kankam and Adomako, 2014). The experiment was terminated 120 days after inoculation when the plants had fully matured.

## Treatment combination and description

T1: Bambara seedlings exposed to natural infection by the nematode in the soil at planting (N)

T2: Bambara seedlings inoculated with 10 cfu/ml of fungus alone (F) after sowing in Carbofuran (Furadan 10g) treated soil (F)

T3: Seedlings exposed to natural infection by nematode in the soil followed by 10 cfu/ml of fungus suspension simultaneously (N+F)

T4: Seedlings exposed to natural infection by nematode in the soil followed by inoculation with 10 cfu/ml of fungus 7 days after germination (N+F7)

T5: Seedlings exposed to natural infection by the nematode in the soil followed by inoculation with 10 cfu/ml of fungus 14 days after germination (N+F14)

T6: Seedlings with no nematode, fungus or bacterium in plots treated with Carbofuran (Furadan 10G) which served as control (C).

## Growth and yield characterization

Yield parameters were determined through standard measurement of length using the meter rule (cm) or weight using digital weighing balance (g) or by direct counting (Iheukwumere and Orkpeh, 2007). The following parameters were determined: shoot fresh and dry weight (g), root fresh and dry weight (g), number of flowers and number of pods.

## Data analysis

Minitab 17.0 software was used to analyse the data collected. Descriptive statistical tools were applied while Two Way ANOVA tool was employed in the determination of treatments and block effects across the various parameters investigated in the field. One Way ANOVA tool was used in the determination of treatment effects in the pot experiments. Means separation was done using Fisher's LSD methods at 95% level of confidence. Friedman and Kruskal Wallis tests were applied as non-parametric tool

## RESULTS AND DISCUSSION

Table 1 presents field evaluation effects of single and mixed infection of root knot nematode (*M. javanica*), fungus (*F. oxysporum*) on total number of flowers as a phenological parameter. The control treatment recorded the highest number of flowers counted ( $94.2 \pm 7.62$ ) followed by nematode treatment ( $54.8 \pm 6.54$ ) while the combined treatment N+F had the smallest value ( $33.2 \pm 2.82$ ). Table 2 gives the average number of flowers per plant and the percentage reduction in flower production caused by inoculated pathogens using the control as a reference. The control treatment recorded the highest with mean of  $18.84 \pm 1.52$  while treatment N+F was the least with an average mean of  $6.64 \pm 0.56$  per plant. As a result, treatment N+F caused the highest percentage reduction in flower (64.76%), followed by N+F7 (52.55%), and bacterium (39.2%). Flowers are the organs of reproduction in angiosperms that accounts for plant yields through fertilization of ovules and development of ovaries to form seeds and fruits respectively (Mkandawire, 2017). The result obtained aligned with the findings of Waleed *et al.* (2023) who found that single and interaction effects of pathogens had drastic effects on flowering of legumes, and that pod size can be reduced significantly if infestation occurs before flowering. The observed reduction in flowering might be as a result of impaired supply of Nitrogen, Potassium and Phosphorus in plants as a result of pathogenic activities which resulted to delayed flowering and flowers abortion (Onyeke and Akueshi, 2011).

**Table 1: Field Evaluation of Single and Mixed Infection Effects of Treatments on Number of Flowers**

Treatments/Blocks	Total B1	Total B2	Total B3	Total B4	Total B5	Grand Mean TRT
N	80	55	45	46	48	54.8±6.54 <sup>b</sup>
F	76	57	48	51	34	53.2±6.84 <sup>b</sup>
N+F	37	36	35	36	22	33.2±2.82 <sup>c</sup>
N+F7	65	41	42	40	35	44.6±5.24 <sup>bc</sup>
N+F14	71	53	46	44	38	50.4±5.68 <sup>bc</sup>
C	124	92	87	82	86	94.2±7.62 <sup>a</sup>
Mean Block	75.11±7.51 <sup>a</sup>	54.33±5.41 <sup>b</sup>	50.11±4.91 <sup>b</sup>	48.56±4.48 <sup>b</sup>	41.33±6.03 <sup>b</sup>	

\* Means that do not share same letter are significantly different

F (Treatment) = 55.57, P= 0.000 (P<0.05)

F (Block) = 55.4, P=0.000 (P<0.05)

**Table 2: Effect of Single and Mixed Infection on Average Number of Flower per Plant**

TREATMENTS	Ground Mean TRT in all Block	Average number of flower per plant	% reduction in number of flowers against control
N	54.8±6.54 <sup>b</sup>	10.96±1.31	41.83
F	53.2±6.84 <sup>b</sup>	10.64±1.37	43.52
N+F	33.2±2.82 <sup>c</sup>	6.64±0.56	64.76
N+F7	44.6±5.24 <sup>bc</sup>	8.92±1.05	52.55
N+F14	50.4±5.68 <sup>bc</sup>	10.08±1.14	46.50
C	94.2±7.62 <sup>a</sup>	18.84±1.52	Reference point

\* Means that do not share same letter are significantly different

F (Treatment) = 55.57, P= 0.000 (P<0.05)

F (Block) = 55.4, P=0.000 (P<0.05)

Table 3 presents field evaluation effects of single and mixed infection of root knot nematode (*M. javanica*), fungus (*F. oxysporum*) on total number of pods as a yield parameter. The control treatment had the highest mean number of pods (74.8±3.34), and nematode (41.8±5.56) as single interaction. Combined or simultaneous treatment N+F recorded the least number of pods (18.2±1.32). The result showed significant difference in treatment (F=38.4, P<0.05) and block (F= 9.98, P<0.05) effects. Table 4 gives the average number of pods per plant and the percentage reduction in pod production caused by inoculated pathogens using the control as a reference. The control treatment recorded the highest with mean of 14.96±0.67 while treatment N+F was the least with an average mean of 3.64±0.26 per plant. Consequently, treatment N+F caused the highest percentage and significant reduction in pod production (75.57%) followed by N+F7 (54.55%).

These pathogens might have certainly altered the physiological processes in the plant thereby negatively impacting on its yield. This observation tallies with the findings of Iheukwumere (2007) and Waleed *et al.* (2023). The reduction in yield, presence of chlorotic regions or patches and stunting of the inoculated plants may be attributed to lack of physiological stability, as a result of reduced translocation, impaired nutrient absorption and abnormal production of growth regulators (Okechalu and Wonang, 2015; Meena *et al.*, 2016; Collett *et al.*, 2021). The parasitic effect of the infected roots by soil borne pathogens causes water stress and induces physiological

responses that lead to the partitioning of carbohydrates in plant organs, reduction of photosynthetic processes and decreased efficiency of carbon-fixation (Meena *et al.*, 2016; Zongo *et al.*, 2018; El-Sayed, 2022).

**Table 3: Field Evaluation of Single and Mixed Infection Effects of Treatments on Number of Pods**

Treatments/Blocks	Total B1	Total B2	Total B3	Total B4	Total B5	Grand Mean TRT
N	41	40	43	44	25	38.60±3.47 <sup>b</sup>
F	30	42	51	57	29	41.8±5.56 <sup>b</sup>
N+F	19	19	17	22	14	18.2±1.32 <sup>c</sup>
N+F7	40	30	38	40	22	34.0±3.52 <sup>b</sup>
N+F14	36	38	40	42	36	38.4±1.17 <sup>b</sup>
C	87	68	70	76	73	74.8±3.34 <sup>a</sup>
Mean Block	40.78±6.21 <sup>a</sup>	38.78±4.38 <sup>a</sup>	43.33±4.78 <sup>a</sup>	47.22±4.87 <sup>b</sup>	32.11±5.53 <sup>c</sup>	

\* Means that do not share same letter are significantly different

F (Treatment) = 38.4, P= 0.000 (P<0.05)

F (Block) =9.98, P=0.000 (P<0.05)

**Table 4: Effect of Single and Mixed Infection on Average Number of Pods per Plant**

TREATMENTS	Ground Mean TRT in all Block	Average number Of leaves per plan	% Reduction in number of leaves agai Control
N	38.60±3.47 <sup>b</sup>	7.72±0.69	48.40
F	41.8±5.56 <sup>b</sup>	8.36±1.11	44.12
N+F	18.2±1.32 <sup>c</sup>	3.64±0.26	75.57
N+F7	34.0±3.52 <sup>b</sup>	6.8±0.70	54.55
N+F14	38.4±1.17 <sup>b</sup>	7.68±0.23	48.66
C	74.8±3.34 <sup>a</sup>	14.96±0.67	

\* Means that do not share same letter are significantly different

F (Treatment) =38.4, P= 0.000 (P<0.05)

F (Block) = 9.98, P=0.000 (P<0.05)

Table 5 presents field evaluation effects of single and mixed infection of root knot nematode (*M. javanica*), fungus (*F. oxysporum*) and on total pod fresh weight (g) as a yield parameter. The control treatment had the highest mean fresh pod weight (317.7±18.1g), followed by fungus (181.0±18.9g). Combined treatment N+F recorded the least number of pods (95.2±6.12g). The result showed significant difference in treatment (F=36.0, P<0.05) and block (F= 7.17, P<0.05) effects. Table 6 gives the average fresh pod weight per plant and the percentage reduction in fresh pod weight caused by inoculated pathogens using the control as a reference. The control treatment recorded the highest with mean of 63.54±3.62 while treatment N+F was the least with an average mean of 19.04±1.22 per plant. Consequently, treatment N+F caused the highest percentage and significant reduction in fresh pod weight (70.0 %) followed by N+F7 (49.92%). The present observation is in consonance with the findings of Iheukwumere *et al.* (2007) who showed that the parasitry effects of both pathogens on the roots of the plant impacted more negatively on the plant that infection with each pathogen alone. The present finding also aligns with the work Kanjo and Iheukwumere (2021) who found a significant reduction in growth components of susceptible and to an extent, resistant tomato plants under the influence of single and mixed infection of *F. oxyporum* and *M. javanica*.

**Table 5: Field Evaluation of Single and Mixed Infection Effects of Treatments on Pod Fresh Weight (g)**

Treatments/Blocks	Total B1	Total B2	Total B3	Total B4	Total B5	Grand Mean TRT
N	198.00	204.30	167.60	194.10	127.50	177.7±13.4 <sup>b</sup>
F	139.20	203.50	178.40	240.20	143.80	181.0±18.9 <sup>b</sup>
N+F	103.20	98.50	88.50	110.50	75.30	95.2±6.12 <sup>c</sup>
N+F7	174.00	170.60	161.80	177.60	111.40	159.1±12.2 <sup>c</sup>
N+F14	168.70	165.20	171.60	185.60	173.40	172.9±3.47 <sup>b</sup>
C	381.70	278.00	289.10	322.90	316.60	317.7±18.1 <sup>a</sup>
Mean Block	188.7±25.9 <sup>a</sup>	187.3±15.7 <sup>a</sup>	174.8±52.0 <sup>a</sup>	206.5±19.1 <sup>b</sup>	154.7±22.4 <sup>c</sup>	

\* Means that do not share same letter are significantly different

F (Treatment) = 36.00, P= 0.000 (P<0.05)

F (Block) = 7.17, P=0.000 (P<0.05)

**Table 6: Effect of Single and Mixed Infection on Average Number of Pod Fresh Weight per Plant**

TREATMENTS	Ground Mean TRT in all Block	Average pod weight per plant	% Reduction in pod weight against Cont
N	177.7±13.4 <sup>b</sup>	35.5±2.68	44.07
F	181.0±18.9 <sup>b</sup>	36.2±3.78	43.03
N+F	95.20±6.12 <sup>c</sup>	19.04±1.22	70.03
N+F7	159.1±12.2 <sup>b</sup>	31.82±2.44	49.92
N+F14	172.9±3.47 <sup>b</sup>	34.58±0.69	45.58
C	317.7±18.1 <sup>a</sup>	63.54±3.62	Reference

F (Treatment) = 36.00, P= 0.000 (P<0.05)

F (Block) = 7.17, P=0.000 (P<0.05)

\* Means that do not share same letter are significantly different

Table 7 presents field evaluation effects of single and mixed infection of root knot nematode (*M. javanica*), fungus (*F. oxysporum*) on total pod dry weight (g) as a yield parameter. The control treatment had the highest mean fresh pod weight (89.16±4.16g). Combined treatment N+F recorded the lowest value (23.68±1.34g). The result showed significant difference in treatment (F=31.97, P<0.05) and block (F= 7.88, P<0.05) effects. Table 8 gives the average dry pod weight per plant and the percentage reduction in dry pod weight caused by inoculated pathogens using the control as a reference. The control treatment recorded the highest with mean of 17.88±0.84 while treatment N+F was the least with an average mean of 4.74±0.27 per plant. Consequently, treatment N+F caused the highest percentage and significant reduction in fresh pod weight (73.49 %) followed by N+F7 (51.45%), and. Figure 1 presents field evaluation effects of single and mixed infection of root knot nematode (*M. javanica*), fungus (*F. oxysporum*) on % reduction on number of flowers, number of pods and pod fresh weight at different treatments. Treatment N+F recorded the highest reduction in three yield parameters. This was followed by mixed treatments in the descending order N+F7, N+F14. These effects caused by mixed interactions were higher than the single treatments, the least being the bacterium inoculum. The manifestation by mineral deficiency symptoms by bambara groundnut infected with *Meloidogyne javanica* and *Fusarium oxysporum* can therefore be attributed to impaired translocation of these elements by the activities of root knot nematodes which feed and block vascular tissues of their host (Waleed *et al.*, 2023).

**Table 7: Field Evaluation of Single and Mixed Infection Effects of Treatments on Pod Dry Weight (g)**

Treatments/Blocks	Total B1	Total B2	Total B3	Total B4	Total B5	Grand Mean TRT
N	50.50	49.20	52.60	53.70	30.80	47.36±4.21 <sup>b</sup>
F	36.80	51.20	61.80	68.80	38.60	51.44±6.28 <sup>b</sup>
N+F	24.10	24.70	22.80	27.50	19.30	23.68±1.34 <sup>c</sup>
N+F7	48.40	37.30	47.10	56.60	27.50	43.38±5.0 <sup>b</sup>
N+F14	44.00	46.70	49.10	51.30	49.20	48.06±1.25 <sup>b</sup>
C	104.30	81.90	81.30	90.80	88.70	89.4±16 <sup>a</sup>
<b>Mean Block</b>	50.0±7.33 <sup>a</sup>	52.54±7.31 <sup>a</sup>	52.94±5.22 <sup>a</sup>	58.19±5.61 <sup>a</sup>	41.13±6.63 <sup>c</sup>	

\* Means that do not share same letter are significantly different

F (Treatment) = 31.97, P= 0.000 (P<0.05)

F (Block) =7.88, P=0.000 (P<0.05)

**Table 8: Effect of Single and Mixed Infection on Average Pod Dry Weight and Percentage Reduction in Dry Weight per Plant**

TREATMENTS	Ground Mean TRT in all Block	Average number Of leaves per plan	% Reduction in number of leaves agai Control
N	47.36±4.21 <sup>b</sup>	9.47±0.84	47.04
F	51.44±6.28 <sup>b</sup>	10.29±1.26	42.45
N+F	23.68±1.34 <sup>c</sup>	4.74±0.27	73.49
N+F7	43.38±5.01 <sup>b</sup>	8.68±1.00	51.45
N+F14	48.06±1.25 <sup>b</sup>	9.61±0.25	46.25
C	89.4±4.16 <sup>a</sup>	17.88±0.84	-

\* Means that do not share same letter are significantly different

F (Treatment) =31.97, P= 0.000 (P<0.05)

F (Block) = 7.88, P=0.000 (P<0.05)

## CONCLUSION

The investigation revealed that damages caused by mixed interactions of pathogens were higher than the single effects, nematode (N) and Fungus n(F). Therefore, inoculation of nematode, fu simultaneously (N+F) caused significant damages on growth and yield components of Bambara nut field trials. This report is crucial in the disease management of Bambara groundnut to enhance its yield and overall productivity to achieve food security.



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# **INNOVATIVE APPROACHES TO ENVIRONMENTAL EDUCATION: LEVERAGING GREEN TECHNOLOGY FOR SUSTAINABLE LEARNING IN NIGERIA**

**Isah Usman HASSAN<sup>1</sup>, & Khalid Usama SALISU<sup>2</sup>**

**<sup>1&2</sup>Geography department, School of Art and Social Sciences, Federal College of  
Education (technical) Bichi, Kano**

**Email: [Isahusmanhassan@gmail.com](mailto:Isahusmanhassan@gmail.com)<sup>1</sup>, [binzaydempire@gmail.com](mailto:binzaydempire@gmail.com)<sup>2</sup>**

## **ABSTRACT**

*Environmental education (EE) is key in promoting sustainability and addressing the global ecological challenges. For Nigeria, there is fast urbanization, forest destruction, and pollution that requires a transformational approach to environmental education. Traditional methods of teaching are unable to engage the students effectively, and therefore the necessity to adopt new approaches such as green technology to enhance learning. This article examines the contribution of green technology in transforming environmental education in Nigeria. Green technology, including renewable energy, online learning platforms, and green infrastructure, offers experiential and interactive learning opportunities that promote environmental conservation. Through the use of smart classrooms, virtual reality simulations, and renewable energy technologies, environmental education can be more effective, empowering students with essential problem-solving skills. In spite of its promise, the incorporation of green technology into Nigerian schools is hindered by challenges such as financial limitations, poor technical capacities, infrastructural shortfalls, and poor policy enforcement. All these obstacles call for more money, capacity building, public-private collaborations, curricular integration, and more legislative support*

**KEYWORDS:** *Environmental education, Green technology, Sustainable learning, Transformative teaching, Global realities*

## INTRODUCTION

Environmental education (EE) plays a critical role in fostering sustainability and addressing ecological challenges worldwide (UNESCO, 1977). In Nigeria, rapid urbanization, deforestation, and pollution pose significant environmental threats, necessitating a robust and dynamic approach to environmental education (Ugwu et al., 2006). Traditional teaching methods often fail to engage students effectively, making it imperative to adopt innovative strategies, such as leveraging green technology, to enhance learning outcomes (Zakri, 2006).

It is evident that our world today is quite changing and is different from that of the agricultural and the industrial revolution. The pressure on the environment due to climate change – higher temperature, shifting seasons, more frequent and extreme weather events such as floods and droughts, the challenge for food production becomes even more daunting. The intergovernmental panel for climate change (2007) noted that some African countries could face reduction in yield of up to 50% by 2020 if they fail to adapt to the changing climate.

Some human activities as a result of search for ‘quality standard of living’ through science and technology have brought other problems on the environment. These problems, Stead, E. and Stead, G. called “the issue wheel”. Such issues include over population, greater pollution, the death and destruction caused by toxic spills and dumps, the massive deforestation of the world’s rain forests for commercial purposes, the harm caused by numerous oil spills, the destruction of wildlife habitats for human development, the release of dangerous gases (greenhouse effect) in the atmosphere such as sulfur dioxide (SO<sub>2</sub>), nitrogen oxide (NO<sub>2</sub>), methane (CH<sub>4</sub>), chlorofluorocarbons (CFCs), the hydroxyl radical (OH), and carbon dioxide (CO<sub>2</sub>). Alberti (2010) pointed out that the interaction of humans and the natural environment may be creating a unique biochemistry of the environment. Rogers and Laffoley (2011) suggested changes in social, economic and environmental consequences.

Environmental education is an essential process of holistic learning, which includes the study of environmental problems, their causes, and their possible solutions. Environmental education integrates different subjects, including science, social studies, literature, and art, to enable learners to understand the interconnection between human activities and environmental systems. Environmental education aims to develop students' skills, knowledge, and attitudes towards the environment and provide them with the tools to make informed decisions about sustainable living. With the rise of global environmental problems, including climate change, loss of biodiversity, and environmental degradation, there is a need to incorporate emerging educational innovations to enhance transformative teaching and learning in environmental education.

Environmental education encompasses various aspects, including understanding ecological systems, biodiversity, climate change, natural resource management, and environmental issues. It emphasizes the interconnectedness between humans and the environment, highlighting the importance of sustainable practices and the need for collective action to address environmental challenges.

Through environmental education, students are encouraged to develop critical thinking, problem-solving, and decision-making skills. They learn to appreciate nature, recognize their role in environmental stewardship, and develop a sense of responsibility towards future generations. Environmental education can be integrated into various subjects across the curriculum, enabling students to explore real-world issues and engage in hands-on learning experiences.

Green technology in education includes the use of digital tools, artificial intelligence, and renewable energy solutions to create immersive and interactive learning experiences (Fontana, 1984). These methods not only equip students with critical problem-solving skills but also promote environmental stewardship by integrating sustainability into the curriculum (Adara, 1997). Through project-based learning, experiential fieldwork, and technological innovations, educators can transform environmental education into a more engaging and impactful discipline (Adeboye, 2002).

This study explores how green technology can revolutionize environmental education in Nigeria, providing insights into its implementation, benefits, and challenges. By integrating sustainable practices into learning environments, this study aims to contribute to the global discourse on environmental sustainability and education reform.

### **Concept of Environmental Education**

In Nigeria, the concerted effort of the Nigerian Conservation Foundation (NCF) in 1988 motivated the fusion of an environmental education element into the citizenship education curriculum in 1990 national curriculum review conference, subsequently followed by a UNESCO sponsored National Workshop on the integration of EE elements in the National School Curriculum and the teacher programme. Education involves the impacting of knowledge and development of skills for self-realization. Salvano Briceno & David C. Pitt (1988), “education has always been part of the process by which people become fitted to live successfully in their world. Education is concerned with development of an individuals’ ability to think, reason, and create. One of its fundamental needs is how learners of all ages learn and what they can learn. The ‘how’ has much to do with the teacher and the ‘what’ of the curriculum or syllabus as the case might be; and ‘kind’ of interaction among the ‘how’, the ‘what’ and of course the receiver – learner. Environment is a broad concept. It refers to all or part of an object’s or a living beings surrounding. It infrastructure. This is leading to increased and concentrated discharge of untreated sewage from communities to waterways, wetland and coastal zones. Millennium Ecosystem Assessment (2005) point to a factor of four - to eight - fold increase in waste water loading within the next four decades over most of Africa. The FAO (2010) estimates that 85% of marine fisheries in 2008 were either fully exploited, over exploited or depleted. In addition, the unabated land and marine based pollution of our oceans and seas has prompted changes to their chemistry, temperature and current which led to ocean acidification, biochemistry loss, and widespread habitat destruction, proliferation of invasive species and simplification of ecosystems. The Millennium Ecosystem Assessment (2005) reported that over the last few decades approximately 35% of mangroves have been lost or converted and approximately 20% of coral reefs worldwide have been destroyed and 20% degraded.

The desire and commitment of government to tackle environment education issues in Nigeria pointed to the need to develop a baseline survey, the Nigeria living standard survey 2003/2004 for monitoring and evaluation of the various government programmes like tree planting campaign, sustainable environmental management technique such as soil erosion control, shelter belt control, afforestation and reforestation, biodegradation programme for pollution amongst others. At 2005, access to safe drinking water, as against about 80% in urban areas (NBS, 2004). Some 29% of the total population live at risk from annual floods, over 90% of the rural population depends, on the forest for livelihood and domestic energy. Since independence in 1960, successive Nigerian government have initiated and promulgated differences policies programmes and projects for environmental education in Nigeria. However, Ugwu (2006) argues that many of these policies and programmes have failed to attain their objectives or fallen short of the ends they were set up to attain.



Environmental education is the process of learning about the natural world and our relationship with it. It aims to increase awareness and understanding of environmental issues, develop critical thinking skills, and inspire action to help protect and sustain the planet.

Environmental education is a multidisciplinary field that promotes the understanding of ecological systems, biodiversity, climate change, and resource management. It encourages learners to analyze environmental issues critically and develop solutions for sustainability.

The primary goals of environmental education, as endorsed by UNESCO (1977), include:

**Awareness:** Fostering sensitivity towards environmental challenges.

**Knowledge:** Equipping learners with comprehensive environmental insights.

**Attitudes:** Instilling values that promote environmental responsibility.

**Skills:** Developing competencies for identifying and resolving ecological issues.

**Participation:** Encouraging active involvement in environmental conservation efforts.

### **Concept of Green Technology**

Green technology, also known as sustainable technology, refers to the development and application of products, systems, and processes that conserve natural resources and reduce negative environmental impacts (Jones & Smith, 2021). It encompasses various fields, including renewable energy, waste management, water conservation, and eco-friendly manufacturing. The primary goal of green technology is to mitigate climate change by promoting sustainable practices that balance economic growth and environmental responsibility (Brown, 2020).

One of the key aspects of green technology is its reliance on renewable energy sources such as solar, wind, and hydroelectric power, which significantly reduce carbon emissions compared to fossil fuels (White & Green, 2019). Additionally, advancements in energy-efficient technologies, such as LED lighting and electric vehicles, contribute to decreasing energy consumption and promoting environmental sustainability (Miller, 2022). With increasing concerns over global warming and resource depletion, the adoption of green technology is becoming essential for achieving long-term ecological stability and economic resilience (Smith et al., 2023).

### **Green Technology and Its Role in Environmental Education**

Environmental education plays a crucial role in promoting the adoption and understanding of green technology. It provides individuals with the knowledge, skills, and attitudes necessary to address environmental challenges and embrace sustainable practices (Johnson & Taylor, 2020). By integrating green technology into environmental education, students and the general public can better understand the importance of renewable energy, waste management, and eco-friendly innovations in mitigating climate change (Smith *et al.*, 2021).

One of the primary objectives of environmental education is to foster awareness and responsibility toward environmental conservation. Green technology serves as a practical application of these principles by demonstrating how sustainable solutions, such as solar power and energy-efficient appliances, can reduce ecological footprints (White & Green, 2019). Educational programs that emphasize green technology help individuals recognize the long-term benefits of sustainable living and encourage them to adopt eco-friendly behaviors (Brown, 2020).

Moreover, environmental education incorporating green technology promotes problem-solving and critical thinking skills. By engaging with real-world applications, students can develop innovative solutions to environmental issues, such as reducing carbon emissions and managing waste efficiently (Miller, 2022). Schools, universities, and community programs can use hands-on projects, such as solar panel installations and recycling initiatives, to reinforce theoretical concepts and inspire future generations to pursue careers in sustainability (Jones & Smith, 2021).

Integrating green technology into environmental education enhances awareness, promotes sustainable behaviors, and empowers individuals to contribute to ecological conservation. As environmental challenges continue to rise, education remains a key driver in shaping a greener and more sustainable future (Smith *et al.*, 2023).

### **Green Technology in Environmental Education**

Green technology encompasses various innovations aimed at minimizing environmental impacts while enhancing learning experiences. Key aspects of green technology relevant to EE include:

#### **Renewable Energy-Powered Schools**

Adopting solar and wind energy in schools reduces reliance on fossil fuels and serves as a practical demonstration of sustainability. Schools utilizing renewable energy can integrate energy management into their curricula, allowing students to monitor energy production and consumption (Ogunbayo et al., 2021).

#### **Digital Learning Platforms**

E-learning tools and mobile applications can supplement traditional teaching methods by providing interactive and multimedia-based content on environmental topics. Platforms such as MOOCs, virtual reality simulations, and gamified learning experiences help students engage with environmental concepts more effectively (Nwosu & Okeke, 2019).

#### **Eco-Friendly Infrastructure**

Green buildings designed with energy-efficient materials and water conservation systems can serve as live laboratories for students. Features such as rainwater harvesting, composting toilets, and vertical gardens demonstrate sustainable practices in action (Adetayo et al., 2022).

#### **Smart Classrooms and Interactive Tools**

Smart boards, augmented reality (AR), and sensors can facilitate immersive environmental education. AR applications allow students to explore ecosystems virtually, enhancing their understanding of biodiversity and conservation (Adebola, 2020).

### **Challenges to the Adoption of Green Technology in Nigerian Schools**

Despite its potential, the adoption of green technology in EE in Nigeria faces some challenges:

**Financial Constraints:** The exorbitant cost of green infrastructure and ICT tools prevents extensive adoption (Akinwale & Olatunji, 2020).

**Dearth of Technical Expertise:** Limited knowledge among teachers and administrators affects adoption (Obafemi, 2021).

**Infrastructural Deficiencies:** Inconsistent electricity supply and internet connectivity are constraints to e-learning (Eze & Nwachukwu, 2019).

**Policy and Regulatory Gaps:** Ineffective enforcement of environmental education policies is a hindrance to progress (Chukwu, 2021).

## Recommendations

To effectively integrate green technology into environmental education in Nigeria, the following broad recommendations are proposed:

1. **Incorporate Environmental Education Across All Levels:** Integrate environmental education (EE) into the national curriculum at primary, secondary, and tertiary levels so that students become environmentally conscious from childhood.
2. **Implement Comprehensive Training Programs:** Implement training programs, such as the "Green Teacher" program, to equip teachers with the necessary skills and knowledge for successful EE education and the integration of green technologies into teaching methodology.
3. **Create Green School Programs:** Encourage sustainable infrastructure utilization by schools, including energy-efficient buildings, renewable power sources, and clean waste management systems, as real-life models to motivate students.
4. **Establish Environmental Laboratories and Clubs:** Establish learning centres where students get involved in laboratory work and activity on recycling, conservation, and sustainability for promoting an environment consciousness culture.
5. **Strengthen EE Policy and Funding Support:** Develop and act on policies of enforcing incorporation of EE and green technology in education and mandating compliance and standards among educational institutions.
6. **Encourage Public-Private Partnerships:** Facilitate collaboration between schools, non-governmental organizations, and private enterprises to enhance the access to resources and funding for EE programs.
7. **Involve Local Communities:** Engage local communities in environmental activities and decision-making processes to promote local stewardship and relevance of EE programs.

## Conclusion

Green technology integration into education in Nigeria is essential for building a generation that can solve the most pertinent environmental problems. It not only enhances the performance of learners but also drives sustainable practices essential to the nation's ecological and economic future. Green technology can be implemented effectively in education through a multi-faceted method: Curriculum Development, Teacher Training, Infrastructure Development, Policy and Funding Support, Community and Stakeholder Involvement

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# **COMBATING FOOD INSECURITY IN NIGERIA: THE EMERGENCE OF AGRO- ENTREPRENEURSHIP MARKETING ON CAMPUS**

**DR. Veronica N. NDUBUISI<sup>1</sup>, DR. Umma A, U. MANI<sup>2</sup> & Babuji Ibrahim JATAU<sup>3</sup>**

<sup>123</sup>Department of Marketing, University of Maiduguri, Maiduguri

[veronicawaltern@gmail.com](mailto:veronicawaltern@gmail.com)<sup>1</sup>; [jatauibrahim@unimaid.edu.ng](mailto:jatauibrahim@unimaid.edu.ng)<sup>3</sup>

## **ABSTRACT**

*Food insecurity remains a pressing issue in Nigeria, particularly in regions like Maiduguri, where climate change challenges such as drought and flooding further exacerbate food production difficulties. This study explores the role of agro-entrepreneurial marketing and campus farming in combating food insecurity at the University of Maiduguri. Using a descriptive survey design, data were collected through structured questionnaires from a sample of 200 respondents, including students and staff involved in agro-entrepreneurship activities. The study focused on farming practices such as backyard gardens, vertical farming, greenhouses, and poultry farming, which are integral to addressing food security on campus. Findings reveal that agro-entrepreneurial marketing plays a key role in enhancing access to affordable food, promoting local food production, creating awareness about food security, and generating income. The study also highlights the active participation of respondents in climate-smart agricultural practices, particularly those aimed at mitigating the effects of climate change. The conclusion suggests that by adopting agro-entrepreneurship and campus farming techniques, universities can become more self-sufficient in food production, contributing to broader national efforts in tackling food insecurity. Recommendations include enhancing agro-entrepreneurship programs, expanding campus farming initiatives, supporting climate-smart practices, and fostering public-private partnerships to ensure sustainable food security solutions.*

**KEYWORDS:** *Agro-Entrepreneurship Marketing, Campus Farming, Food Insecurity, Climate-Smart Agriculture, Sustainable Food Security, Nigeria, Urban Agriculture, Food Production, Public-Private Partnerships.*

## **INTRODUCTION**

In general term, food insecurity is the absence of protection of adversity of life compounded by extreme low standard of living while specifically food insecurity is the persistent concern of insufficient and affordable food at all times which leads to an increase in food poverty and malnutrition in communities with low standard of living. In times of epidemics, wars and natural disasters, food insecurity affects the nutritional conditions of a large population of the world. It can also lead to stress and anxiety in people due to unemployment, low income and limited access to food security (Covid 19, 2022). It is also observable that food severity can vary from mild to severe and this may depend upon the uncertainty, anxiety, unbalanced diet, and changes in diet quality (Covid 19, 2022).

Nigeria is most populous country in Africa, residing more than 206 million people (Wikipedia, 2021). One of the major issues affecting the citizens is hunger which hangs at 40%, representing 82% million people of the citizens who live below International Poverty Line (IPL) of \$1.90 daily while another 25% are vulnerable to hunger Vanguard, 2021 & Bongaarts, 2021). Globally, Nigeria was ranked second poorest in food affordability and sufficiency by the Institute of Development Studies, United Kingdom (Vanguard, 2021). Appendix 1 explains the Nigeria Hunger Statistics from 2001 to 2018. Other factors that contribute to food deficit in Nigeria include, climate change, environmental degradation such as deforestation, conflict and poverty.

## **PROBLEM STATEMENT**

In Nigeria, factors that contribute to hunger in various states of Nigeria are insecurity, environmental factors such as destruction of habitats, devastating effects of Covid-19, and economic challenges (Punch NG, 2021) while climate change is a wider threat to food security in Nigeria (Adjei, 2021) as the country experiences more frequent drought and flood. The climate change leads to weather events, damage crops and live-stocks and at the same time making it difficult for farmers to produce enough food.

Nigeria has many flash points of conflict, Boko Haram insurgency in the Northeast, farmer-header conflict in the Middle Belt, ... in the Northwest and sporadic farmer-header conflict in the South, and thereby exacerbating poverty as a major factor contributing to food insecurity in Nigeria. As such many people cannot afford to buy enough food due to low wages, high food prices and unemployment. As observed by Eme, Onyishi, and Uche (2014) in Wikipedia (2021) that food insecurity in Nigeria has a number of negative consequences that can lead to malnutrition to disastrous health that can impair physical and mental development. The outcome of this is social unrest as people become desperate for food. The manifestation of social unrest is hunger and the product of hunger are malnutrition, under-nutrition and nutritional deficiencies child wasting. According to UNICEF (2019), this manifests to underweight at 36.4%, stunting at 41.3% and wasting at 15.6% in health index scale.

These phenomena and challenges informed the need for this study as food insecurity has a number of negative consequences in Nigeria, leading to hunger – malnutrition, undernutrition, nutritional deficiencies and child wasting. Overall, it is a cycle of poverty manifesting little or no productivity at all.

## **OBJECTIVE OF THE STUDY**

In Nigeria food insecurity is a problem where a large significant proportion of the population cannot have a sufficient and reliable nutritious food. To combat this menace there is clarion call to think out of box to address the challenge leveraging on modern farm technology and



multifaceted methods of farming (Noba Africa, 2024). This paper explored these multifaceted innovation farming practices and has chosen Agro-Entrepreneurship marketing on campus as synonymous to Urban Agriculture with the understanding of how Nigeria can achieve food security. The specific objectives of the study are to:

- i. examine the role of agro-entrepreneurship marketing in combating food insecurity in Nigeria's university campuses.
- ii. assess the effectiveness of campus farming practices (such as backyard gardens, greenhouses, and vertical farming) in improving food security among university students.
- iii. explore the impact of climate-smart agricultural practices and innovative farming technologies on enhancing food production and mitigating food insecurity in Maiduguri, Nigeria.

## LITERATURE REVIEW

### Conceptual Issues

**Food Insecurity:** According to FAO (2024) a person is said to be food insecure when they lack regular access to enough safe and nutritious food for normal growth and development for an active and healthy life. This circumstance may be as a result of unavailability of food or lack of access to obtain food and food insecurity can be experienced at different levels of severity, FAO (2024) emphasized.

On the other hand, hunger is unforeseen or painful physical stimuli or sensation caused by insufficient consumption of dietary energy. When hunger becomes chronic, it gets to a stage when the person does not consume a sufficient amount of calories called dietary energy on regular basis to have a normal, active and healthy life (FAO, 2024).

**Hunger and Food Insecurity:** In a situation when someone is severely food insecure, they are said to have run out of food and must have gone a day or more without eating. In this case and in the absence of normal nutrition, they must most likely experienced hunger. The FAO (2024) goes further to explain that “severe food insecurity is one extreme of the scale, but even moderate food insecurity is worrisome. For those who are moderately food insecure, access to food is uncertain. They might have to sacrifice other basic needs, just to be able to eat. When they do eat, it might be whatever is most readily available or cheapest which might not be the most nutritious food”.

Additionally, the Food and Agricultural Organization continues, “the stress of living with uncertain access to food and going periods without food can lead to physiological changes that can contribute to overweight and obesity. Children facing hunger, food insecurity and undernutrition today may have a higher risk of overweight, obesity and chronic diseases like diabetes later in in life. In many countries, under-nutrition and obesity co-exist and both can be consequences of food insecurity”. Kwashiokor which is a consequence of lack of protein is however not rule out also.

### Monitoring and measuring Food InsecSDG 2

In monitoring and measuring the progress SDG, the FAO (2024) indicator measures the proportion of the population who are experiencing moderating or severe food insecurity in a population:

**Moderate Food Insecurity:** People experiencing moderate food insecurity reduce the quality and quantity of their and they are uncertain about their ability to obtain food as a result of poor

income or other sources of livelihood. Moderate food insecurity can also increase the risk in one form or the other of malnutrition in stunting children, micronutrient deficiency and kwashiorkor in children or obesity in adults.

**Severe Food Insecurity:** Equally, people experiencing severe food insecurity often than not run out of food and the extreme situation have gone days without eating. This group of the population are those for days and nights without food and they are called “hungry”.

### **Situation Report on Food Insecurity in Nigeria**

The situation report by UNICEF (2023) Resident in Nigeria stated that nearly 25 million Nigerians are at risk of facing hunger in 2023 in lean period if urgent action was not taken. This report was from Cadre Harmonise (2023), a Government led and UN-supported food and nutrition analysis. It is observed that conflict, climate change, inflation and rising food crisis are key drivers of this alarming report. The persistent violence affected food access in the North-east states of Borno, Adamawa and Yobe and armed banditry and kidnapping in the states of Katsina, Sokoto, Kaduna, Benue and Niger are also affected by lack of food access.

According to the National Emergency Agency during the same period, wide spread flooding in the 2022 rainy season damaged more than 676,000 hectares of farmlands, diminished harvests and increased the risk of food insecurity for families across the country. The flooding is one of the effects of climate change and variability impacting Nigeria food insecurity.

Of the 17 million who are food insecure, 3 million were in the North-east BAY states. Without immediate action, this figure was expected to increase to 4.4 million in the lean season. This included highly vulnerable displaced populations and the returnees who were already struggling to survive a large-scale humanitarian crisis of which 8.3 million needed assistances.

The food security and nutrition situation was very critical and alarming in Nigeria that Mr. Matthias Schmale, the Resident and Humanitarian Coordinator for Nigeria has this to say:

“The food security and nutrition situation across Nigeria is deeply concerning. I have visited nutrition stabilization centers filled with children who are fighting to stay alive. We must act now to ensure they and others get the lifesaving support they need”.

It was also reported that most vulnerable to food insecurity are children and approximately 6 out of 17 million food-insecure Nigerians today are children under 5 living in BAY states, Sokoto, Katsina and Zamfara states. There is a serious risk of mortality among children attributed to acute malnutrition. In BAY states alone, the number of children suffering from acute malnutrition was expected to rise from 1.74 million to 2 million in 2023.

Around Katsina, Zamfara and Sokoto states in the North-west region is an increasing food insecurity and malnutrition hotspot. According to Cadre Harmonise Phase 3 Report, it is estimated that 2.9 million people are critically food insecure and this figure is projected to increase to 4.3 million in the lean season.

FAO with its partners has been supporting the government to restore lives in the North-west and North-east regions. Included in this supporting program are livestock production, crop production, home stead micro gardening, value chain development and poultry farming.

To mitigate the situation and save the lives of the population threatened by malnutrition and hunger, the United Nations called on the Government of Nigeria, donor communities, and public and private stakeholders to urgently commit resources and implement mitigation measures to save

lives and prevent potentially catastrophic food security and nutrition situation. The UN report ended thus, “Support for vulnerable families across the country is needed today, not tomorrow”.

### **Agro-Entrepreneurial Marketing**

Entrepreneurial Marketing is a critical part of entrepreneurship that focuses on the customer as the fundamental driver of entrepreneurial success with emphasis on agricultural product from farm to distribution and to the consumer. Therefore, it is not an over emphasize that entrepreneurial marketers should not underestimate the importance of gathering customer insight to get new ideas, new products and innovative processes. It is a mix of up/down-down/up process.

Agro-entrepreneurial marketing is the development and implementation of marketing strategies for business that are directly involved in agriculture. It is also known as agricultural entrepreneurship which is a process of starting, managing, and organizing a business that focuses on agriculture.

Agro-Entrepreneurial marketing strengthens and enhances infrastructure such as storage facilities, transport network, and processing plant which reduces post-harvest losses and ensures that farm produce reaches market in good time and in good condition (Noba Africa, 2024).

### **Combatting Food Insecurity in Nigeria**

In Nigeria, food insecurity is a pressing issue involving a very significant population without a reliable access to sufficient and nutritious food. To combat this challenge, a holistic multifaceted approach is required as detailed by Noba Africa (2024), the approach being:

**Harnessing Technology to Combat Food Insecurity:** Technological advancements have the potential to revolutionize agriculture in Nigeria. This involves precision farming which requires the use of data analytics and GPS technology. This technology can optimize planting schedules, irrigation, and fertilizer, leading to increased crop yields. Drones equipped with multispectral cameras can monitor crop health, identify pest infestation, and assess soil conditions, allowing for timely intervention. Mobile apps can provide farmers with real time information on weather, market prices of different farm output, and best practices, enhancing their decision-making processes. By adopting these technologies, Nigerian farmers can significantly improve productivity and reduce food insecurity.

**The Role of Public-Private Partnership:** Public-private partnerships (PPPs) play a crucial role in addressing food insecurity. Collaboration between the government, private sector NGOs can create sustainable solutions. In this collaboration for example, the government can provide infrastructure and policy supports while the private companies can offer technological innovations and investment. At the same time, NGOs can facilitate capacity-building programs and ensure community involvement.

**Empowering Smallholder Farmers:** Empowering them with resources, training and market access is essential for boosting productivity and livelihoods. Initiatives such as providing high-quality seeds, fertilizers, and modern farming equipment can also enhance their yields. Training programs on sustainable farming practices, pest management, post-harvest handling, and equipment will equally improve the quality of their farm produce. In addition, establishing cooperatives will enable the smallholders to pool their resources, access credit, and negotiate better prices for their products.

**Innovative Financing Solutions:** Access to finance is an important barrier for many Nigerian farmers. Innovative finance solutions, like microfinance, insurance schemes and investment funds are supportive of agricultural development. For example, microfinance offers small loans to farmers, enabling them to purchase inputs and invest in their farms; while agriculture insurance protects farmers against crop failures due to adverse weather conditions, reducing their financial risks, and finally investment funds on agriculture provides capital for scaling up operations and adopting modern technology.

**Promoting Sustainable Agriculture:** Techniques such as crop rotation, organic farming and agroforestry can enhance soil fertility, conserve water, and reduce reliance on chemical inputs leading to minimal use of pesticide while protecting crops. These practices in agriculture are essential for sustainable food security.

**Youth Involvement in Agriculture:** Youth involvement in agriculture is essential for agricultural sector to survive in the long-run. This could be done through education, training and entrepreneurial opportunities. While training and internship programs offer experience and mentorship, agricultural education programs provide students with knowledge and skills in modern farm techniques. Entrepreneurial opportunities are supportive of young agripreneurs with access to finance, markets, and technology. These encourage innovation and fasten agricultural growth.

**Urban Agriculture:** This presents a viable solution to food insecurity in Nigeria's urban cities. These initiatives involve flower bed gardens, rooftop gardens, community gardens, horti-culture and aqua culture and vertical farming which provide fresh farm output. Advantages of this practice are reduction of food dependence on rural agriculture, provision of fresh and nutritious food, reduction on commuter fares, improvement of urban resilience, improvement of general well-being of urban population, contribution to greener environment and lastly but not the least, food sufficiency to the households.

**Climate Change Mitigation Strategies:** Unpredictable weather patterns such as droughts, floods and heavy wave lengths pose significant challenges to agriculture in Nigeria. For food sustainability, it is very crucial to mitigate the effects of climate change with climate-smart agriculture practices such as drought-resistant crops of different kinds, efficient water management systems and agroforestry. These will help farmers adapt to changing conditions and improve their farm yields. Further, early warning systems weather-man forecast should be made available to enable farmers make informed decisions and reduce risks.

**Strengthening Agricultural Value Chains:** Strengthening agricultural value chain from lab to farm, farm to production and from production to distribution involves the availability of infrastructure such as storage facilities, transportation networks and processing plants. Certainly, this reduces post-harvest losses and ensures that farm produce get to the target market in good conditions. Thus value chain strengthens food security by increasing efficiency, reducing waste and assuring food insurance.

**Policy Intervention:** These recommendations to scuffle food insecurity in Nigeria leveraging from innovative technology, public-private partnership, youth involvement, urban farming and others stemmed up from government concerns and policy interventions. These interventions and policies become necessary in creating conducive environment for agricultural growth and food security in Nigeria. Investment support such as provision of subsidies for input, access to credit for farmers and promotion of research development will lead to high-yield crop varieties and innovative farming techniques. Following up these policies and implementing them, the

government can achieve its objective of agricultural growth, food security and provision of nutritious food to its population.

Of all these agricultural technologies and innovations, study is carried out in University of Maiduguri using campus farming as synonymous to urban farming. It embraces all urban farming practices (Machuka, 2021) under the purview of campus farming.

## **METHODOLOGY**

### **Study Area**

This study is home agriculture domiciled at the University of Maiduguri as “Combatting Food Insecurity in Nigeria: Emergence of Agro-Entrepreneurial Marketing on Campus”. The study is grown out of curiosity to combat food insecurity and to have food safety by having fresh and nutritious vegetables, fruits, and meat products. This campus study encompasses backyard gardens, tactical gardens, greenhouses, green walls, vertical walls, and poultry farming.

Climate change poses a significant challenge in general in Nigeria and in Maiduguri in particular. In Maiduguri, this includes unpredictable weather patterns, drought and, floods. Mitigating these effects according to Noba Africa (2024) is crucial for food security and these require specialist agriculture practices such as drought-resistant crop varieties and efficient water management. Early warning system and weather man forecast are readily available in UNIMAID campus radio station for expertise information to the resident farmers. Cultivated are sweet potato, cucumber, maize, okro, yakwa, saint leave, ugu, pawpaw, groundnut, beans and poultry.

### **Research Design**

This study adopted a descriptive survey design. It aimed to collect data on the role of agro-entrepreneurial marketing and campus farming practices in addressing food insecurity in Nigeria, specifically at the University of Maiduguri. The approach was quantitative and involved structured questionnaires administered to respondents involved in campus farming.

### **Population**

The target population consisted of students and staff involved in agro-entrepreneurship and campus farming activities at the University of Maiduguri. Additionally, local farmers who practiced urban agriculture within the region were considered part of the population.

### **Sample**

A sample of 200 respondents was selected from the University of Maiduguri. This included individuals actively involved in campus farming, such as those participating in farming activities, and those directly engaged with agro-entrepreneurial marketing initiatives.

### **Sampling Technique**

A stratified random sampling technique was used to ensure that the sample represented different groups (students and staff). Random selection within each stratum ensured that diverse perspectives were captured from participants involved in different aspects of campus farming.

### **Method of Data Collection**

Data were collected through questionnaires designed to assess participants' involvement, awareness, and perspectives on agro-entrepreneurial marketing and food security. The

questionnaire included both closed and open-ended questions to gather both quantitative and qualitative data.

### Instrument for Data Collection

A structured questionnaire was developed for the study. The instrument consisted of demographic information such as age, gender, and academic level; knowledge of food insecurity and campus farming; involvement in agro-entrepreneurship and urban agriculture; perceptions of the effectiveness of campus farming in combating food insecurity; and attitudes toward sustainable farming and innovative technologies.

### Method of Data Analysis

Data were analyzed using descriptive statistics, including frequencies, percentages, and means, to summarize the responses. The results were presented in tables to allow for clear interpretation. Additionally, inferential statistics (such as chi-square tests) were applied to explore relationships between demographic variables and involvement in campus farming or agro-entrepreneurial marketing.

## DATA ANALYSIS AND DISCUSSION

**Table 1: Socio-Demographic Characteristics of Respondents n = 200**

Variable	Category	Frequency	Percentage
Age Group	18–24 years	120	60%
	25–30 years	50	25%
	31–35 years	20	10%
	36 years and above	10	5%
	<b>Total</b>	<b>200</b>	<b>100%</b>
Gender	Male	100	50%
	Female	100	50%
	<b>Total</b>	<b>200</b>	<b>100%</b>
Academic Level	Undergraduate	150	75%
	Postgraduate	40	20%
	Staff	10	5%
	<b>Total</b>	<b>200</b>	<b>100%</b>
Field of Study	Agriculture / Agricultural Science	80	40%
	Environmental Science	40	20%
	Engineering	30	15%
	Social Sciences	30	15%
	Business Administration	20	10%
	<b>Total</b>	<b>200</b>	<b>100%</b>
Level of Involvement in Campus Farming	Actively involved	120	60%
	Moderately involved	50	25%
	Not involved at all	30	15%
	<b>Total</b>	<b>200</b>	<b>100%</b>



Table 1 presents the socio-demographic characteristics of the 200 respondents included in the study. The age distribution shows that the majority of respondents (60%) were between 18 and 24 years, followed by 25% in the 25–30 age group. A smaller proportion of respondents (10%) were aged 31–35 years, while only 5% were 36 years and above, indicating a predominantly younger population.

The gender distribution was balanced, with an equal proportion of males and females (50% each), reflecting gender inclusivity in the study sample.

In terms of academic level, 75% of the respondents were undergraduate students, making up the largest group, while 20% were postgraduate students and 5% were staff members. This shows that the majority of participants were students, particularly at the undergraduate level.

Respondents were also categorized by their field of study, with 40% coming from Agriculture or Agricultural Science, which is not surprising given the study's focus on agro-entrepreneurship and campus farming. Other fields represented include Environmental Science (20%), Engineering (15%), Social Sciences (15%), and Business Administration (10%). The distribution highlights the multidisciplinary interest in campus farming practices.

Regarding the level of involvement in campus farming, a significant majority of respondents (60%) were actively involved, while 25% reported moderate involvement. Only 15% of the respondents were not involved in campus farming at all. This indicates strong participation in farming activities among respondents, aligning with the study's aim to assess agro-entrepreneurship and its role in addressing food insecurity.

### **Objective 1: Examine the role of agro-entrepreneurship marketing in combating food insecurity on campus.**

**Table 2: Role of Agro-Entrepreneurship Marketing in Combating Food Insecurity on Campus**      **n = 200**

<b>Response Category</b>	<b>Frequency</b>	<b>Percentage</b>
Enhancing Access to Affordable Food	70	35%
Encouraging Local Food Production	85	42.5%
Creating Awareness of Food Security Challenges	30	15%
Generating Employment and Income	15	7.5%
<b>Total</b>	<b>200</b>	<b>100%</b>

**Source:** Field Survey, 2025

Table 2 highlights the significant contributions of agro-entrepreneurship marketing in addressing food insecurity on campus, as perceived by the respondents. The most prominent role identified is encouraging local food production, with 85 respondents (42.5%) recognizing this as a critical aspect. This indicates that agro-entrepreneurship marketing fosters local farming practices, thereby increasing food availability and reducing dependence on external food supplies.

Another significant role is enhancing access to affordable food, cited by 70 respondents (35%). This suggests that the marketing and distribution of locally produced food help reduce food costs, making nutritious options more accessible to students and staff.

A smaller but noteworthy proportion of respondents (15%, or 30 individuals) acknowledged that agro-entrepreneurship marketing plays a role in creating awareness of food security challenges.

This implies that marketing efforts not only facilitate food distribution but also educate the campus community about the importance of food security and sustainable farming practices.

Lastly, generating employment and income was identified by 15 respondents (7.5%) as a role of agro-entrepreneurship marketing. This highlights the potential economic benefits of such initiatives, including job creation for students and other individuals engaged in farming and marketing activities.

Overall, the data underscores the multifaceted role of agro-entrepreneurship marketing in promoting food security on campus, addressing both accessibility and production challenges while offering educational and economic benefits.

## **Objective 2: Assess the effectiveness of campus farming in improving food security.**

**Table 3: Effectiveness of Campus Farming in Improving Food Security**

<b>Farming Practice</b>	<b>Frequency</b>	<b>Percentage</b>
Backyard Gardens	60	30%
Greenhouses	50	25%
Vertical Farming	40	20%
Poultry Farming	50	25%
<b>Total</b>	<b>200</b>	<b>100%</b>

**Source:** Field Survey, 2025

Table 2 highlights respondents' perceptions of the effectiveness of agro-entrepreneurship marketing in addressing food insecurity on campus. Out of the 200 respondents, 42.5% considered agro-entrepreneurship marketing to be effective, while 35% viewed it as very effective. Together, these two categories account for a significant majority (77.5%), indicating a strong belief in the potential of agro-entrepreneurship marketing to combat food insecurity within the campus setting.

In contrast, 15% of respondents perceived agro-entrepreneurship marketing as not effective, suggesting that a minority may not have experienced its benefits or may have concerns about its implementation. Additionally, 7.5% of respondents selected "Don't know," implying either a lack of awareness or uncertainty about the impact of agro-entrepreneurship marketing.

Overall, the findings demonstrate that most respondents recognized agro-entrepreneurship marketing as a valuable tool in addressing food insecurity on campus. However, the presence of respondents who viewed it as ineffective or expressed uncertainty underscores the need for more awareness campaigns, training, or enhanced initiatives to maximize its impact.

## **Objective 3: Explore the impact of climate-smart agricultural practices.**

**Table 4: Impact of Climate-Smart Agricultural Practices**

<b>Practice</b>	<b>Frequency</b>	<b>Percentage</b>
Use of drought-resistant crops	90	45%
Efficient water management	65	32.5%
Agroforestry practices	45	22.5%
<b>Total</b>	<b>200</b>	<b>100%</b>

**Source:** Field Survey, 2025

Table 4 provides insights into the adoption of climate-smart agricultural practices among respondents. The most widely practiced strategy was the use of drought-resistant crops, reported by 45% of respondents. This high adoption rate reflects a growing awareness of the importance of crop resilience in mitigating the effects of climate change, particularly in regions prone to erratic rainfall or prolonged dry seasons.

Efficient water management was the second most common practice, accounting for 32.5% of responses. This finding highlights the importance of sustainable water-use techniques, such as irrigation scheduling, water recycling, or the use of water-saving technologies, in ensuring agricultural productivity under changing climatic conditions.

Agroforestry practices, such as integrating trees with crops or livestock, were reported by 22.5% of respondents. While this figure is relatively lower, it demonstrates recognition of the role of agroforestry in enhancing soil fertility, sequestering carbon, and providing shade for crops and livestock.

Overall, the data indicate that respondents are actively engaging in diverse climate-smart agricultural practices to address climate-related challenges. However, the lower adoption rates for agroforestry and efficient water management suggest the need for targeted interventions, such as capacity-building programs, incentives, or access to resources, to encourage broader implementation of these sustainable practices.



**Maize**



**Sweet Potato Plant**



**Potato Tubers**





**Ugu Vegetable**



**Fruiting mango**



**Scent Leaf**



**Chicken Layers**



**Potatoes chips**



**Chicken Layers**



**Maize:** This was a source of food at harvest season and neighbors around were able to have surplus of it as food gift. There was more to eat at a time. Further, to preserve the surplus, the maize was grinded for fufu porridge.

**Potato:** Potato was surplus at harvest. To control the surplus, the harvesting was phased because of the storing nature of sweet potato that becomes pathogen poisonous if stored. Thus, potatoes made a good gift to neighbors who cared for it. To control waste, the potato tubers were turned to chips to be grinded at a later stage for potato porridge.

**Ugu and scent leaves:** These were source of gnashing soup, salads and take-aways. They are all season-vegetables. It is another source of income to cushion the biting inflation.

**Chicken:** A mini chicken farm was among the campus farming. It is an on-going poultry farm providing eggs all round. The cost of producing one crate of egg was 100% less than the selling price at the prevailing price index.

## Summary of Findings

1. Enhancing access to affordable food, encouraging local food production, creating awareness of food security challenges and generating employment and income were the role of agro-entrepreneurship marketing in combating food insecurity on campus.
2. Majority of the respondents recognized agro-entrepreneurship marketing as a valuable tool in addressing food insecurity on campus.
3. Majority of the respondents are actively engaging in diverse climate-smart agricultural practices to address climate-related challenges.

## Discussion

The findings of this study reveal the pivotal role agro-entrepreneurship marketing plays in combating food insecurity on campus. The identified contributions include enhancing access to affordable food, encouraging local food production, creating awareness of food security challenges, and generating employment and income. These roles align with previous studies that highlight agro-entrepreneurship marketing as an effective strategy for addressing food security issues by improving food accessibility, reducing costs, and promoting sustainable local farming practices (Adekunle et al., 2020). By prioritizing local food production and affordable pricing, agro-entrepreneurship marketing directly contributes to reducing the prevalence of food insecurity within the campus community.

Furthermore, the study indicates that the majority of respondents view agro-entrepreneurship marketing as a valuable tool in addressing food insecurity. This widespread acknowledgment reflects its impact on bridging gaps in food supply chains, fostering self-reliance, and creating economic opportunities for campus residents. Empirical research by Okafor and Eze (2021) similarly supports the notion that agro-entrepreneurship initiatives enhance food availability and affordability, particularly in institutional settings.

Additionally, the findings underscore active engagement in diverse climate-smart agricultural practices as a response to climate-related challenges. Practices such as the use of drought-resistant crops, efficient water management, and agroforestry were notably embraced by respondents. These practices demonstrate a proactive approach to mitigating the effects of climate change on agricultural productivity, which is crucial for ensuring food security. Previous studies, such as those by Akinyele and Yusuf (2019), have emphasized the importance of climate-smart agriculture in sustaining food production amid increasing environmental uncertainties.



Collectively, these findings illustrate a comprehensive approach to addressing food insecurity on campus, combining the benefits of agro-entrepreneurship marketing with adaptive agricultural strategies. This dual approach not only ensures food accessibility but also fosters resilience to climate-induced food production challenges, thereby contributing to the overall sustainability of food systems.

## Conclusion

Agro-entrepreneurship marketing and the adoption of campus farming techniques can significantly improve food security on university campuses in Nigeria. Climate-smart practices are especially vital in areas prone to drought and flooding. By leveraging these farming practices, universities like the University of Maiduguri can become more self-sufficient in food production and contribute to broader efforts in combating national food insecurity.

## Recommendations

1. **Enhance agro-entrepreneurship programs:** Universities should promote agro-entrepreneurship through practical training and access to resources such as funding and technology.
2. **Expand campus farming initiatives:** Increase the number of farming initiatives like vertical farming, greenhouses, and poultry projects to improve food availability.
3. **Support climate-smart practices:** The government and universities should invest in research and technologies related to drought-resistant crops and efficient water management systems.
4. **Encourage public-private partnerships:** Collaboration between universities, the government, and private sector can help create sustainable models for food security.

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## APPENDIX 1

Nigeria Hunger Statistics

Year	% of population	Annual Change
2018	12.60%	0.70%
2017	11.90%	-0.10%
2016	12.00%	0.90%
2015	11.10%	1.30%
2014	9.80%	1.20%
2013	8.60%	1.00%
2012	7.60%	0.10%
2011	7.50%	0.10%
2010	7.40%	0.10%
2009	7.30%	0.10%
2008	7.20%	0.30%
2007	6.90%	-0.10%
2006	7.00%	-0.40%
2005	7.40%	-0.80%
2004	8.20%	-0.60%
2003	8.80%	-0.30%
2002	9.10%	0.00%
2001	9.10%	0.00%

Source: Nigeria Hunger Statistics (2021).

# FORENSIC ACCOUNTING TECHNIQUES AS TOOLS FOR NIGERIAN PRACTITIONERS

Obot Akpan UDOH

Department of Accountancy, School of Business and Management  
Akwa Ibom State Polytechnic, Ikot Osurua, Ikot Ekpene, Akwa Ibom State, Nigeria  
E-mail: [aniediudoekanem@gmail.com](mailto:aniediudoekanem@gmail.com)

## ABSTRACT

*Forensic accounting has emerged as a critical discipline in combating financial irregularities, fraud, and corruption. However, this paper examines forensic accounting techniques as tools for Nigerian Practitioners. The study adopts a qualitative approach, involving case studies and document analysis. The case study method provided a deep exploration of specific instances where forensic accounting techniques were successfully employed to uncover financial fraud in Nigeria; while the document analysis method involved a systematic review of existing literature, regulatory frameworks, and policies that govern forensic accounting in Nigeria. The case study examined public sector embezzlement case involving inflated contracts where over NGN 2 billion was misappropriated. The approach considered **Data Collection, Data Mining, Benford's Law, Digital Forensics and Comparative Analysis as tool**. IDEA (Interactive Data Extraction and Analysis) and ACL (Audit Command Language) was used for data mining and fraud detection. Another case study considered bank mismanagement case which involved a high-profile incident within a commercial bank in Nigeria. In this case the data were collated through analysis of bank statements, internal memos, and loan approval documentation, interviews conducted with whistleblowers, affected customers, and implicated bank employees while **System Logs** were reviewed base on digital transaction logs to identify unauthorized activities. The results for case 1 and case 2 showed that NGN 1.2 billion and NGN 200 million were recovered respectively and repayment agreements with some beneficiaries. On the whole, the findings underscored the need for enhanced internal controls, continuous monitoring, and capacity building to strengthen the financial sector against similar risks in the future.*

**KEYWORDS:** Forensic accounting, Financial Fraud, Nigeria, financial management, Data Mining, Benford's law, IDEA, ACL

## 1. INTRODUCTION

Forensic accounting has emerged as a critical discipline in combating financial fraud, corruption, and economic malfeasance. In a globalized economy where financial crimes pose significant threats to businesses, governments, and individuals, the role of forensic accounting cannot be overstated. It involves the application of accounting, auditing, and investigative skills to detect, analyze, and prevent fraudulent activities, making it an indispensable tool for practitioners, especially in Nigeria. Nigeria, as one of Africa's largest economies, faces persistent challenges of corruption, mismanagement, and financial irregularities across both public and private sectors. Reports from anti-corruption agencies, such as the Economic and Financial Crimes Commission (EFCC), highlight the magnitude of fraud cases, ranging from embezzlement of public funds to corporate financial misconduct. These issues undermine investor confidence, economic growth, and the efficient allocation of resources, creating an urgent demand for forensic accounting interventions.

Forensic accounting techniques encompass various methodologies, including data analytics, trend analysis, and digital forensic tools, which enable practitioners to uncover anomalies, trace illicit financial flows, and provide litigation support. These tools are not only reactive—used to investigate fraud after it occurs—but also proactive, helping organizations design systems to deter fraudulent behavior. This paper aims to explore the relevance and application of forensic accounting techniques for Nigerian practitioners, highlighting their role in tackling the nation's financial crimes. By addressing challenges such as inadequate expertise, limited adoption of advanced tools, and regulatory barriers, this study underscores the potential of forensic accounting to enhance transparency, accountability, and trust within Nigeria's economic landscape. This discussion will provide insights into the key forensic accounting techniques, their integration into Nigerian practices, and how they can be leveraged to meet the country's unique socio-economic and regulatory needs.

This paper aims to:

1. Examine the key forensic accounting techniques employed by Nigerian practitioners.
2. Analyze the challenges and limitations of these techniques.
3. Propose strategies to enhance their application in Nigeria.

## 2. Literature Review

Forensic accounting integrates accounting, auditing, and investigative skills to address financial discrepancies. Studies have shown that forensic accounting is effective in uncovering complex fraud schemes, particularly in sectors like banking, oil and gas, and public administration (Owojori and Asaolu, 2009). Despite its potential, its adoption in Nigeria has been hindered by limited expertise, inadequate technology, and resistance to transparency (Okoye and Gbegi, 2013). The literature underscores the need for specialized training, robust legal frameworks, and advanced technological tools to enhance the effectiveness of forensic accounting in Nigeria.

### 2.1. Forensic Accounting and Corruption in the Nigerian Public Sector

Modugu et al (2013) made a study on forensic accounting and corruption in the Nigerian Public Sector. The objective was to assess how forensic accounting techniques can curb corruption in Nigeria's public sector and improve accountability. A case study approach was adopted, focusing on major corruption cases handled by the Economic and Financial Crimes Commission (EFCC)

where forensic accounting was applied. Secondary data from court proceedings and EFCC reports were analyzed. Forensic accounting techniques were successfully used in 80% of the analyzed cases, leading to convictions and recovery of misappropriated funds. The study noted that public awareness of forensic accounting was low, which limited its full potential. The study found that forensic accounting contributed to identifying fraudulent activities and prosecuting offenders effectively. However, it highlighted the need for improved training and resources to optimize forensic accounting practices in Nigeria.

Okoye et al (2013) studied the role of forensic accounting in fraud detection and prevention. The objective was to examine the effectiveness of forensic accounting in detecting and preventing fraud in public and private organizations. A survey design was used, with questionnaires administered to accounting professionals and financial auditors. Descriptive statistics and regression analysis were applied. The study found that organizations employing forensic accounting techniques had a 70% higher success rate in detecting fraudulent activities compared to those that relied on traditional accounting practices. It also revealed a significant positive correlation between forensic accounting adoption and fraud prevention. On the whole the study established that Forensic accounting significantly enhances fraud detection and prevention. The authors recommended mandatory incorporation of forensic accounting techniques in financial audits across Nigerian organizations.

Adeniyi and dada (2017) studied on digital forensics in forensic Accounting: The Future of Fraud Investigation. The major objective was to explore the role of digital forensic tools in complementing traditional forensic accounting methods for fraud detection in Nigeria. The study adopted a mixed-method approach, combining interviews with forensic accountants and surveys of corporate organizations. The study showed that 85% of organizations using digital forensic tools, such as data mining and transaction monitoring software, experienced faster and more accurate fraud detection. It also revealed that the high cost of digital tools was a barrier to adoption in smaller firms. However, the research established that 85% of organizations using digital forensic tools, such as data mining and transaction monitoring software, experienced faster and more accurate fraud detection. It also revealed that the high cost of digital tools was a barrier to adoption in smaller firms.

Owojori and Asaolu (2009) studied the Impact of Forensic Accounting on Corporate Governance in Nigeria. The objective was to evaluate how forensic accounting practices influence corporate governance and internal control systems in Nigerian companies. A survey design was used, targeting board members, internal auditors, and accountants in selected firms. Correlation analysis was employed to interpret the data. The result founded that companies implementing forensic accounting practices reported a 60% improvement in internal control systems and a reduction in cases of financial irregularities. Additionally, 75% of respondents agreed that forensic accounting promoted transparency in financial reporting. To this, forensic accounting enhances corporate governance by improving transparency, strengthening internal controls, and promoting ethical financial practices.

Efiong (2012) conducted a study on challenges of Implementing Forensic Accounting in Developing Economies: A Nigerian Perspective. The major focus was to identify and analyze the challenges hindering the adoption of forensic accounting in Nigeria and propose actionable solutions. A qualitative research design was employed, gathering data through interviews with accounting professionals, regulatory officials, and academic experts. Content analysis was used to identify recurring themes. The study identified major challenges, including: limited forensic accounting training programs in Nigeria, high cost of forensic tools and software, resistance from stakeholders who benefit from financial malpractices and Insufficient regulatory frameworks to

enforce forensic accounting practices. The study established that addressing these challenges through policy reforms, capacity building, and public education could enhance the adoption of forensic accounting in Nigeria.

Izedonmi and Ibadin (2012) studied forensic accounting in developing Economies: Problems and Prospects. The aim was to examine the challenges and future potential of forensic accounting in Nigeria. Qualitative analysis of practitioner feedback and secondary data were conducted. Nonetheless, the result established that lack of technology, training, and political will are significant barriers to forensic accounting's success. To this, the study concluded that Forensic accounting in Nigeria requires significant reform and investment to reach its full potential.

Enofe and Okpako (2014) studied the relevance of forensic accounting in combating fraud. The objective of the study was to explore the relevance of forensic accounting techniques in reducing fraudulent activities. Surveys were administered to accountants in various industries. **Results showed that** forensic accounting is relevant in fraud detection, but its adoption is hampered by the cost of implementation and low awareness. On the whole the study established that there is a need for increased funding and public-private partnerships to promote forensic accounting practices.

Nwaze (2011) studied on the fraud detection: The Role of Forensic Accountants. The major objective of the study was to assess the role of forensic accountants in detecting and mitigating fraud. The study reviewed fraud cases and interviews with forensic accountants. **On the whole** forensic accountants play a pivotal role in fraud detection, particularly in high-profile cases. However, the study upheld that limited access to digital tools remains a challenge while strengthening the forensic accounting profession is vital for combating fraud in Nigeria.

### **Techniques of Forensic Accounting in Nigeria**

Okoye and Gbegi (2013) emphasized the role of digital tools in forensic accounting in Nigeria. Their study highlighted the adoption of data analytics software such as IDEA and ACL in fraud detection and prevention. These tools enabled forensic accountants to analyze large volumes of financial data, detect anomalies, and identify fraudulent transactions with precision. The authors recommend increased investment in technological training for forensic accountants to enhance their efficiency.

Adebisi and Matthew (2017) explored the role of forensic accountants in litigation support within the Nigerian context. The study finds that forensic accountants frequently collaborate with legal teams to analyze financial statements, provide expert testimony, and prepare evidence for court proceedings. The authors argued that forensic accounting services in litigation enhance the judicial process by offering objective, evidence-based financial analysis.

Emeh and Obi (2018) investigated the impact of forensic accounting in combating corruption in Nigeria. Their findings revealed that forensic accounting methods, including asset tracing, lifestyle audits, and forensic audits, are instrumental in uncovering embezzlement and misappropriation of funds in both public and private sectors. The study underscored the need for legislative support to strengthen the application of forensic accounting techniques in corruption cases.

### **Case-Based Approaches and challenges in Forensic Accounting**

Adetunji (2020) highlighted the use of case-based methodologies in forensic accounting investigations. The study reviewed specific fraud cases in Nigeria, detailing how forensic

accountants applied methodologies such as ratio analysis, document review, and interviews to uncover fraudulent activities. The research advocated for a combination of qualitative and quantitative approaches in forensic investigations to achieve comprehensive results.

Oladele and Bamidele (2022) examined the challenges faced by forensic accountants in Nigeria. The study identifies limited access to financial records, lack of advanced forensic tools, and resistance from organizations as major obstacles. Despite these challenges, the authors commended the use of forensic methods such as bank reconciliation reviews and payroll audits in fraud detection. The study called for a collaborative approach involving regulatory bodies to overcome these challenges.

Ifeanyi and Uchenna (2019) examined how forensic accounting can be integrated into standard auditing practices to enhance fraud detection in Nigeria. The study used surveys of auditing firms to assess the effectiveness of incorporating forensic techniques like digital analytics and forensic interviews into routine audits. Results showed that firms using forensic methods reported a 40% increase in fraud detection rates. The authors conclude that integrating forensic accounting into auditing enhances both the scope and accuracy of financial reviews.

Chukwu and Abiola (2021) investigated the role of professional training on the effectiveness of forensic accountants in Nigeria. The study surveyed forensic professionals across various sectors, finding that 85% of respondents agreed that regular training on emerging technologies and regulations significantly improves their performance. The authors recommended mandatory continuous professional development programs for all forensic accountants in Nigeria.

Adetoso and Oseni (2015) researched on forensic accounting as a Tool for Fraud Control in Nigeria. The Objective was to explore the role of forensic accounting in fraud control within the Nigerian banking sector. The study employed a qualitative research design, analyzing case studies of fraudulent activities in selected Nigerian banks. Interviews with forensic accountants were conducted to gather primary data. The research found that forensic accounting techniques such as forensic auditing and computer-assisted auditing tools (CAATs) were effective in uncovering fraudulent transactions in banks. However, the study concluded that forensic accounting is critical for maintaining transparency and accountability in the banking sector, recommending its incorporation into anti-fraud policies.

### **3. Methodology**

#### **3.1. Introduction**

The study adopts a qualitative approach, involving:

**Case Studies:** Analysis of three high-profile financial fraud cases in Nigeria where forensic accounting played a role in uncovering discrepancies.

**Document Analysis:** Review of existing literature, laws, and policies related to forensic accounting in Nigeria.

##### **3.1.1. Case Studies: Analysis of High-Profile Financial Fraud Cases in Nigeria**

###### **Background of the Case**

The case study method provided a deep exploration of specific instances where forensic accounting techniques were successfully employed to uncover financial fraud in Nigeria. This



approach allows for the analysis of real-world scenarios, offering insights into the practical application, challenges, and outcomes of forensic accounting practices.

### **Approach**

#### **a. Selection of Cases:**

The study will focus on three high-profile financial fraud cases in Nigeria where forensic accounting played a pivotal role. Potential cases may include:

- i. The investigation into a major bank's financial mismanagement.
- ii. A public sector embezzlement case involving inflated contracts.
- iii. A corporate fraud case highlighting the misuse of company funds.

#### **b. Analysis Framework:**

Each case will be evaluated based on the following parameters:

- i. **Background of the Case:** Description of the organization, individuals involved, and the nature of the fraud.
- ii. **Forensic Accounting Techniques Used:** Specific methods, such as data mining, Benford's Law, or digital forensics, utilized in uncovering discrepancies.
- iii. **Outcomes:** Results of the investigation, including the recovery of funds, prosecution of offenders, and policy recommendations.
- iv. **Challenges Faced:** Barriers encountered during the forensic investigation, such as resistance to transparency or lack of advanced tools.

### **3.1.2. Document Analysis: Review of Existing Literature, Laws, and Policies Related to Forensic Accounting**

The document analysis method involved a systematic review of existing literature, regulatory frameworks, and policies that govern forensic accounting in Nigeria. This method is critical for understanding the institutional and legal environment in which forensic accounting operates.

### **Approach**

#### **a. Sources of Documents:**

- i. **Academic Literature:** Research papers, journal articles, and books discussing forensic accounting concepts, techniques, and applications.
- ii. **Government Policies:** Regulatory guidelines from institutions like the Central Bank of Nigeria (CBN) and the Financial Reporting Council of Nigeria (FRCN).
- iii. **Legal Frameworks:** Acts and laws related to financial crime prevention, such as the Economic and Financial Crimes Commission (EFCC) Act and the Money Laundering (Prohibition) Act.
- iv. **Industry Reports:** Publications from auditing firms, anti-corruption agencies, and global bodies like Transparency International.

**b. Analysis Criteria:**

- i. **Historical Context:** Evolution of forensic accounting practices in Nigeria and their adoption over time.
- ii. **Strengths and Weaknesses:** Assessment of the legal and institutional frameworks supporting forensic accounting.
- iii. **Comparative Insights:** Evaluation of Nigeria's practices relative to global standards.
- iv. **Gaps in Policy:** Identification of weaknesses in existing regulations and policies that hinder the effective application of forensic accounting.

**Case study 1: A public sector embezzlement case involving inflated contracts**

This section examined a public sector embezzlement case involving inflated contracts within a Nigerian state government agency, where over NGN 2 billion was misappropriated. Forensic accounting techniques were used to uncover the discrepancies and achieve accountability.

**Approach adopted**

**1. Data Collection:**

- i. **Financial Records:** Examination of financial statements, payment vouchers, and procurement records to identify anomalies.
- ii. **Interviews:** Conducted with whistleblowers and relevant staff to gather testimonies regarding the irregularities.
- iii. **Digital Forensics:** Analysis of electronic fund transfers and recovery of deleted records to trace fund movements.

**2. Forensic Accounting Techniques Used:**

- i. **Data Mining:** Employed to analyze large datasets and identify unusual patterns or trends in financial transactions.
- ii. **Benford's Law:** Used to detect irregular patterns in numerical data, particularly within payment transactions.
- iii. **Digital Forensics:** Applied to retrieve deleted files and trace unauthorized electronic fund transfers.
- iv. **Comparative Analysis:** Cross-checking inflated contract values against market standards and independent contractor quotes.

**3. Analytical Tools:**

- i. Software like IDEA (Interactive Data Extraction and Analysis) and ACL (Audit Command Language) was used for data mining and fraud detection.

## **Case study 2: Bank Mismanagement Case**

### **Background of the Case**

The bank mismanagement case involved a high-profile incident within a commercial bank in Nigeria. The fraud, estimated at NGN 800 million, was uncovered following customer complaints about unauthorized withdrawals and discrepancies in loan approvals. Investigations revealed a pattern of systemic failures, including inadequate internal controls, poor oversight of high-value transactions, and non-compliance with regulatory protocols. A senior staff member exploited these weaknesses to bypass standard operating procedures, facilitating fraudulent loan disbursements and unauthorized transactions. This case attracted significant media and regulatory attention, prompting an in-depth forensic accounting investigation to uncover the full extent of the mismanagement.

### **Approach adopted**

This section examined a high-profile bank mismanagement case involving unauthorized withdrawals, loan diversions, and systemic failures in internal controls. The total fraud was estimated at NGN 800 million.

#### **1. Data Collection:**

- i. **Transaction Records:** Analysis of bank statements, internal memos, and loan approval documentation.
- ii. **Interviews:** Conducted with whistleblowers, affected customers, and implicated bank employees.
- iii. **System Logs:** Review of digital transaction logs to identify unauthorized activities.

#### **2. Forensic Accounting Techniques Used:**

- i. **Data Analytics:** Pattern recognition algorithms were employed to detect unauthorized withdrawals and irregular loan disbursements.
- ii. **Control Analysis:** Assessment of the bank's internal controls and compliance with regulatory requirements.
- iii. **Tracing Transactions:** Use of digital forensic tools to follow fund movements across accounts and identify beneficiary accounts.

#### **3. Analytical Tools:**

- i. Specialized banking fraud detection software was utilized alongside manual audits.

### **4. Results and discussion**

#### **4.1. Case study 1: Results**

The application of forensic accounting techniques yielded the following outcomes:

##### **1. Identification of Irregularities:**

- i. Approximately NGN 1.2 billion was traced back to unauthorized accounts.

- ii. Contracts were inflated by up to 80%, with falsified invoices submitted for nonexistent projects.

**2. Recovery of Funds:**

- i. NGN 1.2 billion was recovered through account seizures and asset tracing.

**3. Prosecution:**

- i. Three senior officials were prosecuted, leading to convictions and fines.

**4.1.1. Challenges**

- i. Resistance from agency officials who attempted to obstruct investigations.
- ii. Limited cooperation from some financial institutions in providing transaction details.
- iii. Inadequate record-keeping practices that slowed down the investigative process.

**4.2. Case study 2: Results**

**a. Key Findings:**

- i. Unauthorized withdrawals totaling NGN 300 million were traced to a single employee's fraudulent activities.
- ii. Loan approvals bypassed standard protocols, resulting in NGN 500 million in unverified disbursements.

**b. Recovery of Funds:**

- i. NGN 200 million was recovered through asset seizures and repayment agreements with some beneficiaries.

**c. Systemic Weaknesses Identified:**

- i. Inadequate segregation of duties in loan approval processes.
- ii. Weak monitoring mechanisms for high-value transactions.

**d. Prosecution:**

- i. Two employees were dismissed and charged with financial crimes, leading to court proceedings.

**4.2.1. Challenges**

- i. Difficulty in retrieving funds from beneficiaries due to delayed detection.
- ii. Resistance from internal staff during the investigation process.
- iii. Limited integration of advanced fraud detection software in the bank's systems.

## 5. Recommendations

- i. The implementation of independent audits and mandatory transparency reports for state government contracts.
- ii. Introduction of stricter procurement oversight mechanisms to prevent similar fraud in the future.
- iii. Implementation of automated approval systems for loans to minimize human interference.
- iv. Regular compliance audits and whistleblower protection programs to encourage reporting of fraudulent activities.

## Conclusion

Case study 1 underscores the importance of forensic accounting in combating public sector fraud in Nigeria. By leveraging advanced techniques such as digital forensics and data analysis, financial crimes can be identified and mitigated. However, systemic challenges, including limited cooperation and weak institutional frameworks, highlight the need for stronger policies and capacity building to improve forensic accounting practices. The findings from this case serve as a benchmark for addressing similar challenges in public sector financial management and emphasize the role of accounting professionals in promoting accountability and transparency.

Case study 2 emphasizes the critical role of forensic accounting in uncovering and addressing financial mismanagement within banking institutions. By utilizing advanced analytics, digital forensics, and compliance evaluations, the investigation not only exposed fraudulent activities but also highlighted systemic weaknesses that facilitated the fraud. The findings underscore the need for enhanced internal controls, continuous monitoring, and capacity building to strengthen the financial sector against similar risks in the future. However, this study advocates for the use of approaches such as review of account documents, software like IDEA (Interactive Data Extraction and Analysis) and ACL (Audit Command Language) can be used for data mining, use of Benford's Law and the like.

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# **ASSESSING THE CONDITIONS OF SCHOOL BUILDING IN TERTIARY INSTITUTIONS OF BENUE STATE, NIGERIA**

**IGBANYAM, C.<sup>1</sup>, YADUMA, P.S.<sup>2</sup>, ENEMALI, J.D.<sup>3</sup>, & CHEDI, J.M.<sup>4</sup>**

<sup>1</sup>Department of Technical Education, College of Education Oju, Benue State Nigeria

<sup>2,3,4</sup> Department of Construction Technology, Education Abubakar Tafawa Balewa University Bauchi Nigeria

Corresponding Author's Email: [ibgbacletus2021@gmail.com](mailto:ibgbacletus2021@gmail.com)

## **ABSTRACT**

*This research is aimed to assess the Conditions of School Building Facilities in tertiary Institutions of Benue State, Nigeria. One research questions and one null hypotheses were formulated to guide the study, the researcher employed survey research design that utilized a structured questionnaire developed by the researcher based on the extensive review of the literature related to this study titled Building Maintenance Assessment Tool (BMAT). The research population is 269 comprising of 23 directors of works and 246 maintenance officers. Total Population Sample was used. The overall reliability of the research instrument was found to be .908 and hence it was reliable. Data was collected using a step by step method of administering and retrieving the instrument from the sampled respondents. The data obtained was analyzed using Descriptive Statistics of Mean and Standard Deviation. Statistical Package for Social Sciences (IBMSPSS) version 25 was used and t-test was used to test the hypotheses at 0.05 level of significance. Through the data collected it was found that the Condition of school buildings in tertiary institution of Benue State, Nigeria are moderate. It was therefore recommended that all Tertiary Institutions building should be properly maintained by the Government as this will enable the students learn comfortably without the fear of the building collapsing on them.*

**KEYWORDS:** School Building, Facilities, Tertiary Institutions.

## INTRODUCTION

It is noteworthy that decent educational buildings enhance teaching and learning thereby making the process meaningful and purposeful. Thus, educational buildings are crucial because they foster effective learning and boost good result (Iyamu, Imasuen, & Osakue, 2018). The quality and standard of a school is ideally rooted on the provision of sufficiency, operation and supervision of educational facilities. Considering the deplorable state of public buildings across the country for decades, a large chunk of the country's resources have been channelled towards Transportation Infrastructure, Government administrative Buildings for ministries and Parastatals, Colleges of Education, Universities, Primary and Secondary Schools (Eke, Musa, Fashubaa, & Abass, 2017).

In spite of millions of Naira spent to erect all these buildings, they are left, as soon as commissioned to face premature but steady and rapid deterioration, decay and dilapidation (Adenuga, 2012). Any constructed facilities can be considered as asset or investment that needs to be maintained to ensure its optimal value over its life cycle. Tertiary institution infrastructure system consists of different types of assets that could have life span beyond 35 years (Olasunkanmi, (2021)). Olasunkanmi, (2021), further assert that building system like roof, mechanical or electrical systems usually have a shorter life span of 30 years and their supporting structures, these systems are in constant need of maintenance to ensure that they continue to function optimally and retain their value in good appearance. Thus, maintenance is the combination of all technical and administrative actions intended to retain an item, or restore it to a state in which it can perform its required functions. Alblawi and Elhajji (2021) reported that the field of asset management is becoming increasingly professionalize operational knowledge for the practice of asset was found to exist within literature, current software and current practice. However, this body of knowledge in Nigerian tertiary institution particularly in Benue State in particular appears to be less developed and with little or no records (Adah & Maroof, 2022).

Accordingly, a report by National Center for Education Statistics and the National Cooperative Education Statistics System (2003), Planning Guide For Maintaining School Facilities (n.d.) states that school buildings are one of the important facilities for getting basic knowledge in everyday life. Maintenance of school building is also required to serve staff and students well-being besides paying for the brick and mortar of the building. To this end effective school maintenance protects capital investment, ensures the health and safety of the Students, and supports educational performance.

. Hence, such nations take maintenance of their infrastructures seriously and use them to attract tourists to their country, yielding revenue for them (Ugwu *et al.*, 2018).

According to Oyigbo and Ugwu (2017), many institutions carry out infrastructure development through PPP but measurable indicators of success or otherwise do not exist. Maintenance is "a combination of any actions carried out to retain an item in, or restore it to an acceptable condition" (BSI 1984, 3811). However, maintenance, according to Olanrewaju (2015), is "the processes and services to preserve, repair, protect, and care for a building fabric and engineering services after completion, repair, refurbishment, or replacement to current standards to enable it to serve its intended function throughout its entire lifespan without drastically upsetting its basic features and use". From the definitions, it can be seen that maintenance is a vital component of an organisation's existence in relation to asset management. It is of great importance that construction management practises are given great attention (Iyamuet *al.*, 2018). Higher education institution buildings constitute a significant part of the nation's assets. As it is understood that tertiary education is an important wheel for the development and progress of a

nation, the importance of educational facilities which play host to a large number of users with various needs as typified by tertiary education facilities cannot be overemphasised (Anifowose & Lawal, 2013). It is through the university buildings that future leaders, captains of industry, entrepreneurs, professionals, and scientists are produced (Eke *etal.*, 2017).

### **Statement of the Problem**

Public and private tertiary institution in Nigeria and particularly Benue State, Nigeria has continued to increase without corresponding increase in school buildings which are in deterioration or over utilized, not properly maintained for effective teaching and learning.

Evidence to this, Onuoha (2022) noted that most of Nigerian school buildings are dilapidated due to inadequate maintenance and repair. In the same vain (Olasunkanmi, 2021), observed that administrators and educational planners have confirmed that buildings in schools especially tertiary institute in Benue State of Nigeria are inadequate and even the available ones are in a state of deterioration. Similarly, Alblawi (2021) observed that the inadequacy of infrastructural facilities and lack of maintenance of available buildings were major problem facing education system and especially in tertiary institution in general. It is in view of the above that Marjanovic-Halburd, (2020), reported the lack of policy guidelines on infrastructure development and the maintenance that affect management of tertiary institutions.

In most of the tertiary institution of Benue State, there are inadequate classroom, staff offices, laboratories, workshop, libraries lecture theater and conveniences. This situation is worrisome since the government has failed to establish policy directives, and or standard in relation to school building maintenance and repair. This problem if not controlled or checked it will go a long way to hamper the teaching and learning process in tertiary institutions of Benue State. It is against this background that the researcher intends to determine the state/condition of school buildings in tertiary institution of Benue State, Nigeria.

### **Purpose of the Study**

The main objective of the study was to determine the condition of school buildings in tertiary institution of Benue State, Nigeria.

### **Research Questions**

This study was guided by one research questions:

- i. What are the conditions of school buildings in tertiary institutions of Benue State, Nigeria?

### **Hypotheses**

The study was guided by one null hypothesis and tested at 0.05 level of significance:

**H<sub>01</sub>:** There is no significant difference between the mean responses of Director of Works and Building Maintenance Officers on the conditions of school building in tertiary institutions of Benue State, Nigeria.

### **Methodology**

The study was carried out using Research and Development research design. The study was carried out in Benue State, Nigeria. The population for the study comprised all the 23 Director of work and 246 maintenance officers of the 23 tertiary institutions of Benue State, Nigeria. Total

sample population was used. The instrument for data collection in this research was a structured questionnaire developed by the researcher from literature. The instrument was validated by three experts in the Department of Vocational and Technology Education Abubakar Tafawa Balewa University Bauchi and the internal consistency of the questionnaire was determined using Cronbach's Alpha and reliability coefficient was found to be .908.. The data collection was done by the researcher and trained research assistants and the data were analyzed using descriptive statistics of mean and standard deviation and the hypotheses were tested at 0.05 level of significance using independent t-test. The decision rule was that any mean score of 3.00 and above was accepted and where otherwise was rejected. The rating of the instrument are given Strongly Agree (SA) = 4 points, Agree (A), = 3 points, Disagree (D) = 2 points, and Strongly Disagree (SD) = 1 points

## Results and Discussion

**Research Question One:** What are conditions of school buildings in tertiary institutions of Benue State, Nigeria?

Table 1 shows the mean and standard deviation of the respondents on the state/conditions of school building in tertiary institutions of Benue State. The result shows the cluster mean of Director of Works ranging from 3.45 to 4.75 with standard deviation also ranging from .639 to 1.137 and the mean of Maintenance Officer ranging from 3.05 to 4.45 with the standard deviation also ranging from .946 to 1.126 respectively. The cluster mean of Director of Works is 3.91 and 3.69 for Maintenance Officers. The grand mean of the respondents is 3.71 which indicates that the conditions school buildings in tertiary institution of Benue State is Moderate.

**Table 1: Mean and standard deviation of the respondents on the conditions of school uilding in tertiary institutions of Benue State**

S/N	Items	X <sub>d</sub>	SD <sub>d</sub>	X <sub>m</sub>	SD <sub>m</sub>	X <sub>g</sub>	Remark
1	Status of roof	4.75	.639	4.45	1.016	4.48	Good
2	Status of ceiling	4.10	.718	3.72	.946	3.75	Moderate
3	Status of Walls	4.40	.821	4.00	1.050	4.03	Good
4	Status of Plaster	3.85	.933	3.82	.953	3.82	Moderate
5	Status of Paint	3.75	1.070	3.70	1.126	3.70	Moderate
6	Status of Doors	3.70	1.081	3.68	.977	3.68	Moderate
7	Status of Windows	3.65	1.137	3.39	1.044	3.41	Moderate
8	Status of slab	3.50	1.100	3.43	1.026	3.44	Moderate
9	Status of Floor	3.45	1.050	3.05	1.372	3.08	Moderate
	<b>Cluster Mean</b>	<b>3.91</b>		<b>3.69</b>		<b>3.71</b>	<b>Moderate</b>

Source: Fieldwork, 2024

## Result of Null Hypotheses

**Null Hypothesis One (H<sub>01</sub>):** There is no significant difference between the mean responses of Director of Works and Building Maintenance Officers on the conditions of school building in ertiary institutions of Benue State, Nigeria.

The result of the independent t-test is presented in Table 2 showed that there is no significant difference between the mean responses of Directors of Work and Building Maintenance Officers on the conditions of school building in tertiary institutions in Benue ate, Nigeria within the df of 267, t-value = 1.306, p-value = .194. Since the p value is greater han the confidence level ( $P > 0.05$ ) therefore, the null hypothesis was accepted. This implied that there is no significant difference between the mean responses of Directors of Work and Building Maintenance Officers on the state/conditions of school building in tertiary institutions in Benue State, Nigeria.

**Table 2 t-test analyses of the mean responses of Directors of Work and Building Maintenance Officers on the state/conditions of school building in tertiary institutions in Benue State, Nigeria**

	N	X	S.D	Df	t-val	p-val	Decision
Director of Works	23	3.91	.561	267	1.306	.194	Accepted
Maintenance Officers	246	3.69	.676				

### Findings of the Study

Below is the finding of this study:

1. Condition school buildings in tertiary institution of Benue State, Nigeria are moderate and hence Null Hypotheses one ( $H_{01}$ ) was upheld which means there is no significant difference between the mean responses of Directors of Work and Building Maintenance Officers on the state/conditions of school building in tertiary institutions in Benue State, Nigeria.

### Discussion

Condition school buildings in tertiary institution of Benue State, Nigeria are moderate. This finding is in agreement with that of Kanayochukwua, (2020) who states that that the conditions of educational facilities are not in disarray and properly maintained but however this finding does not agree with that of Luka, et al, (2023) who observed that buildings of the Bauchi State Technical Colleges are in a bad and deplorable working condition and therefore need a maintenance. Furthermore, this finding did not also agree with that of that of Eke et al (2017) who reported that many public school building and government-owned facilities are not well maintained and in poor condition and fail to agrees with that of Babayo (2017) who also reported that in Bauchi State especially in the suburb areas, most of the school buildings are in shambles. Some of them still wear the look of the old and the work of Adenuga and Iyagba (2005) which noted that public buildings in Nigeria are in very poor and deplorable conditions of structural and decorative disrepairs. The study also revealed that the existing building stocks in the schools were in a state of decay due to lack of maintenance and repair. Lastly this finding is also in concord with the work Izobo-Martins et al (2014) who similarly confirmed that most public secondary school buildings in Ogun State Nigeria are in very poor and deplorable conditions of infrastructural disrepair

## Conclusion

In conclusion, the condition of Tertiary Institution buildings in Benue State, Nigeria is moderate and there is also the need for adequate maintenance activities to be carried out on the other buildings which require such services.

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# **ORGANIZATIONAL STRUCTURE AND EMPLOYEES JOB PERFORMANCE: A STUDY OF SELECTED DEPOSIT MONEY BANKS IN ABAKALIKI**

**Chukwuoyims Kevin E.<sup>1</sup>, Iroegbu Franca N.<sup>2</sup>, Ozurumba Keyna C.<sup>3</sup>, Adama Linus<sup>4</sup>, Onya Victoria, O.<sup>5</sup>, Okoro Isaac<sup>6</sup>**

**<sup>1,2,3,4,5</sup>Business Admin. Dept., Alex Ekwueme Federal University Ndufu Alike Ikwo, Ebonyi**

**<sup>6</sup>First City Monument Bank Abakaliki**

**Correspondence: ORCID: 0000-0001-3210-726X | [chukwuoyims.kevin@funai.edu.ng](mailto:chukwuoyims.kevin@funai.edu.ng)**

## **ABSTRACT:**

*An organization can be likened to a building whose strength is determined by the structure and frames which holds it. The structure is the manner in which interrelated elements (resources) are arranged so that the building can be stable, resist stress and it provides the right form. To this end, for the performance of an organization to be effective, it is important to understand the right manner in which interrelated elements (structure) in the specific organization is arranged. To measure the performance of the organization, dependent variables such as sales, profit, and customer satisfaction will be considered. This is to show the effects of the dependent variables on the independent variable. The research adopted quantitative design and applied mono method which brought about numerical data generated from questionnaire administered. The population of this study comprises of all staff of selected deposit money banks, in Ebonyi State Nigeria. Total population of staff of 98 in the three state visited with a sample size of 79. The propositions assumed for this study are that: there is no relationship between structure and performance in selected deposit money banks, there is no effect of structure on the enhancement of zenith bank performance and to what extent does structure have an effect on workers' performance of the zenith. Also, among the secondary data collected are views of various management researchers. As a result of the primary and secondary data collected, the study recommends that organizations should adopt decentralization structure and reduce formalization in the workplace.*

**KEYWORDS: Organization, Organizational Performance, Organizational Structure**

## INTRODUCTION

Organizational structure holds an important role on the performance of an organization. Therefore, anyone managing an organization must understand the importance of structuring an organization. There are various studies associated with effects of organizational structure and organizational performance. To start with, organization, generally is a managerial function of organizing, that involve grouping of activities, establishing authority and responsibility relationship, coordinating different functional activities in pursuit of achieving overall organizational objective and goals, and delegation of authority.” Shafae, Rahnama, Alaei and Jasour (2012); Chegini, Yousefi and Rastad (2013) agreed that productivity is very important for an organization and that the main goal of every organization is to ensure the highest means of productivity level. Malik (2017) states that the placement of organizational members into strategic positions of responsibility with authority and with a view to achieving organisational objectives is known as structuring, hence organizational structure is an essential condition to continuous existence of every organisation. He also elucidated that designing a structure that fits company needs is a major challenge because appropriate structure determines the performance of organisation.

According to Chegini, et al (2013), Ahmed (2017), they believe that performance is one of the most essential and major issues that all organizations face and that with productivity all organization benefit of all sources and facilities to achieve more advantages. Chegini, et al, (2013) stated in their work that many elements influence on organizational performance as well as organizational structure. With the above statement this means there are factors that make up the dimensions of organizational structure which would show the relationship between organizational structure and organizational performance. According to some researchers in their literature they have pointed out what these dimensions are and which also has constituted their organizational structure variables. Scholars like (Chegini, et al, 2013; Rajaeepour, Azizollah, Mahmoud and Shokouhi, 2012; Teixeira, Koufteros, & Peng., 2012; Csaszar, Stephen, Arbor & Michigan 2012, Chien, 2015; Chigozie, & Chijioke, 2015) have all stated in their work what these dimensions are as regards to organizational structure some dimensions presented were the same while others presented were different.

In literature scholars have agreed that performance is a major issue in most organizations and in day to day activity of organizations around the world they use different organizational structure and from literature review it can structure include; Flat structure, Tall Structure, Matrix Structure, Divisional Structure, Geographical Structure, bureaucratic structure etc. These structures are expected to lead to different combination of effort and performance and utilization of resources. However existing evidence shows that organization that makes use of either same or different structure don't get same result. Also, organizational structure is concluded in literature to be determined by various factors such as; size, environment strategy and technology. This results to the need to harmonize the variables presented by these scholars. And therefore, this study is one that attempts at harmonizing the variables which will also constitute the measurement for the construct organizational structure and show the level of relationship to organizational performance.

### Statement of the Problem

Evidence show that organization that makes use of certain structures cannot do without structuring their organization with an element or dimension or mixed dimensions and in the process of operating these dimensions with structure of the organization, organization ends up achieving different result.

Organizational designed is the choice of appropriate structure for the organization. Some corporate managers often do not critically align the structures of the firm with its nature and scope. This non-alignment makes the mechanism for corporate effort and desired organization performance difficult to be actualized. In a state where no one is given order in that chain of command creates a situation of ineffective leadership and conflict role overlap. Employees' is thus affected in such an organization leading to high labour turnover which is often unhealthy for the growth of the bank. Labour turnover is often seen as the flow of manpower into and out of an organization, in which the inflow is referred to as accession and the outflow as separation hence seen as one of the unorganized forms of industrial conflict in which employees usually retreat from unsatisfactory situations.

Previous studies have provided many important insights on what is the relationship between structure and performance in commercial banks. Specific works on Nigerian commercial banks explored mostly how independent variables such as globalization, credit risks and ownership structure affect performance. The operations of the organization can either provide exasperation or satisfaction to the employee depending on how concentrated the structure is in terms of the organisation's complexity and formality and in all the, the overall performance of the employees is at the receiving end (Nwonu, 2017).

These problems are as a result of the poor services rendered to customers and the complaints of customers based on the structures of the organisations in selected commercial banks in Abakaliki, Ebonyi state. Thus, this study is aimed at investigating the effect of organizational structure on the employee performance. There is a gap on the place of organization structure of commercial banks performance in Nigeria. It is this gap that this study seeks to filling using the selected commercial banks in Nigeria.

### **Objective of the Study**

1. To examine the nature of relationship between structure and performance of selected deposit money banks,
2. To evaluate the effects of structure on the performance of the selected deposit money banks,
3. To determine the effect of structure on workers' performance in selected deposit money banks,

### **Research Question**

1. What is the nature of the relationship between structure and performance in selected deposit money banks?
2. What is the effect of structure on the enhancement of selected deposit money banks performance?
3. To what extent does structure have an effect on workers' performance of the selected deposit money banks?

### **Research Hypothesis**

There is positive relationship between structure and performance in selected deposit money banks,

Structure have significant positive effect on the enhancement of performance in selected deposit money banks,

Structure of selected deposit money banks has significant positive effect on workers' performance

## **LITERATURE REVIEW**

According to Owolabi and Kingsley, (2007) and Okafor, Kalu & Ozioma (2017) agree that an organization is a social set up, which has a boundary that separates it from its environment, pursues its own collective goals, and controls its own performance. For managers, the term organization implies a formalized intentional structure of roles positions. Blessing, (2008) refers to it as a social unit or a human grouping intentionally constructed and reconstructed.

Structure is thus an integral component of the organization. Nystrom and Starbuck (1981:21) define structure as the arrangement and interrelationship of component parts and positions in an organization. It provides guidelines on: division of work into activities; linkage between different functions; hierarchy; authority structure; authority relationships; and coordination with the environment. Mon (2019) opined that organizational structure promotes employee-employer relationship as well as participative decision making. In addition, Nwosu (2020) added that the structure of an organization is the foundation upon which strategy is build. This means that strategies whether corporate, operational or business cannot be implemented if there is no pattern or hierarchy of work relationship in the organization.

Organizational structure may differ within the same organization according to the particular requirements. Structure in an organization has three components (Robbins, 1989:11). Complexity, referring to the degree to which activities within the organization are differentiated, this differentiation has three dimensions: horizontal differentiation refers to the degree of differentiation between units based on the orientation of members, the nature of tasks they perform and their education and training, vertical differentiation is characterized by the number of hierarchical levels in the organization, and spatial differentiation is the degree to which the location of the organization's offices, facilities and personnel are geographically distributed; Formalization refers to the extent to which jobs within the organization are specialized.

### **Nature of Organizational Structure**

Akande and Ojokuku, (2008) described organizational structure as a group of people occupying a formal structure of position to achieve a particular purpose. They are institutions that enable society to pursue goals that could not be achieved by individuals' action alone. An organization is generally defined as a structure of relationships to get work done. It is a social system involving interpersonal relationships. Nwugballa, (2011) was of the view that establishment of an organizational structure presupposes the absence of a sole-proprietorship. It also assumes a level of operation that requires the joint effort many persons to successfully execute. This underscores the need to specify the different tasks that should be carried out by different individual job (job descriptions), how it should be carried out (operating procedures), expected standards of performance, line of authority, etc., in order to avoid confusion and conflict. It also requires the relationships and interactions between jobs; system of integration and coordination that would ensure organizational cohesion and, effective and efficient operations. Simply put, organizational structure defines the formal division, grouping, and coordination of job tasks (Robbins, 2005; Tamburri, Kazman & Fahimi, 2023). In the context of this study, the definition of an organisation as given by McNamera (2018) in conjunction with the organisational structure definition as given by Robbins et al. (2014) provided the core definition of an organisational structure in terms of this study.

As far as an organization is concerned structures of different forms exist, and it is the consciousness of creating and applying structure chosen that brings in changes in an organizations' output or performance. Every management has to establish its own organization structure for efficient handling of business activities. The term 'Organization structure' has become very important in the business world today, which in other words has also distinguished different organizations in the world. The word "organization" is gotten from the word 'organism' which means a structure of body divided into different parts that are held together by a fabric of relationship as one organic whole. Organizational Structure can be seen as the rules that oversee the relationship between individuals or teams who try to achieve the organizational goals (Ahmed, 2017).

In an organization of any size or complexity, employees' responsibilities most often are defined by what they do, who they report to, and for managers, who reports to them. Also put differently by another scholar, kuye (2004) referred jones (1995), in his book, that organizational structure is the formal system of task and reporting relationships that determines how employees use resources to achieve organizational goals.

With the above definition, it shows that organizational structure is essential for the conduct of business activities or relationships that exist in the organization like task and reporting activities or relationships which dedicates how employee use available resource effectively to bring about efficient result. Adding that "When a work group is very small and face-to-face communication is frequent, formal structure may be unnecessary, but in a larger organization decisions have to be made about the delegation of various tasks. Thus, procedures are established that assign responsibilities for various functions. It is these decisions that determine the organizational structure."

Organizational structure finds a way to ensure that information flows from a particular level to another level within the company. Muo & Muo (2007) in their book cited Robert Duncan who defined organizational structure as "a pattern of interactions and co-ordinations that links technology, task and human components of the organization to ensure that the organization accomplishes its purpose".

With the definition above given by various scholars this work finds out that organizational structure has to do with relationships between people, resources and levels in an organization, which makes structure very important for companies or businesses that wants to be productive in their day to day activities. These definitions points out the importance of structure in an organization; some of which are that it ensures optimum utilization of a nation's human resources or specialized workers from aboard, it facilitates coordination of different resources, gives room for division of work where possible, allows growth, expansion and diversification, and it stimulates creativity. Chegini et al, 2013, pointed out their dimensions for organizational structure as complexity, formality and concentration.

Power density at a point implies on concentration and lack of density or low density is a sign of decentralization. Concentration is the issue of distribution rate in powers decision making no geographical separation of organization. Concentration is the emphasis with formal organizational structure no with the informal organization and only used formal authority, focus look at decision-makers votes and comments. Organization will facilitate achieving the goals through group efforts coordination. Decision making and information processing are the key elements of coordination. Due to employee participation in decision-making process, decentralization in decision making is caused motivation (Robins, 2000).



It means the degree to which the jobs within an organization are standardized or formalized. Where formalization is low, there will be wider use of discretion by employees and subordinates. Formalization is defined as the extent of written procedures, instructions, laws and communication. Formalization can be done within a job or it can be imposed from outside when formalization is determined from outside for a job used in terms of external behaviour for it. Organisational structures are set up to define the duties of each department and to determine each department's objectives and contribution to the overall organisation's performance and objectives. According to Root (2017) one of the dangers of creating departments is the appearance of different groups' mentality between the departments whereby each group sees themselves as independent of the other instead of working together for the better good of the organisation.

In this case rules and procedures are executed directly by the lower management that represents jobs that unskilled workers can do the job incumbent (Dehkordi, 2009). Formalization can be referred to as the maximum level to which an organization relies on rules and procedures in order to direct the behaviour of workers in the organization. Richard et al, (2009) stated that "organizational performance encompasses three specific areas of firm outcomes:

- (a) financial performance (profits, return on assets, return on investment, etc.)
- (b) product market performance (sales, market share, etc.); and
- (c) shareholder return (total shareholder return, economic value added, etc.)."

As seen in other literature on organizational performance, Ismael, Nor'Aini, and Davoud, (2010) performance is all about achieving the objectives that organizations/firms set for themselves.

The objectives of an organization / firm could be financial, that is to say, profit-making or nonfinancial such as spreading awareness among a certain community etc. Organizational performance therefore could be categorized under two: financial and nonfinancial. The profitability of an organization is an important financial indicator to reflect the efficiency of the organization and the owners/managers ability to increase sales while keeping the variable costs down (Davis, Schoorman, Mayer, & Tan 2000).

Profit margin, return on assets, return on equity, return on investment, and return on sales are considered to be the common measures of financial profitability (Robinson, 1982; Galbraith & Schendel, 1983). Ismael, Nor'Aini, and Davoud, (2010) organizational performance is widely measured through the financial success of the organization. Financial stress for most profit-oriented organization can be assessed both in terms of sales as well as profitability measures (Davis et al., 2000).

Other scholars Zani and Berzieri, (2008) argued that Customer Satisfaction is a key performance indicator of the activity of a firm or a corporation (Fornel, 2008). Mohammad, Shaeir, Shahram, Seyed and Seyyed, (2011) supported this view that "customer satisfaction and delight is presented as solid bedrock of bank longevity and profitability, and in their work they cited Keiningham, Perkins-Munn, Aksoy, and Estrin (2005), stating that "it is a significant affiliation between customer satisfaction, purchase intentions, and consequently financial performance". According to Armstrong and Kotler (2009) considered relationship marketing as a kind of index for customer satisfaction, and they believed that the maintenance of excellent relationship marketing between the enterprise and customers would be beneficial in increasing customer satisfaction.

Ambro and Praprotnik, (2008) stated "Customer satisfaction is an organization's ability to attract and retain customers and to improve customer relationship over time". According to Karunaratne

and Jayawardena, (2010) Customer satisfaction has become a key performance indicator for the hotel business. Mohammad and Shahzad, (2012) customer satisfaction is depended on perceived quality and perceived value. Every firm in the competitive market struggles to maximize their profits. So, they can maximize their profitability by providing attractive products and services to their customers.

Ambro and Praprotnik, (2008) defined Customer satisfaction as the outcome of his or her needs and expectations which influence the interaction with service providers and other customers. The quality of this interaction impacts customer decisions to repurchase the service, his retention and the intention of the customer to recommend to other potential customer.

The higher or lower satisfaction of a consumer will depend upon the quality of brand characteristics that offered by a company (Gerpott, Rams & Schindler, 2001). To ensure retention of consumer, it is important to satisfy consumers (Guo, Xiao and Tang, 2009). That is when there is low quality services customers are not satisfied and this will lead to low performance in the organization. Service is an important element for consumer satisfaction but this is not to say that it is the only element which is responsible (Lin and Wu, 2011).

## THEORETICAL FRAMEWORKS

The study will consider Weber's Way of Bureaucracy and Taylor's scientific management theories. Max Weber believed that an ideal bureaucracy has to do with six specific characteristics: hierarchy of authority, impersonality, written rules of conduct, promotion based on achievement, specialized division of labor, and efficiency.

This ultimate characteristic of Weberian bureaucracy, which states that bureaucracies are very efficient, is controversial and by no means accepted by all sociologists. There are certainly both positive and negative consequences to bureaucracy, and strong arguments for both the efficiency and inefficiency of bureaucracies.

Weber's theory of bureaucracy says that it is extremely efficient, adding that bureaucracy is the most efficient form of organization. Also, that bureaucracies are necessary to ensure the continued functioning of society, which has become drastically more modern and complex in the past century. To him, without the structured organization of bureaucracy, the complex society would be much worse off, due to the fact that society would act in an inefficient and wasteful way. He saw bureaucracies as organizations driven towards certain goals, which they could carry out efficiently.

### Organizational Structures and Design

Some important considerations, say Anderson (1988:3), in designing an effective organizational structure are:

1. **Clarity** The structure of the organization should be such that there is no confusion about people's goals, tasks, style of functioning, reporting relationship and sources of information.
2. **Understanding** The structure of an organization should provide people with a clear picture of how their work fits into the organization.
3. **De-centralization** The design of an organization should compel discussions and decisions at the lowest possible level.

4. **Stability and adaptability** While the organizational structure should be adaptable to environmental changes, it should remain steady during unfavourable conditions.

### 2.2.2 Principles of Organization Structure

Modern organizational structures have evolved from several organizational theories, which have identified certain principles as basic to any organization.

#### Specialization

Specialization facilitates division of work into units for efficient performance. According to the classical approach, work can be performed much better if it is divided into components and people are encouraged to specialize by components. Work can be specialized both horizontally and vertically (Anderson, 1988:8). Vertical specialization in a research organization refers to different kinds of work at different levels, such as project leader, scientist, researcher, field staff, etc. Horizontally, work is divided into departments like genetics, plant pathology, administration, accounts, etc. Specialization enables application of specialized knowledge which better the quality of work and improves organizational efficiency. At the same time, it can also influence fundamental work attitudes, relationships and communication. This may make coordination difficult and obstruct the functioning of the organization. There are four main causal factors which could unfavourably affect attitudes and work styles. These are differences in: goal orientation; time orientation; inter-personal orientation; and the formality of structure (Lawrence and Lorsch, 1967:112).

#### Coordination

Coordination refers to integrating the objectives and activities of specialized departments to realize broad strategic objectives of the organization. It includes two basic decisions pertaining to: which units or groups should be placed together; and the patterns of relationships, information networks and communication (Anderson, 1988:15). In agricultural research institutions, where most of the research is multidisciplinary but involves specialization, coordination of different activities is important to achieve strategic objectives. Efficient coordination can also help in resolving conflicts and disputes between scientists in a research organization.

Hierarchy facilitates vertical coordination of various departments and their activities. Organizational theorists have over the years developed several principles relating to the hierarchy of authority for coordinating various activities. Some of the important principles are discussed below.

**Unity of Command** Every person in an organization should be responsible to one superior and receive orders from that person only. Fayol (1949:3) considers this to be the most important principle for efficient working and increased productivity in an organization.

**The Scalar Principle** Decision making authority and the chain of command in an organization should flow in a straight line from the highest level to the lowest. The principle evolves from the principle of unity of command. However, this may not always be possible, particularly in large organizations or in research institutions. Therefore Fayol (1949:6) feels that members in such organizations could also communicate directly at the same level of hierarchy, with prior intimation to their superiors.

**The Responsibility and Authority Principle** For successfully performing certain tasks, responsibility must be accompanied by proper authority. Those responsible for performance of tasks should also have the appropriate level of influence on decision making.

**Span of Control** This refers to the number of specialized activities or individuals supervised by one person. Deciding the span of control is important for coordinating different types of activities effectively. According to Barkdull (1963:13), some of the important situational factors which affect the span of control of a manager are: similarity of functions; proximity of the functions to each other and to the supervisor; complexity of functions; direction and control needed by subordinates; coordination required within a unit and between units; extent of planning required; and organizational help available for making decisions.

In addition, within an organization that operates under bureaucratic standards, the members will be better off due to the heavy regulation and detailed structure. Not only does bureaucracy make it much more difficult for arbitrary and unfair personal favours to be carried out, it also means that promotions and hiring will generally be done completely by merit. The Scientific Management theory was introduced by Frederick Winslow Taylor to foster production efficiency and effectiveness. Taylor argues that inefficiencies could be tamed through managing production as a science.

The scientific management view deals with the concept of planning of activities to gain efficiency, standardization, specialization and simplification. For productivity to be increased then there has to be mutual trust between management and workers. Taylor (1947) identified four principles of scientific management which includes: Taylor identifies four inherent principles of the scientific management theory, Science, not rule-of-thumb; Scientific selection of the worker, Management and labour cooperation rather than conflict; and Scientific training of workers.

### **3.0 RESEARCH METHODOLOGY**

#### **3.1 Research Design**

Baridam (2001) defined a research design as “a blueprint for conducting a study with maximum control over factors that may interfere with the validity of the findings”. Research design could be seen as a framework or plan that is used as a guide in collecting and analyzing the data for a study. Thus, there are two types of research design, the experimental and the quasi - experimental designs. In the experimental design, all the elements of the design are largely under the control of the researcher. In quasi - experimental research design, the various elements of the design are not under the control of the researcher (Cooper and Schindler, 2011). However, the researcher adopted a cross-sectional survey which is one aspect of quasi - experimental design because the element of study is not under the control of the research. Secondly, cross-sectional survey supports the use of questionnaire in collecting data from respondents (Cooper & Schindler, 2011).

#### **3.2 Sources Data**

Zikmund, Babin, Carr & Griffin (2013) elucidates that there are basically two sources of data collection in social research which are the primary and secondary.

#### **3.3 Population of the study**

Sreejesh, Mohapatra & Anusree (2014) defined population as “the total number of units from which data can be collected”, such as individuals, artifacts, events or organizations. However, the target population for this study consists of selected deposit money banks that are currently

operating within Abakaliki metropolis. These are *UBA, First Bank, Access Bank, Unity Bank, GTB, Fidelity, Heritage Bank, Ecobank, Union Bank, Stanbic IBTC Bank, FCMB, Zenith Bank, Polaris Bank and Keystone Bank*. The researcher was able to select five deposit money banks using convenience sampling. Convenience sampling refers to the collection of information from members or organizations that are conveniently available to the researcher (Sekaran & Bougie, 2016). These are *Fidelity (Ogoja Road), GTB (Ogoja Road), FCMB (Ogoja Road), Access Bank (Ogoja Road), and Zenith Bank (Ogoja Road)*. The total population of staffs from human resource departments of the above five selected banks as at the period this research was carried out are as shown on table 3.1 below.

**Table 3.1: Staff strength of selected banks**

<b>Deposit Money Banks</b>	<b>Number of staffs</b>
Fidelity Banks	19
GTB	21
FCMB	18
Access Bank	16
Zenith Bank	24
<i>Total</i>	<b>98</b>

**Source: Field Survey, 2024**

### 3.4 Sample Size Determination

To determine the sample size of this study, Taro Yamane formular was employed as follows:

$$n = \frac{N}{1 + N (e^2)}$$

Where:

n = Sample size

N = Population

e<sup>2</sup> = level of significance (0.05)

$$\begin{aligned}
 &= \frac{98}{1 + 98 (0.0025)} \\
 &= \frac{98}{1 + 0.245} \\
 &= \frac{98}{1.245}
 \end{aligned}$$

Sample size (n) = 79

### 3.5 Data Analysis Technique

It has been revealed that conclusion often arises whenever a wrong statistical test is used to analyze the data; when this happens, the purpose of the study is defeated (Baridam, 2001). The respondents' demographic characteristics was analysed using simple percentages while the response rates on the research questions was analysed using simple percentages. Hypotheses of

this study were analysed with Spearman's Rank Order Correlation Coefficient ( $\rho$ ). However, Sreejesh, Mohapatra and Anusree (2014) asserted that survey data that is purely on ordinal level (ranking) should be treated with the right statistical tool such as Spearman's Rank Order Correlation Coefficient ( $\rho$ ) or Pearson Product Moment Correlation Coefficient ( $r_s$ ) in line with the way research hypotheses were stated. Statistical Package for Social Sciences (SPSS 22.0) was used to carry out the analysis effectively.

### 3.6 Research Instruments

Research instrument otherwise known as questionnaire was designed in line with indicators of independent variable (organizational structure) and dependent variable (employee retention) indicators. The questionnaire was divided into two segments. Section 'A' covered the profiles of respondents while section 'B' covered research questions on organizational structure indicators (work specialization, formalization, and centralization). Section 'C' covered research questions on employee retention indicators.

### 3.7 Reliability of the Study/Instrument

The reliability of the instrument was ascertained using cronbach alpha coefficient with aid of statistical package for social sciences (SPSS 21.0). Saunders, Lewis & Thornhill (2009) affirmed that reliability benchmark between 0.7-0.8 coefficients is good for research questions in social and management sciences. Instrument reliability result of this study revealed that all the indicators fall within the above acceptable ranges of 0.7 and 0.8  $\alpha$  coefficients.

### 3.8 Validity of the Study/Instrument

Validity is the appropriateness of or the extent to which an instrument measures what it intends to measure (Baridam, 2001). The questionnaire was given to my supervisor (face validity) for approval. The instrument is valid because it gives the same result repeatedly.

### 3.9 Variable Measurement

Five point Likert scale ranging from ranging from 5=Strongly Agree, 4=Agree, 3=Strongly Disagree, 2=Disagree, 1=Undecided was used to measure organizational structure and employee retention indicators. Organisational structure was measured with eight (8) research questions (items). Employee retention was measured with eight (8) research questions (items).

## 4. DATA PRESENTATION, ANALYSIS AND DISCUSSION

### 4.1 Data Presentation

**Table 4.1: Administration of Questionnaire**

Deposit Money Banks	Staff	Questionnaire administered	Questionnaire Returned
Fidelity Banks	19	15	12
GTB	21	17	15
FCMB	18	15	14
Access Bank	16	13	12
Zenith Bank	24	19	17
<b>Total</b>	<b>98</b>	<b>79</b>	<b>70</b>

Source: Field Survey, 2024



For equally distribution of the questionnaire to the respective deposit money banks, the researcher made use of Bowley (1926) sample proportion formular to carry out the allocation. The reason is that the numbers of staff in each bank are not equal. Bowley's formula is stated as follows:

$$\text{Sample proportion} = \frac{\text{Number of staff} \times \text{Sample size}}{\text{Total Population of the study}}$$

From the above administration of questionnaire, the respondents were able to filled seventy (70) copies correctly leaving nine (9) copies incomplete. The researcher used seventy (70) to carry out the analysis.

## 4.2 Descriptive Analysis

**Table 4.2: Gender of Respondents'**

	Frequency	Percent	Valid Percent	Cumulative Percent
Male	44	62.9	62.9	62.9
Valid Female	26	37.1	37.1	100.0
Total	70	100.0	100.0	

Source: Field Survey, 2024

The above shows that 44 respondents representing 62.9% are males while 26 respondents representing 37.1% are females. This means that males are more than females as at the time of this research.

**Table 4.3: Age Bracket of Respondents'**

	Frequency	Percent	Valid Percent	Cumulative Percent
41&above	31	44.3	44.3	44.3
Valid 31-40	24	34.3	34.3	78.6
18-30	15	21.4	21.4	100.0
Total	70	100.0	100.0	

Source: Field Survey, 2024

Table 4.3 above show that 31 respondents representing 44.3% are between the age of 41 years and above. 24 respondents representing 34.3% fall within 31-40 years, while 15 respondents representing 21.4% are between 18-30 years.

**Table 4.4: Educational Qualification of Respondents'**

	Frequency	Percent	Valid Percent	Cumulative Percent
Others	14	20.0	20.0	20.0
OND/HND	12	17.1	17.1	37.1
Valid Master	15	21.4	21.4	58.6
Bachelor	29	41.4	41.4	100.0
Total	70	100.0	100.0	

Source: Field Survey, 2024

Table 4.4 above revealed that 14 respondents representing 20.0% hold other educational qualifications. 12 respondents representing 17.1% hold OND/HND (Ordinary National Diploma/Higher National Diploma) diploma certificates.15 respondents representing 21.4% hold Master Degrees.29 respondents representing 41.4% hold Bachelor degrees.

**Table 4.5: Respondents' Number of Years Worked in Bank**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 7-11	36	51.4	51.4	51.4
12year&above	16	22.9	22.9	74.3
1-6	18	25.7	25.7	100.0
Total	70	100.0	100.0	

Source: Field Survey, 2024

Table 4.5 above shows the number years respondents have worked in their respective banks. 33 respondents representing 51.4% have worked in the banks between 7-11 years. 16 respondents representing 22.9% have worked in the banks between 12 years and above. 18 respondents representing 25.7% have worked in the bank between 1-6 years.

### 4.3 Test of Hypotheses

**Table 4.6 Test of Hypothesis One**

**H1: There is positive relationship between structure and performance in selected deposit money banks,**

#### Correlations

			Specialization	Supervisor support
Spearman's rho	Specialization	Correlation Coefficient	1.000	.782**
		Sig. (2-tailed)	.	.000
		N	70	70
	Supervisor support	Correlation Coefficient	.782**	1.000
		Sig. (2-tailed)	.000	.
		N	70	70

\*\*. Correlation is significant at the 0.01 level (2-tailed).

The above result shows that specialization has significant positive relationship with supervisor support in selected deposit money banks in Abakaliki. Correlation coefficient output is high and also positive (.782\*\*) while p value (.000) is less than the significant level of 0.01. This implies that the null hypothesis is rejected and alternate hypothesis accepted.

**Table 4.7 Test of Hypothesis Two**

**H2: Structure have significant positive effect on the enhancement of performance in selected deposit money banks,**

#### Correlations

			Decentralization	Work-life balance
Spearman's rho	Decentralization	Correlation Coefficient	1.000	.788**
		Sig. (2-tailed)	.	.000
		N	70	70

Work-life balance	Correlation Coefficient	.788**	1.000
	Sig. (2-tailed)	.000	.
	N	70	70

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The result of hypothesis two above shows that decentralization has significant positive relationship with work-life balance in selected deposit money banks in Abakaliki. Correlation coefficient is high with positive (.788\*\*) while p value (.000) is less than the significant level of 0.01. This means that the null hypothesis is rejected and alternate hypothesis accepted.

**Table 4.8 Test of Hypothesis Three**

**H3: Structure of selected deposit money banks has significant positive effect on workers' performance**

#### Correlations

		Formalization	Career development
Spearman's rho	Formalization	Correlation Coefficient	1.000
		Sig. (2-tailed)	.834**
		N	.000
	Career development	Correlation Coefficient	.70
		Sig. (2-tailed)	.70
		N	.000

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The above result shows that formalization has significant positive relationship with career development opportunities in selected deposit money banks in Abakaliki. From the above, the correlation coefficient is high and also positive (.834\*\*) while p value (.000) is less than the significant level of 0.01. This means that the null hypothesis is rejected and alternate hypothesis accepted.

#### 4.4 Discussion of Findings/Results

Based on the hypotheses results above, the following discussions were made. Result of hypothesis one revealed that specialization has significant positive relationship with supervisor support in selected deposit money banks in Abakaliki. This implies that as specialization increases, supervisor support also increases in deposit money banks. This is in line with Eketu et al., (2020) results on the effects of organizational structure on employee resilience in Nigeria. Their finding revealed that that organisational structure has positive significant effect on employee resilience.

Hypothesis two result revealed that decentralization has significant positive relationship with work-life balance in selected deposit money banks in Abakaliki. This means that as decentralization increases, work-life balance will decrease in deposit money banks. This result is in line with Faruk & Gary (2016) that examined the impact of organizational structure on management innovation. Their finding showed that decentralization has a significant positive

impact on management innovation. In another study of Eze, Bello & Adekola (2017) who investigated the effects of organizational structure on the performance of organizations. Their finding indicated that there is relationship between organizational decentralization and organizational customer satisfaction as well as organizational profit,

Result of hypothesis three revealed that formalization has significant positive relationship with career development opportunities in selected deposit money banks in Abakaliki. This means that as formalization increases, career development opportunities will also increase in deposit money banks. The result of hypothesis three is in line with Nwosu (2020) who investigated organizational structure and employee's performance in Nigeria breweries. Nwosu's finding revealed that formalization has significant positive effect on employee's performance.

## **THEORETICAL FINDINGS**

This study notes that as organizations are being formed over time, it has given rise to studies and development of theories or principles that will govern the establishment of organizations as well as the structure inside it. Furthermore, this study has found out that the theories as related to organizations include Bureaucracy, Rationalization (Scientific Management), and the Division of Labor. As organizations are implemented over time, many people experimented as to which one was best. But each theory provides distinct advantages and disadvantages when implemented.

Further findings of this study reveal that the management of the modern office is based upon written rule, and rules that are stable and can be learned. This means that most modern organizations operate with some form of formalization which everyone in the organization must follow. Another finding of this study is that the perspective of Rational System shows that specificity of goals and formalization are very crucial to an organization. Goal specification provides guidelines for specific tasks to be completed along with a regulated way for resources to be allocated. Formalization is a way to standardize organizational behavior and stable expectations. Standardization of work which is brought about by formalization may not be a perfect tool all the time for employee's performance. For instance, in the theory of scientific management, problems arose and one of them is that standardization leads workers to rebel against the mundane.

Another is that workers may reject the incentive system because they are required to constantly work at their optimum level, an expectation that may be unrealistic. Doing the same routines may not be for everyone. Also, employees were not familiar with other parts of the job. They couldn't assist employers of different parts of the system.

One other finding of this study is that organizational structure follows some laws and they must be functional under the rules of those laws. These laws govern the modern organizations and lead them in the direction that will maximize profits efficiently. Thus, the modernity of organizations is to generate maximum profit. Further findings is that Max Weber believed that an ideal bureaucracy consists of six specific characteristics: hierarchy of authority, impersonality, written rules of conduct, promotion based on achievement, specialized division of labor, and efficiency. So therefore, any organization running an idea bureaucracy that organization must consist of six specific characteristics. Also, this study further find's that the hierarchical nature of bureaucracies allows employees to demonstrate achieved social status when an office holder is elected instead of appointed, that person is no longer a purely bureaucratic figure.

## RECOMMENDATIONS

The study recommends that management of organizations use decentralization as a dimension of organizational structure to restructure their organization when centralization is not giving required organizational performance. Perhaps this way they may attain strong positive relationship between decentralization and customers' satisfaction and also between decentralization and organizational profit etc. Since using organization centralization brings about a weak positive relationship on their organizational customer satisfaction, and no significant relationship on profit. Also, seeing organizational formalization does not have any significant relationship with both customers satisfaction and profit of the organization, it is recommended that management of the organization adjust the way things are formalized by reducing the way work are standardized in the organization so as to increase the performance of the organization. So therefore, in order to avoid all this problems that scientific management had, it will be good to make the organization less formal allowing employee to have the freedom to get job done efficiently and increase organization performance through whatever means known to the employees of the organization.

## CONCLUSION

This study has shown that one of the null hypotheses was rejected because there is a relationship between organizational centralization (independent variable) and organizational customer satisfaction (dependent variable) but this relationship is a weak positive one, therefore the results means the two variables do not complement each other so well. This study has therefore recommended that another organizational dimension should be look into for organizational performance to increase. And concerning the rest null hypothesis such as; There is no relationship between organizational centralization and organizational profit. There is no relationship between organizational formalization and organizational customer satisfaction. There is no relationship between organizational formalization and organizational profit. were accepted and the alternative hypothesis was rejected. And therefore, the above 1-3 hypothesis do not play any important role in organizational performance.

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# **IMPACT OF DIGITAL LITERACY ON INNOVATIONS AMONG GEN Z ENTREPRENEURS IN NIGERIA**

**Damian-Okoro INETIMI (PhD)<sup>1</sup> & HARRY, Amieibi Harcourt (PhD)<sup>2</sup>**

**<sup>1,2</sup>Department of Marketing, Faculty of Administration and Management, Rivers State  
University, Port Harcourt**

**Emails: [roseline.damian-okoro@ust.edu.ng](mailto:roseline.damian-okoro@ust.edu.ng)<sup>1</sup>; [amieibihary@gmail.com](mailto:amieibihary@gmail.com)<sup>2</sup>**

## **ABSTRACT**

*This paper examined how digital proficiency enables young entrepreneurs to leverage technology, automation, and online platforms to scale their businesses and drive economic growth. The research highlights how productivity and efficiency are improved through cloud-based collaboration tools, automation, and AI-driven business processes, enabling young entrepreneurs to manage businesses remotely and optimize performance. Moreover, the research investigated the rise of digital-first business models which have allowed Nigerian entrepreneurs to compete in the global digital economy. The study also examined how alternative financing and crowdfunding have transformed startup funding, enabling young entrepreneurs to secure investments through peer-to-peer lending, cryptocurrency-based financing, and crowdfunding platforms like NaijaFund and GoFundMe. Despite these advancements, challenges such as cybersecurity threats, digital infrastructure limitations, and regulatory barriers persist. By fostering a robust digital ecosystem, young Nigerian entrepreneurs can leverage digital literacy to drive long-term innovation, business success, and economic development.*

**KEYWORDS:** *Digital literacy, Gen Z entrepreneurs, innovation, digital-first business models, alternative financing, crowdfunding.*

## INTRODUCTION

The rise of digital technology has significantly influenced entrepreneurship, particularly among Generation Z (Gen Z) entrepreneurs. Born between 1997 and 2012 (Dimock, 2019), this cohort has grown up in a digital era, making digital literacy a fundamental aspect of their personal and professional lives. Digital literacy—the ability to effectively find, evaluate, and communicate information using digital technologies—has become a key determinant of business innovation and success (Eshet, 2012). In Nigeria, where youth entrepreneurship is increasingly seen as a solution to unemployment and economic stagnation, understanding the impact of digital literacy on innovation is essential.

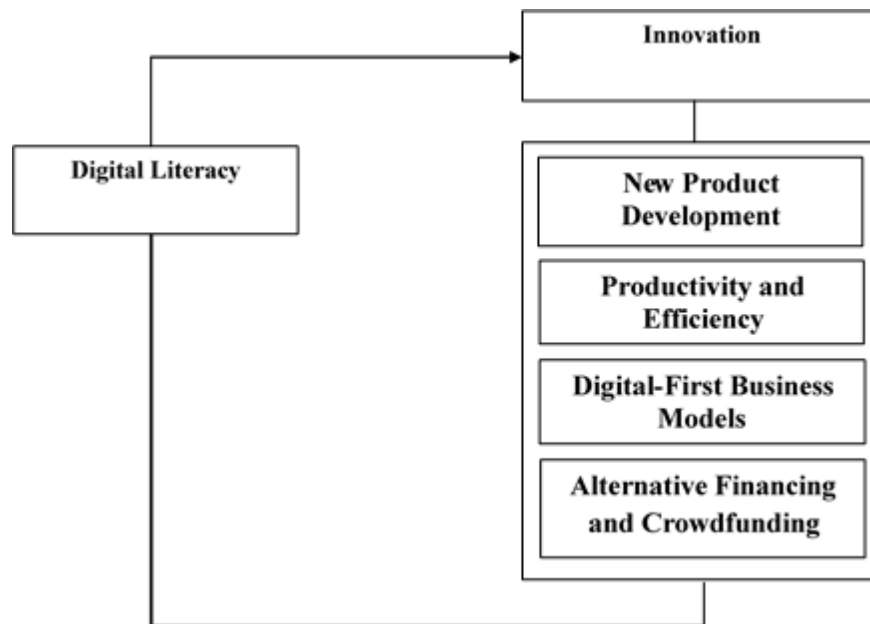
Innovation is a crucial factor in the success of modern enterprises, driving competitive advantage and sustainability (Schumpeter, 1942). For Gen Z entrepreneurs in Nigeria, innovation is often linked to their proficiency in digital skills, including social media marketing, e-commerce, data analytics, and emerging technologies such as artificial intelligence (AI) and blockchain (Oyelaran-Oyeyinka, 2020). Digital literacy enables these entrepreneurs to leverage technology for problem-solving, business process optimization, and market expansion. Moreover, the growing digital economy in Nigeria, fueled by increased internet penetration and mobile technology adoption, provides a conducive environment for tech-savvy entrepreneurs to thrive (Adepetun, 2021).

Despite these opportunities, challenges such as inadequate digital infrastructure, high data costs, and digital skill gaps hinder the full realization of digital literacy's impact on innovation among Nigerian Gen Z entrepreneurs (Ovia, 2018). While some young entrepreneurs acquire digital skills through formal education, many rely on self-learning, online courses, and peer networks (World Bank, 2020). The disparity in digital literacy levels across socio-economic backgrounds suggests that access to technology and education plays a significant role in shaping entrepreneurial innovation.

This paper examines the relationship between digital literacy and innovation among Gen Z entrepreneurs in Nigeria. It explores how digital skills contribute to business ideation, operational efficiency, and market expansion. Additionally, it evaluates the challenges and policy implications surrounding digital literacy in the Nigerian entrepreneurial landscape. By investigating these dynamics, this study provides insights into strategies for enhancing digital literacy and fostering innovation among young entrepreneurs in Nigeria.

### Conceptual and Theoretical Framework

Gen Z entrepreneurs are driving innovation across various domains, and several key indicators highlight their innovative approaches. However in this paper, the specific focus is on new product development, productivity enhancement, novel business models, and alternative financing and crowdfunding. Additionally, this investigation is founded on Schumpeter's Theory of Innovation. Literature is reviewed on all the variables, and the relevance of this theory to digital literacy and entrepreneurial innovation is examined.



**Figure 1:** *Conceptual framework of the Impact of Digital Literacy on Innovation Among Gen Z Entrepreneurs in Nigeria.*

### **Digital Literacy among Nigerians and its Impact on Innovations**

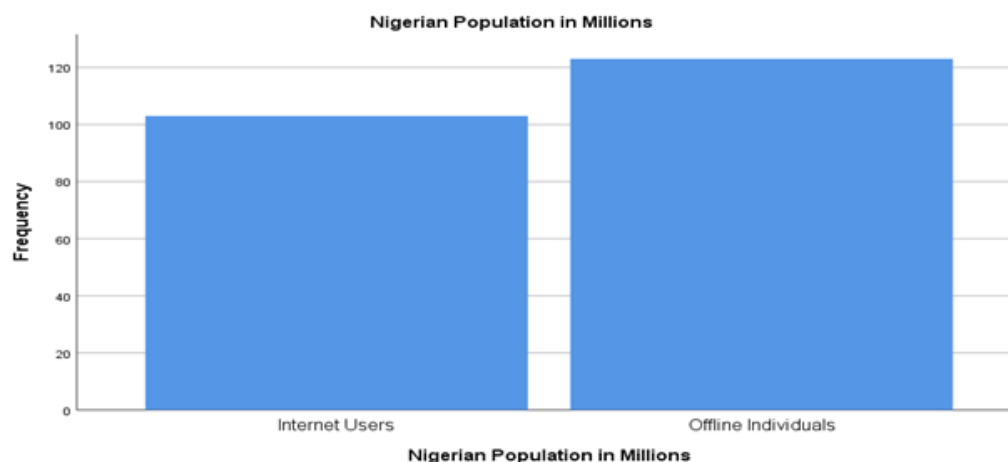
Digital literacy, which encompasses the ability to access, evaluate, and utilize digital technologies effectively, has become a crucial aspect of economic and social development in Nigeria. As the country continues to experience rapid digital transformation, the level of digital literacy among Nigerians significantly influences their participation in the modern economy, innovation, and global competitiveness (Okon & Etim, 2021). While digital penetration has increased due to the availability of affordable mobile devices and internet services, disparities in digital literacy levels remain a challenge (Adeleke & Afolabi, 2020).

One of the key areas where digital literacy has had a profound impact is in technological innovations. With the rise of fintech, e-commerce, and digital entrepreneurship, Nigerians with higher digital literacy skills are more likely to create and leverage digital solutions to address socio-economic problems (Adeyemi et al., 2022). The fintech sector, for example, has witnessed exponential growth due to increased digital awareness, enabling mobile banking, digital payments, and blockchain technology applications (Eke, 2023). However, a lack of digital literacy among a significant portion of the population has hindered the full potential of these innovations.

Moreover, digital literacy has transformed the education sector in Nigeria by facilitating e-learning and online academic resources (Ogunleye & Bello, 2021). Digital tools have made remote learning possible, especially during the COVID-19 pandemic, allowing students to continue their education despite physical restrictions. However, the digital divide, influenced by socio-economic status and geographical location, continues to affect equitable access to digital learning opportunities (Salami et al., 2022).

In addition, digital literacy is essential in improving governance and civic engagement. E-governance initiatives, such as online voter registration, digital tax filing, and national identification systems, rely on the ability of Nigerians to navigate digital platforms effectively (Usman & Yakubu, 2020). Greater digital literacy fosters transparency, efficiency, and inclusivity in governance, thereby enhancing democratic participation.

Despite these benefits, challenges persist in promoting digital literacy among Nigerians. Limited infrastructure, especially in rural areas, high costs of digital devices, and inadequate ICT education in schools are significant barriers (Nwankwo, 2023). As of January 2024, Nigeria's population stood at approximately 226.5 million, with 103 million internet users, indicating an internet penetration rate of 45.5% (DataReportal, 2024). This suggests that over half of the population remains offline, highlighting a substantial digital divide. Furthermore, a 2021 World Bank report revealed that more than 50% of Nigerians lack digital skills, limiting their ability to utilize data services.



**Figure 2: Population of Internet Users and Offline Individuals in Nigeria**

The disparity is more pronounced among Nigerian graduates, with a survey indicating that 85% lack digital skills, rendering them unprepared for job opportunities that require such competencies (GetBundi, 2023). Additionally, approximately 61% of rural Nigerians are unconnected, compared to 40% in urban areas, underscoring a significant rural-urban digital divide (DataReportal, 2024).

To address these issues, stakeholders, including the government, private sector, and civil society, must collaborate to develop digital literacy programs, integrate ICT training in formal education, and promote digital inclusion initiatives. Recognizing these challenges, the Nigerian government aims to achieve 95% digital literacy by 2030, reflecting a commitment to equip citizens with necessary digital skills (Zawya, 2023). The National Information Technology Development Agency (NITDA) has developed a National Digital Literacy Framework to guide these efforts (NITDA, 2023).

Digital literacy among Nigerians plays a pivotal role in fostering innovation, improving education, enhancing governance, and driving economic growth. While there has been notable progress, efforts must be intensified to bridge the digital divide and ensure that all Nigerians can effectively participate in the digital economy, and fully harness the benefits. Investments in digital infrastructure, policy reforms, and educational initiatives will be critical in achieving comprehensive digital literacy in Nigeria.

### **Impact of Digital Literacy on Innovations among Nigerian Entrepreneurs**

Innovation is a key driver of economic growth and development in any society. It involves the introduction of new ideas, processes, and technologies that improve existing systems or create

entirely new ones (Schumpeter, 1934). In Nigeria, innovation has been significantly influenced by the increasing levels of digital literacy, leading to advancements in various sectors such as finance, agriculture, education, and health.

One of the most notable innovations in Nigeria due to digital literacy is the rise of fintech solutions. Companies like Flutterwave and Paystack have revolutionized digital payments, making transactions easier and more accessible for businesses and individuals (Adeleke, 2021). These fintech startups leverage digital literacy to enhance financial inclusion, enabling people without traditional bank accounts to engage in e-commerce and online transactions.

**Flutterwave** was co-founded by **Olugbenga "GB" Agboola** in **2016**. He is a Nigerian entrepreneur and fintech expert. Flutterwave is a leading payments technology company that facilitates seamless transactions across Africa and beyond. **Paystack** was co-founded by **Shola Akinlade** and **Ezra Olubi** in **2015**. It is a Nigerian fintech company that provides payment processing solutions for businesses across Africa. In **2020**, Paystack was acquired by **Stripe** for approximately **\$200 million**, making it one of the largest startup acquisitions in Africa.

In agriculture, digital platforms such as Farmcrowdy provide innovative solutions by connecting farmers with investors and markets. Through mobile applications and web-based platforms, farmers receive real-time information on weather conditions, pricing, and farming techniques, thereby increasing productivity and profitability (Okonkwo, 2020). This digital transformation has made agribusiness more sustainable and attractive to young entrepreneurs.

**Farmcrowdy** was founded by **Onyeka Akumah** in **2016**. It is Nigeria's first digital agriculture platform, connecting small-scale farmers with investors to boost agricultural productivity and food security. Farmcrowdy has raised significant funding through investments, grants, and partnerships to scale its agricultural technology solutions in Nigeria. Key financial milestones include:

**i. Seed Funding (2017):** Farmcrowdy raised \$1 million in seed funding to expand its operations and improve its digital platform.

**ii. Series A Funding (2019):** The company secured an additional \$1 million from investors such as Cox Enterprises and Techstars, bringing its total funding to over \$2 million at the time.

**iii. Merger with Agritech Companies (2020):** Farmcrowdy expanded its financial base by acquiring and merging with other agritech startups, including Best Foods Livestock & Poultry Ltd to strengthen its presence in Nigeria's agricultural sector.

**iv. Government & Developmental Support:** Farmcrowdy has also benefited from partnerships with government agencies, NGOs, and development banks focused on boosting food production and supporting smallholder farmers.

Education has also benefited from digital literacy, particularly through e-learning platforms. Platforms like uLesson and Tuteria offer digital education resources, allowing students to access learning materials remotely (Ogunyemi, 2022). This is particularly beneficial in a country where access to quality education is limited by geographical and economic constraints. **uLesson** was founded by **Sim Shagaya** in 2019. It is an EdTech company that provides digital learning resources for students across Africa, focusing on K-12 education. **Tuteria** was founded by **Godwin Benson** in 2015. It is an online tutoring platform that connects students with qualified tutors for personalized learning experiences.



Sim Shagaya, the founder of uLesson, is a Nigerian entrepreneur known for his contributions to the tech and education sectors in Africa. Godwin Benson, the founder of Tuteria, is also a Nigerian and was recognized for his work in education technology, even winning the prestigious Royal Academy of Engineering Africa Prize for Engineering Innovation in 2017. With regard to the **financial base, uLesson and Tuteria** have received significant funding through venture capital investments. Some key financial milestones include:

#### uLesson

- In **2020**, uLesson raised **\$7.5 million** in a Series A funding round led by Owl Ventures, with participation from LocalGlobe and TLcom Capital.
- In **2021**, the company secured **\$15 million** in a Series B round, making it one of the most funded EdTech startups in Africa. Investors included Tencent, Owl Ventures, and TLcom Capital.

#### Tuteria

Tuteria has had a more modest financial backing compared to uLesson but has still received notable funding and grants:

- In **2017**, Tuteria won the **Royal Academy of Engineering Africa Prize for Engineering Innovation**, which came with a **£25,000** (approximately \$32,000 at the time) cash prize.
- It also received support from the **Lagos Angel Network** and other private investors.

While Tuteria has not raised large venture capital rounds like uLesson, it operates on a revenue model that charges a commission on transactions between tutors and students. Also, uLesson has continued to expand its services across Africa, using its funding to improve content, technology, and market reach.

More also, the healthcare sector has seen advancements through digital health solutions such as Helium Health and LifeBank. Helium Health was co-founded by **Adegoke Olubusi, Tito Ovia, and Obafemi Williams** in 2016. It is a Nigerian health tech company focused on digitizing healthcare records and improving hospital management across Africa. LifeBank was founded by **Temie Giwa-Tubosun** in 2016.

It is a health-tech company that facilitates the delivery of blood and other essential medical supplies to hospitals in Nigeria and beyond. These innovations improve access to medical records, emergency blood supply, and telemedicine services, ensuring better healthcare delivery (Ajayi, 2019). The ability to harness digital tools to address healthcare challenges demonstrates the impact of digital literacy on societal well-being.

### Digital Literacy and New Product Development

New Product Development (NPD) refers to the process of conceptualizing, designing, and bringing a new product or service to market. In Nigeria, the rise of digital literacy has significantly influenced NPD across various sectors, especially in fintech, e-commerce, and agritech. Digital literacy - the ability to use digital tools, navigate the internet, and apply technology effectively - has empowered Nigerian entrepreneurs to develop innovative products that address local challenges.

One notable example is Paystack, a fintech company founded by Nigerians Shola Akinlade and Ezra Olubi. Paystack leveraged digital literacy to develop an online payment processing system that simplifies transactions for businesses and individuals (Adeleke, 2021). The success of

Paystack led to its acquisition by Stripe for \$200 million in 2020, demonstrating the impact of digital skills on NPD in Nigeria (Ogunleye, 2022).

Furthermore, in the agricultural sector, Farmcrowdy, a digital agritech platform, utilizes technology to connect farmers with investors. Through mobile applications and digital marketing, Farmcrowdy enhances food production and financial inclusion, showcasing the role of digital literacy in product innovation (Eze, 2020).

Similarly, in developed nations like the United States and China, digital literacy has led to the rapid growth of tech startups and innovations. For example, **Tesla's electric vehicles** and **Alibaba's e-commerce ecosystem** showcase how digital skills drive the development of cutting-edge products (Zhang & Wang, 2019).

Alibaba's e-commerce ecosystem is a prime example of how digital literacy drives New Product Development (NPD) and business growth. Founded by Jack Ma in 1999, Alibaba has transformed China's e-commerce industry by leveraging digital skills, big data, and artificial intelligence (Zhang & Wang, 2019). The company's ecosystem includes platforms like Taobao, Tmall, and Alibaba Cloud, which provide businesses with innovative digital solutions for marketing, logistics, and payments.

One of the key innovations within Alibaba's ecosystem is its AI-driven recommendation system, which enhances user experience by analyzing consumer behavior and offering personalized product suggestions (Huang et al., 2020). Additionally, Alibaba has integrated smart logistics through Cainiao, which uses big data to optimize delivery routes and reduce shipping times (Chen & Liu, 2021).

The success of Alibaba demonstrates how digital literacy enables businesses to develop new products and services that revolutionize industries. Countries with strong digital skills, like China, have been able to scale such innovations rapidly, influencing global e-commerce trends.

Tesla's success in the electric vehicle (EV) industry is a testament to how digital literacy fosters New Product Development (NPD). Founded by Elon Musk, Tesla has revolutionized the automotive industry by integrating artificial intelligence (AI), big data, and software engineering into vehicle design and production (Anderson et al., 2021).

One of Tesla's key innovations is its Autopilot and Full Self-Driving (FSD) system, which uses machine learning and real-time data from cameras and sensors to enable autonomous driving (Brown & Taylor, 2022). Additionally, Tesla's over-the-air (OTA) software updates allow vehicles to receive new features and performance improvements without requiring physical modifications (Smith, 2020).

Moreover, Tesla's Gigafactories, powered by advanced robotics and automation, enhance efficiency in battery production and vehicle assembly (Chen & Wang, 2021). This level of digital integration showcases how nations with strong digital literacy capabilities, such as the United States, lead in cutting-edge product development.

Tesla's impact on the global EV market underscores the importance of digital skills in engineering, software development, and AI in driving innovation. Countries investing in digital education and technological infrastructure are better positioned to compete in high-tech industries.

As digital literacy continues to grow in Nigeria, more entrepreneurs are leveraging technology to create market-driven solutions. However, challenges such as inadequate internet access and cybersecurity threats remain barriers to maximizing the potential of digital-driven NPD (Ajayi & Olanrewaju, 2021). Addressing these issues will further accelerate innovation and economic growth in Nigeria.

### **Impact of Digital Literacy on Productivity and Efficiency among Gen Z Entrepreneurs**

Digital literacy has significantly enhanced productivity and efficiency among Gen Z entrepreneurs and businesses. Gen Z, born between the late 1990s and early 2010s, is the first generation to grow up with advanced digital tools, cloud computing, and artificial intelligence (AI), allowing them to optimize business operations and scale rapidly (Ng, 2021).

One of the key ways digital literacy boosts productivity is through automation and digital collaboration tools. Platforms like Trello, Slack, and Notion help Gen Z entrepreneurs manage tasks, streamline workflows, and improve communication in remote or hybrid work environments (Smith & Lee, 2022). For example, young entrepreneurs running dropshipping businesses use AI-driven analytics and Shopify's automated fulfillment systems to optimize inventory and order processing with minimal manual intervention (Brown, 2023).

Additionally, social media marketing has transformed how Gen Z businesses reach customers. With expertise in TikTok, Instagram Reels, and YouTube Shorts, young entrepreneurs leverage content creation and algorithmic insights to maximize audience engagement and drive sales (Johnson, 2022). An example is the rise of digital-native fashion brands, where Gen Z entrepreneurs use AI-powered design tools and influencer collaborations to reduce marketing costs and increase efficiency.

However, despite these advantages, challenges such as digital burnout and cybersecurity risks remain. To sustain productivity, experts recommend digital wellness strategies and stronger cybersecurity measures (Williams, 2021).

### **Digital-First Business Models among Gen Z Businesses and Entrepreneurs**

The rise of digital-first business models has transformed how Gen Z entrepreneurs in Nigeria and other nations operate, leveraging digital literacy to build scalable, innovative ventures. A digital-first business model prioritizes online platforms, cloud-based operations, and AI-driven automation to reduce costs and enhance efficiency (Smith & Lee, 2022). Gen Z entrepreneurs prioritize digital platforms, including direct-to-consumer (DTC) e-commerce, social commerce, and subscription-based services. These models emphasize convenience and sustainability, aligning with consumer demand for eco-conscious and tech-integrated solutions (Taylor, 2021). The use of influencer marketing and community-driven brand building further enhances their market presence (Lee & Kim, 2022).

In Nigeria, Gen Z entrepreneurs have embraced fintech, e-commerce, and social media-driven businesses. For example, Flutterwave, a digital payment platform, was co-founded by young Nigerian innovators to facilitate seamless financial transactions across Africa (Adegoke, 2021). Additionally, Instagram and WhatsApp-based e-commerce have become mainstream, with many Gen Z entrepreneurs selling fashion, beauty, and tech gadgets online without physical stores (Eze, 2022).

Globally, similar trends are evident. In the United States, digital-native brands like Gymshark, founded by Gen Z entrepreneur Ben Francis, thrived by using social media marketing and direct-

to-consumer (DTC) strategies instead of traditional retail (Johnson, 2023). In China, Gen Z entrepreneurs leverage TikTok's live-stream shopping model, integrating AI-driven analytics to optimize sales and customer engagement (Zhang & Wang, 2021).

The success of digital-first businesses is driven by Gen Z's high digital literacy, preference for online interactions, and adaptability to emerging tech trends (Williams, 2020). However, challenges such as cybersecurity risks, digital market saturation, and infrastructure limitations in developing nations remain barriers to long-term success (Ogunleye, 2023).

#### Alternative Financing and Crowdfunding among Gen Z Businesses and Entrepreneurs

Access to funding is a critical challenge for Gen Z entrepreneurs, leading many to explore alternative financing and crowdfunding as viable options. Alternative financing includes peer-to-peer (P2P) lending, venture capital (VC), angel investments, and blockchain-based fundraising, while crowdfunding allows businesses to raise small contributions from a large number of people via digital platforms (Smith & Lee, 2022). These platforms have enabled young entrepreneurs to test market demand before scaling their businesses (Chen, 2021). Unlike previous generations, Gen Z entrepreneurs rely more on crowdfunding, decentralized finance (DeFi), and peer-to-peer lending rather than traditional bank loans (Hernandez, 2023).

In Nigeria, Gen Z entrepreneurs are increasingly turning to crowdfunding platforms like NaijaFund and GoFundMe to support their startups, especially in fintech, agritech, and creative industries (Eze, 2023). For example, RiceAfrika, a Nigerian agritech startup, successfully raised funds through crowdfunding to expand its operations and support local farmers (Adegoke, 2022). Additionally, the rise of cryptocurrency-based funding has allowed Nigerian startups to bypass traditional banking limitations and secure investments via decentralized finance (DeFi) (Ogunleye, 2023).

Globally, similar trends are visible. In the United States, crowdfunding platforms like Kickstarter and Indiegogo have helped Gen Z entrepreneurs launch innovative products without relying on traditional banks (Johnson, 2023). A notable example is Pebble, a minimalist e-paper smartwatch, which raised over \$10 million through Kickstarter, proving the power of community-driven financing (Brown, 2021). Meanwhile, in Europe, platforms like Seedrs and Crowdcube provide equity crowdfunding opportunities, allowing young entrepreneurs to attract angel investors in exchange for company shares (Williams, 2022).

Alternative financing is reshaping entrepreneurial funding, particularly for Gen Z, who are digitally savvy, socially connected, and eager to leverage technology-driven fundraising solutions (Ng, 2020). However, challenges such as fraud risks, regulatory uncertainties, and difficulties in scaling after crowdfunding success persist, especially in developing economies (Ogunleye, 2023).

#### **Schumpeter's Theory of Innovation and its Relevance to Digital Literacy among Gen Z Entrepreneurs**

Joseph Schumpeter's Theory of Innovation, also known as the Schumpeterian model of economic development, emphasizes the role of entrepreneurship in driving economic change through innovation. Schumpeter (1934) identified innovation as a key force that disrupts equilibrium and creates new markets, business models, and technological advancements. He outlined five types of innovations: new products, new production methods, new markets, new sources of supply, and new organizational structures. According to Schumpeter, entrepreneurs are the agents of this creative destruction, as they introduce innovations that replace outdated economic structures and drive progress.

Schumpeter's theory is particularly relevant in the digital age, where technological advancements have lowered barriers to entry for new entrepreneurs, especially among Generation Z. Digital literacy - the ability to effectively use digital tools, platforms, and data—has become a critical enabler of innovation among young entrepreneurs. Digital literacy allows Gen Z entrepreneurs to leverage emerging technologies, such as artificial intelligence, blockchain, and cloud computing, to develop innovative products and services. Moreover, it enables them to access global markets, automate business operations, and utilize data-driven decision-making strategies (Pradhan et al., 2020).

In the context of Schumpeter's theory, digital literacy serves as a modern enabler of creative destruction, fostering continuous entrepreneurial innovation. Gen Z entrepreneurs, who are digital natives, have a unique advantage in navigating the digital economy. Their ability to adapt quickly to technological changes aligns with Schumpeter's emphasis on dynamic competition and innovation-driven economic growth (Nambisan, 2017). As digital literacy expands among young entrepreneurs, it accelerates the process of business transformation, leading to the rapid evolution of industries and consumer preferences.

Furthermore, digital literacy also enhances entrepreneurial resilience, allowing Gen Z entrepreneurs to innovate in response to crises, such as the COVID-19 pandemic, which accelerated digital transformation across industries (Agarwal & Brem, 2021). By integrating digital tools with business strategies, these entrepreneurs exemplify Schumpeter's notion of disruptive innovation, reshaping traditional business models and creating new economic opportunities.

Thus, Schumpeter's Theory of Innovation provides a valuable framework for understanding the impact of digital literacy on Gen Z entrepreneurs. As technology continues to evolve, digital literacy will remain a crucial factor in fostering entrepreneurial innovation, aligning with Schumpeter's vision of continuous economic development through creative destruction.

## **Conclusion**

Digital literacy plays a pivotal role in shaping innovation among Gen Z entrepreneurs in Nigeria, influencing new product development, productivity, business models, and financing strategies. The ability to leverage digital tools, data analytics, and emerging technologies has enabled young entrepreneurs to create innovative products and services, particularly in sectors like fintech and e-commerce. Platforms such as Flutterwave demonstrate how digital literacy fosters seamless financial solutions and scalable business ideas.

Moreover, digital literacy enhances productivity and efficiency through automation and cloud-based collaboration tools. Gen Z entrepreneurs in Nigeria use platforms like Slack, Notion, and Trello to streamline workflows, optimize remote work, and reduce operational costs. The adoption of AI-driven decision-making and e-commerce platforms has further accelerated business efficiency and scalability.

Additionally, digital literacy has led to the rise of digital-first business models, where Nigerian entrepreneurs prioritize online operations, leveraging social media marketing and direct-to-consumer (DTC) strategies to build sustainable ventures. The success of social commerce on Instagram, WhatsApp, and TikTok highlights the power of digital engagement in reaching broader audiences.

Finally, alternative financing and crowdfunding have emerged as key enablers of entrepreneurship, allowing Gen Z startups to secure capital without relying on traditional banks.



Platforms like NaijaFund, GoFundMe, and cryptocurrency-based funding solutions have empowered young entrepreneurs to launch and grow businesses despite financial constraints (Williams, 2022). However, challenges such as cybersecurity risks and regulatory concerns must be addressed to maximize the potential of digital financing (Ogunleye, 2023).

Therefore, this paper concludes that, digital literacy is a driving force behind entrepreneurial innovation in Nigeria, equipping Gen Z with the tools to create, manage, and fund businesses efficiently. As digital skills continue to evolve, fostering education, infrastructure, and regulatory frameworks will be crucial in sustaining long-term economic growth and technological advancements in Nigeria's entrepreneurial ecosystem.

## **Recommendations**

To maximize the benefits of digital literacy-driven innovation, the following recommendations are proposed:

**i. Enhancing Digital Literacy Education:** The Nigerian government, educational institutions, and private organizations should integrate comprehensive digital literacy programs into school curriculums. This should include coding, data analytics, AI, and digital marketing to equip young entrepreneurs with the skills needed for innovation.

**ii. Improving Access to Digital Infrastructure:** Many Gen Z entrepreneurs face challenges due to poor internet connectivity, high data costs, and unreliable electricity. Investments in broadband expansion, affordable digital tools, and stable power supply will enhance the effectiveness of digital-first business models.

**iii. Encouraging Digital-First Business Strategies:** Business development programs should focus on helping startups adopt digital-first models, leveraging e-commerce platforms, AI-driven automation, and social media marketing. Government and private sector collaborations can support startups in optimizing direct-to-consumer (DTC) strategies.

**iv. Expanding Alternative Financing Opportunities:** The Nigerian financial sector should create more inclusive crowdfunding regulations and support cryptocurrency-based financing while ensuring security and compliance with global standards. This will enable Gen Z entrepreneurs to access non-traditional funding sources like DeFi, P2P lending, and venture capital platforms.

**v. Strengthening Cybersecurity and Digital Policies:** With the rise of cyber threats and fraud in digital financing and e-commerce, stronger cybersecurity frameworks, digital fraud protection laws, and entrepreneur-focused cybersecurity training should be implemented.

**vi. Building Entrepreneurial Support Networks:** The government and private sector should create business incubators, mentorship programs, and networking hubs to connect Gen Z entrepreneurs with experienced investors and industry experts. These platforms should offer training, funding access, and collaborative innovation spaces.

By implementing these recommendations, Nigeria can foster a thriving digital entrepreneurial ecosystem where Gen Z innovators leverage digital literacy to drive economic growth and technological advancements.



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# **EFFECT OF STRATEGIC LEADERSHIP ON THE PERFORMANCE OF SELECTED NON- GOVERNMENTAL ORGANIZATIONS IN NIGERIA**

**Dr. ENYI L.A.<sup>1</sup>, Abi Onyuma ABIGAIL<sup>2</sup>, Dr. Ochepo ISAIAH<sup>3</sup>, & Lawani BRIGET<sup>4</sup>**

**<sup>1,2</sup> Business Education Department, Benue State College of Education, Oju**

**<sup>3</sup> Technical Education Department, Benue State College of Education, Oju**

**<sup>4</sup> Business Education Department, Benue State College of Education, Oju**

**Correspondence Email [envilarry1970@gmail.com](mailto:envilarry1970@gmail.com)**

## **ABSTRACT**

*The study investigated the effect of strategic leadership on the performance of selected NGOs in Nigeria. The research specifically examined how strategic direction setting and strategic alignment affect the performance of selected NGOs in Nigeria. A survey research design was utilized and data were retrieved from a population of 169 staff of eight selected NGOs in Nigeria using an online questionnaire. The data retrieved from the participants were analysed using mean, standard deviation and regression with the aid of the Statistical Package for Social Sciences (SPSS version 25). The study found that strategic leadership practices (strategic direction setting and strategic alignment) have positive and significant effects on organizational performance. The study concludes that strategic leadership significantly affects the performance of selected NGOs in Nigeria. The study recommends, among others, that NGOs in Nigeria should clearly set out a well-defined strategic direction by ensuring that resources and efforts are concentrated on high-priority areas.*

**KEYWORDS:** *Leadership, Strategic Leadership, Strategic Direction Setting, Strategic Alignment, Organizational Performance, Operational Efficiency.*

## INTRODUCTION

Businesses today operate in a volatile climate due to rivalry, globalization, and technological advancements, which have changed the conditions under which modern companies can prosper. In the wake of these challenges, the business landscape has become more competitive and challenging than before. Organizations need leaders that have the ability to swiftly and effectively implement new strategies that will improve organizational performance. The performance of organizations holds paramount importance because organizational performance is attained when organizations efficiently and effectively achieve their objectives, surpassing their competitors in the process. Organizational performance is determined by the results and output of firms, profits, staff attitude and the responses to the external environment (Mwasiri & Muchiri, 2022).

Strategic leadership has emerged as a critical factor in the success and sustainability of organizations in an increasingly complex and dynamic business environment. Strategic leadership is the practice of guiding an organization toward its long-term objectives by fostering a clear vision, making informed decisions, and inspiring stakeholders to achieve collective goals. This approach is essential in navigating complex business environments and ensuring sustainable success. Unlike traditional leadership, which primarily focuses on operational and tactical aspects, strategic leadership emphasizes innovation, adaptability, and foresight in navigating uncertainties and changes (Ahmed et al., 2024).

Strategic leadership is particularly relevant in today's globalized economy, where businesses, governments, and non-profit organizations must respond to rapid technological advancements, evolving market conditions, and geopolitical challenges. Leaders who exhibit strategic thinking can anticipate future trends, inspire teams, and implement policies that foster organizational growth and resilience. Strategic leadership dimensions identified in the literature, include strategic direction setting and strategic alignment (Mwasiri & Muchiri, 2022; Abdullah & Anwar, 2021). Strategic direction setting focuses on the plans and actions you need to implement in order to progress toward a vision for the organization's future. Strategic alignment is the process of ensuring that all aspects of an organization, including its goals, resources, and activities, are coordinated and in harmony with its overall strategy (Haule & Mushi, 2024).

Strategic leadership within Non-Governmental Organizations (NGOs) in Nigeria plays a pivotal role in driving sustainable development and societal transformation. NGOs in the country operate across various sectors, including health, education, human rights, and economic empowerment, often addressing gaps left by governmental agencies (Kegeni & Kimencu, 2021). Effective strategic leadership ensures these organizations can navigate complex socio-economic landscapes, mobilize resources efficiently, and achieve their missions. It enables leaders of NGOs to articulate clear, long-term objectives that align with their organizations' mission and the broader developmental goals of the society. This involves building robust relationships with beneficiaries, donors, government entities, and other NGOs, which enhance collaboration and resource sharing while amplifying the impact of initiatives (Dahri et al., 2019).

In USA, Owusu-Boadi (2019) contended that, the ineffective use and implementation of strategic leadership factors of strategic direction, risk management, strategic control, efficient planning, skills or competence development and efficient usage of scarce resources affected huge corporations' performances. In South Africa the organization has failed to appropriately implement the strategic leadership practices including strategic vision, establishing balanced strategic controls that considerably affected the organization performances (Kabetu & Iravo, 2018). In addition, Onu et al. (2018) stated that, strategic leadership has been a key factor that affect the growth and performance of Nigerian manufacturing firms. Otieno and Lewa (2020)



found positive significant association between strategic leadership practices and performance of organizations in the maritime sector in Kenya. The study explores how leaders develop and implement strategic leadership strategies that ensure long-term organizational success. By understanding the principles of strategic leadership, organizations can cultivate leaders who drive sustainable success and maintain a competitive edge in their respective industries.

### **Statement of the Problem**

Strategic leadership is crucial for the effectiveness and sustainability of Non-Governmental Organizations (NGOs) in Nigeria. However, many NGOs in Nigeria operate with limited financial and human resources, making it difficult to attract and retain skilled leaders. This challenge hampers long-term planning and the execution of strategic initiatives. Also, insecurity in various regions of Nigeria affects the operational reach of NGOs. Leaders must constantly adapt strategies to ensure the safety of their staff and the communities they serve, which can divert focus from long-term goals. There is a continuous need for capacity building among NGO leaders to enhance strategic planning and implementation skills, but limited access to professional development opportunities have impeded the growth of effective leadership within the sector. There is a dearth of literature on strategic leadership and organizational performance in the NGOs sector in Nigeria. To address the gap in literature the current study is conducted to ascertain how strategic leadership practices affect the performance of selected NGOs in Nigeria.

### **Objectives of the Study**

The aim of the research is to examine the effect of strategic leadership on the performance of selected NGOs in Nigeria. The specific objectives of the study include to:

- i. determine the effect of strategic direction setting on the performance of selected NGOs in Nigeria
- ii. ascertain the effect of strategic alignment on the performance of selected NGOs in Nigeria

### **Research Hypotheses**

The study is guided by the following null hypotheses:

- H<sub>01</sub>: Strategic direction setting has no significant effect on the performance of selected NGOs in Nigeria
- H<sub>02</sub>: Strategic alignment has no significant effect on the performance of selected NGOs in Nigeria

## **LITERATURE REVIEW**

### **Strategic Leadership**

Leadership involves the capacity to guide, empower, and inspire individuals to enhance the productivity and progress of their respective organizations (Anwar, 2017). Strategic leadership involves guiding an organization toward its long-term objectives by making informed decisions, leveraging core competencies, and ensuring cohesive alignment across all levels (Lengingiro et al., 2024). Strategic leadership is described as the ability of a leader to foresee challenges, maintain adaptability, and empower others to implement strategic changes as needed (Banda, 2022). This form of leadership enables organizations to anticipate and envision future scenarios,

remain flexible, and empower individuals to identify strategic opportunities and viable paths forward (Ali & Anwar, 2021).

Strategic leadership encompasses the capacity of firms to anticipate and visualize future scenarios, while maintaining adaptability, engaging in strategic thought, and implementing changes that can foster a competitive edge in the future. Previous researches have highlighted the role strategic leadership in organizations and identified its key components to include strategic direction setting, and strategic alignment (Wakhisi, 2021; Mwasiri & Muchiri, 2022).

### **Strategic Direction Setting**

Strategic direction setting is a critical component of effective leadership, involving the articulation of an organization's vision, mission, and long-term objectives (Ali & Anwar, 2021). This process provides a clear roadmap, guiding decision-making and aligning efforts across all levels to achieve desired outcomes. Strategic direction entails defining the organization's vision, mission, and long-term goals. Leaders provide a clear roadmap, articulating the desired future state and the strategies to achieve it. This clarity enables all members to understand their roles in contributing to the organization's success. Effective strategic direction involves continuous assessment of the external environment and internal capabilities to adapt and refine strategies as needed (Serfonten, 2021).

### **Strategic Alignment**

Strategic alignment involves synchronizing the organization's structure, resources, and processes with its strategic objectives (Kitonga, 2017). This ensures that all departments and employees are working cohesively toward common goals. Achieving strategic alignment requires clear communication, effective change management, and the establishment of performance metrics that reinforce desired behaviors. When successfully implemented, strategic alignment enhances efficiency, improves decision-making, and fosters a unified organizational culture (Ramos et al., 2023). Maintaining strategic alignment between organizational priorities and resources improves the capacity of the organization to react to external pressures and propels it toward a higher performance level by integrating the core ideas of its goals and objectives (Kegeni & Kimencu, 2021).

### **Organizational Performance**

Organizational performance refers to the utilization of resources by an organization to accomplish predetermined goals (Serfontein, 2015). The performance of organizations is evaluated by comparing the actual outcomes with the predetermined objectives and goals (Costa, 2020). It is the ability of firms to convert inputs into outputs to achieve specific goals (Mui et al., 2018). The requirement for strategic leadership that can capitalize on the distinctive skills that businesses build to succeed has been highlighted in a number of studies on organizational performance (Banda, 2022; Jooste & Fourie, 2016). The study used market growth and operational efficiency in line with Abdullah and Anwar (2021).

### **Market Growth**

Market growth describes how a market expands in size over time (Costa, 2020). Market growth is a vital indicator of organizational performance, reflecting an organization's ability to expand its market presence, increase revenue, and gain a competitive edge. Organizations that achieve sustainable market growth demonstrate strong business strategies, adaptability, and customer-

centric approaches (Shao, 2019). It can result from factors such as increased demand, successful marketing strategies, product innovation, and geographic expansion (Mwangi, 2017).

### **Operational Efficiency**

Operational efficiency is a critical measure of an organization's performance, reflecting how well an entity utilizes its resources to achieve its objectives. It encompasses productivity, cost-effectiveness, quality of output, and overall resource optimization (Kegeni & Kimencu, 2021). Organizations that achieve high operational efficiency can maximize output while minimizing waste, leading to improved profitability and sustainability. Operational efficiency refers to the ability of an organization to deliver products or services in the most cost-effective manner without compromising quality. It is achieved by streamlining processes, reducing redundancies, and optimizing resource utilization (Ahmed et al., 2024).

### **Theoretical Framework**

The upper echelon theory, which Hambrick and Mason (1984) developed, serves as the foundation for this investigation. According to the thesis, decisions made by leaders in organizations are a reflection of their personal traits. The notion was based on the idea that the knowledge, experience, and skill of strategic leaders had a direct impact on the outcomes of organizations. The performance of an organization and strategic leadership practice are highly correlated with knowledge, experience, and skills. According to the thesis, companies resemble the strategic executives who run them. The idea demonstrates that strategic leaders are critical to achieving organizational performance, which makes it pertinent to the current investigation.

### **Empirical Studies**

Lengingiro et al., (2024) examined the effect of strategic leadership on organizational performance of universities in Kenya. The study used a descriptive research design. The population of the study was the 77 universities in Kenya and a census study was used. The study used mixed methods in data collection with a structured questionnaire and interviews. Descriptive statistics were applied to the quantitative data, and correlation results were used to test the hypothesis. The results showed that there is a strong positive correlation between strategic leadership and organizational performance of universities in Kenya. The study is related to the current study but was conducted in Kenya.

Haule and Mushi (2024) examined the impact of strategic leadership practices on the performance of Kigamboni Municipal Council in Tanzania. The research employed a quantitative, cross-sectional design, targeting councilors and employees as respondents. The data were collected from 61 participants through a questionnaire, and analysis was conducted using descriptive statistics and linear multiple regression. Results indicated significant relationships were found between strategic practices and organizational performance. Ramos et al. (2023) examined the influence of strategic leadership, organizational learning, and organizational culture on organizational performance through organizational citizenship behavior in Australia. The study used a quantitative survey design to gather information from 310 company management employees as a sample. The results of the use of structural equation modeling (SEM) demonstrated a substantial relationship between organizational performance and organizational learning, culture, and citizenship behavior as well as strategic leadership.

Chen et al. (2022) looked at how Chinese manufacturing companies performed in relation to strategic leadership. The study employed a descriptive research design. 330 managers and employees who worked for manufacturing companies made up the target group. The data obtained

from the questionnaire was evaluated using both descriptive and inferential statistics. The study found that company performance is positively impacted by strategic leadership.

Mwasiri and Muchiri (2022) investigated the influence of strategic leadership practices on performance of telecommunication firms in Kenya. The sample for the study, which employed a descriptive research design, included 70 workers from Telkom Kenya's Mombasa branch. The study employed a simple random sample strategy, and the data collected through the use of a semi-structured questionnaire were analyzed using regression and correlation techniques. It was found that strategic leadership techniques (strategic direction setting, strategic articulation, intelligence leadership, and strategic alignment) significantly and considerably linked with performance.

Ali and Anwar (2021) investigated how strategic leadership effectiveness affect organizational effectiveness in Iraq. The design used was a survey research design, and a selfadministered questionnaire was used to gather data. A sample of 152 individuals was utilized, while 175 small and medium-sized companies made up the overall population. Regression analysis was employed in analyzing the data, and the outcomes demonstrated that managerial skill was significantly impacted by the effectiveness of strategic leadership.

In India a research by Birasnav and Bienstock (2019) investigated the impact of strategic leadership on performance of manufacturing companies. A total of fifty (50) manufacturing companies in India constituted the targeted population and to gather primary data, a semi-structured set of questions was employed. Regression analysis was performed, and the results showed that strategic leadership improves business performance.

Santoso, Budiman and Lena (2019) investigated the effect of strategic leadership on corporate performance in Indonesia. The study engaged 100 leaders of AIA Financial in the East Indonesia region and used a survey design to gather primary data. Partial Least Square was used to analyze the data that were gathered. The study's findings demonstrated that organizational performance was not significantly impacted by strategic leadership techniques. Musafiri, Mulyungi and Rukia (2018) researched on the effect of strategic leadership on organizational performance with focus on MTN Rwanda. The survey design employed was descriptive. The target population was the twenty-one managerial employees of MTN Rwanda's headquarters. Primary data were gathered using a semi-structured questionnaire, and Pearson Coefficient Correlation was employed for analysis. The study found a strong link between organizational success and strategic leadership approaches.

## **RESEARCH METHODOLOGY**

A survey research design employed for this study. This method helped to gather data from the participants to help achieve objectives of the study. The population is made up of 169 staff of eight selected NGOs in Nigeria, including Médecins Sans Frontières (MSF), International Committee of the Red Cross (ICRC), Save the Children Nigeria, Action Against Hunger (ACF), CARE International, Mercy Corps Nigeria, Catholic Relief Services (CRS) and ActionAid Nigeria. The target population include on staff who are into leadership. A census technique was used and the whole population was used. A structured questionnaire was used to collect primary data from the participants through online google forms. The study conducted both validity and reliability tests to ensure consistency and accuracy of the measurement items. The data collected were analysed using mean, standard deviation and regression with the aid of the Statistical Package for Social Sciences (SPSS version 25).

## RESULTS AND FINDINGS

The mean and standard deviation were utilized in the data presentation process to account for respondents' agreement with the responses. Data was gathered using a Likert scale to rate the degree of agreement on a scale of 1 to 5, with 5 denoting strong agreement and 1 strongly disagree.

**Table 1: Strategic Direction Setting**

Statement	Mean	Std Deviation
The organization evaluates the vision statement on a regular basis	4.65	.519
The organizations's moral mission is dispersed throughout the organization	4.51	.536
The management has established realistic organizational goals	4.86	.881
The organization has a mission statement in writing that outlines our identity and the people we serve	4.69	.703
<b>Overall Mean</b>	<b>4.68</b>	<b>.659</b>

**Source:** Field Survey, 2025.

As can be seen from Table 1, 4.65 and 4.51, respectively, suggest that respondents agreed with the claims that the organization regularly reviews its vision statement and that its moral purpose is spread across the entire organization. The company has a defined mission statement that outlines who we are and who we serve, according to a mean score of 4.69, and respondents felt that management had set attainable organizational goals, according to a mean score of 4.86. The total mean score of 4.68 indicates that the respondents strongly agreed that the organizations utilized strategic direction setting.

**Table 2: Strategic Alignment**

Statement	Mean	Std Deviation
The business actively engages staff members to guarantee that behavior changes.	2.57	.753
The business creates a new culture that makes achieving goals possible	4.66	.748
To increase efficiency, the organization incentivizes employees to follow business policies	4.41	.741
The demands of employees and the company's goals are closely connected	4.04	.756
<b>Overall Mean</b>	<b>3.92</b>	<b>.749</b>

**Source:** Field Survey, 2025.

In Table 2, the results showed that respondents (Mean = 2.57) disagreed with the statement that they continuously engage staff to achieve behavior change. However, as evidenced by a mean of 4.66, respondents agreed that they attempt to instill new culture that is conducive to goal achievement. The consensus among the respondents was that they encourage employees to follow corporate policies in order to boost output (Mean=4.41) and that the objectives of the business

and the demands of the workforce are closely linked (Mean = 4.04). With a mean score of 4.68 overall, it was suggested that respondents agreed that the organizations used strategic alignment.

**Table 3: Hypotheses Testing**

Obs	169		
R <sup>2</sup>	0.737		
R <sup>2</sup> adjusted	0.724		
Sig	0.000		
Variable	$\beta$	t-value	Sig
Strategic Direction Setting	.469	5.184	.000
Strategic Alignment	.336	3.825	.008

**Source:** Computation from SPSS Output, 2025.

The impact of strategic leadership strategies on organizational performance is delineated in Table 3. According to the findings, strategic leadership is responsible for 73.7% of the variation in organizational performance, with external factors accounting for the remaining 26.3% ( $R^2=0.739$ ). With a coefficient value of 0.469 for strategic direction setting, the organization is expected to see a 46.9% rise in performance for every unit increase in strategic direction setting. Similarly, a unit change in strategic alignment will result to 33.6% improvement in firm performance. The result therefore implies that strategic direction setting has the greatest effect on firm performance.

The result of the hypothesis one indicates that there is substantial effect of strategic direction setting on firm performance ( $\beta=.469$ ;  $t=5.184$ ;  $p=.000$ ) hence the null hypotheses which states that strategic direction setting has no significant effect on the performance of selected NGOs in Nigeria is rejected and alternate hypothesis accepted.

Hypothesis three stated that strategic alignment has no significant effect on the performance of selected NGOs in Nigeria and the outcome indicates a positive effect of strategic alignment on firm performance ( $\beta=.336$ ;  $t=3.825$ ;  $p=.008$ ), hence the null hypotheses is rejected and alternate hypothesis accepted.

## Findings

The outcome the first hypothesis indicated a positive and significant effect of strategic direction setting on the performance of selected NGOs in Nigeria. The result is in agreement with Chen et al. (2022) who found a significant effect of strategic direction setting on organizational performance. The result is also supported by Mwasiri and Muchiri (2022) who affirmed that strategic direction setting and organizational performance are significantly and positively related. The implication of the finding to management of organizations is that leaders of the company set clear and realistic goals and plans on how to achieve such goals on time thereby improving their performance to remain competitive.

The research also reported that there is a positive and significant effect of strategic alignment on the performance of selected NGOs in Nigeria. In agreement with the finding, Mwasiri and Muchiri (2022) found a positive connection between strategic alignment and firm performance. The result is corroborated by Mwangi (2017) who affirmed a significant effect of strategic



alignment on the performance of organizations. The finding implies that companies' primary problem is to have a sufficiently defined structure to guarantee that all members of the company are aware of and willing to support effective strategic leadership practices.

## CONCLUSION

The study examined the extent to which strategic leadership affects organizational performance. The study found that improving organizational performance requires the application of strategic leadership approaches. The study concludes that strategic direction enables NGOs to set realistic and attainable goals thereby improving performance. The study also concludes that the alignment of organizational culture and values is important in improving performance.

## RECOMMENDATIONS

Based on findings and conclusions drawn, the study recommends that:

- i. NGOs in Nigeria should clearly set out a well-defined strategic direction by ensuring that resources and efforts are concentrated on high-priority areas. They should have a strategic plan provides a framework for making informed decisions on funding, projects, and partnerships.
- ii. NGOs in Nigeria should foster coordination between different departments, teams, and external partners. They should also leverage synergies with government agencies, donors, and peer organizations for greater impact. When projects and initiatives align with the NGO's strategic vision, they are more likely to achieve intended results.

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# **DESIGN AND IMPLEMENTATION OF A DIGITAL SCHOOL LIBRARY MANAGEMENT SYSTEM FOR ENHANCED ACCESSIBILITY**

**OKPOMU, E. Bethel<sup>1</sup>, & PATANI, I. Joseph<sup>2</sup>**

**<sup>1&2</sup> Department of Computer Science**

**School of Applied Science**

**Federal Polytechnic, Ekowe, Bayelsa State, Nigeria**

**Corresponding Author: Okpomu, Bethel Ebika. okariebi@gmail.com**

## **ABSTRACT**

*The design and implementation of a Digital School Library Management System aim to enhance accessibility, streamline operations, and improve user experience for students and staff. This project transitions traditional library systems into a digital framework, addressing challenges such as inefficiency, manual errors, and lack of centralized management. Developed using technologies such as HTML, CSS, JavaScript, PHP, and MySQL, the system includes features like user registration, book cataloging, borrowing and returning functionalities, and automated notifications. Testing revealed significant improvements in accessibility and resource management, demonstrating the system's effectiveness in meeting institutional needs. This project represents a step towards modernizing library services, fostering better educational outcomes through efficient resource management.*

**KEYWORDS:** Management information System, Data Security, Online Library, accessibility, Remote access, E-books

## **INTRODUCTION**

The project titled Digital Library Management System is Library Management software for monitoring and controlling the transactions in a library .The project “Library Management System” is developed in php, which mainly focuses on basic operations in a library like adding new books, and updating new information, searching books and members and return books.

This project of “LIBRARY MANAGEMENT” of gives us the complete information about the library. We can enter the record of new books and retrieve the details of books available in the library. We can issue the books to the students and maintain their records and can also check how many books are issued and stock available in the library. In this project we can maintain the late fine of students who returns the issued books after the due date.

Throughout the project the focus has been on presenting information and comments in an easy and intelligible manner. The project is very useful for those who want to know about Library Management System.

### **Background of the study**

Library Management System is an application which refers to library systems which are generally small or medium in size. It is used by librarian to manage the library using a computerized system where he/she can record various transactions like issue of books, return of books, addition of new books, addition of new students etc.

Books and student maintenance modules are also included in this system which would keep track of the students using the library and also a detailed description about the books a library contains. With this computerized system there will be no loss of book record or member record which generally happens when a non-computerized system is used.

In addition, report module is also included in Library Management System. If user’s position is admin, the user is able to generate different kinds of reports like lists of students registered, list of books, issue and return reports.

All these modules are able to help librarian to manage the library with more convenience and in a more efficient way as compared to library systems which are not computerized.

### **Statement of problem**

Normally, designing and implementing a school library management system typically involves identifying challenges and shortcomings in the current library system, such as manual book tracking leading to errors, inefficient borrowing and returning processes, lack of centralized data for inventory management, difficulty in accessing resources, limited user engagement, and inadequate reporting capabilities. The goal is to address these issues through the development of a comprehensive library management system that meets the needs of students, staff, and administrators while enhancing overall efficiency and effectiveness.

### **Aim and Objective**

It aim is to create a user-friendly and efficient platform that enhances the overall library experience for both students and staff. This objective of the study is;

- To make all the system computerize



- To reduce time consumption
- To reduce error scope
- To make all system managements automated
- To centralized database management
- Easy operations for operator of the system
- No paper work requirement

### **Significance of the study**

A Digital Library Management System (DLMS) gives access to and manages the resources in the library. A well-chosen system will increase your library's efficiency, save valuable administration time, lead to a better educational experience for pupils and help develop independent learning.

### **Scope of the Study**

This study covers the design and implementation of a digital school library management system using Federal Polytechnic Ekowe as a case study.

### **Definition of Terms**

**Management System:** is the way in which companies organize themselves in their structures and processes in order to act systematically, ensure smooth processes and achieve planned results.

**Data Security:** is the process of safeguarding digital information throughout its entire life circle to protect it from corruption, theft, or unauthorized access.

**Management information System:** is the study of people, technology, organization, and the relationships among them.

**Online Library:** an online database of digital objects that can include text, still images, audio, video, digital documents, or other digital media formats or a library accessible through.

### **Review of Existing Digital Library Management Systems**

The implementation of digital library systems in academic institutions has led to a variety of management solutions, each with distinct features tailored to the specific needs of the institution:

1. **OpenBiblio:** open-source library automation software used by many educational institutions. It provides essential functions such as cataloging, circulation management, and user management.
2. **Koha:** Another open-source library system widely adopted by libraries around the world. Koha provides advanced features like integrated acquisitions, cataloging, and circulation, as well as web-based access.

### **Historical Evolution of Digital Libraries**

Digital libraries have evolved significantly since the late 20th century with advancements in internet technology. Early systems were simple repositories of scanned texts, but they have grown to include multimedia formats, interactive user interfaces, and integration with academic tools.

Libraries like the Internet Archive and Google Books revolutionized accessibility to digital resources, serving as benchmarks for new systems.

Digital libraries trace their origins back to the 1990s, as the internet became more accessible. Early digital library systems were essentially digital repositories of scanned books, journals, and manuscripts, accessible via simple online catalogs. However, as digital technology progressed, so did the complexity of these systems. Initially, digital libraries like Project Gutenberg provided access to public domain books in digital formats, mostly text-based. Over time, libraries have integrated multimedia elements, offering audio, video, and interactive content alongside textual data.

By the early 2000s, the development of more robust content management systems and advances in internet speeds allowed for the development of vast, searchable digital archives. Libraries like the Internet Archive and Google Books began to digitize not only books but also multimedia and ephemera, transforming the concept of a "library" from a physical space to a global digital resource hub. This shift opened new opportunities for collaboration and knowledge sharing between academic institutions and libraries worldwide.

### **Case Studies in Digital Library Implementation**

**African Digital Library (ADL):** The ADL provides access to thousands of e-books across the African continent, addressing the challenges of limited physical resources. However, it faces issues such as internet access and user literacy.

**JSTOR:** A widely-used academic digital library, JSTOR integrates journals, books, and primary sources. It serves as a global model, emphasizing high-quality metadata and search efficiency.

**The National Digital Library of India (NDLI):** This library aggregates content from various national institutions and allows access to textbooks, research papers, and multimedia.

### **Current Emerging Trends in Digital Libraries**

Digital libraries have evolved with trends such as:

**Artificial Intelligence (AI):** AI-driven recommendation systems enhance user experience by suggesting relevant resources.

**Blockchain Technology:** Used to protect copyrights and ensure the integrity of digital materials.

**Cloud-Based Systems:** Offer scalability and ensure data accessibility from anywhere.

**Open Access Publishing:** Many modern digital libraries are working with universities and authors to make academic papers and books available for free, promoting knowledge dissemination and accessibility. This movement has been aided by platforms like arXiv and JSTOR's open-access initiatives.

**Cloud-Based Digital Libraries:** Many institutions now prefer cloud-based systems for storage due to their scalability and remote accessibility. Services like Amazon Web Services (AWS) are increasingly being used for hosting library collections, ensuring that users can access content without worrying about server management.

Integration with AI and Machine Learning: AI is now being used to improve the search and retrieval of digital content. Machine learning algorithms can categorize resources based on content analysis and recommend materials based on user behavior.

### **Global Case Studies**

Europeana (Europe): Europeana aggregates millions of digitized items from Europe's leading galleries, libraries, archives, and museums, providing access to books, artworks, maps, and photographs. It stands as a model for European digital libraries, allowing users to explore Europe's history, culture, and heritage online.

The Digital Public Library of America (DPLA): A network of libraries, museums, and archives in the U.S. that provides free access to millions of digital resources, including books, photographs, and maps. DPLA connects users to a wealth of information while preserving the cultural heritage of the United States.

Digital Library of India (DLI): A project that started in the early 2000s aimed to digitize the nation's academic, cultural, and historical content. The initiative has been lauded for its efforts in preserving texts in regional languages and expanding access to knowledge.

### **Benefits of Digital Libraries**

1. **Increased Accessibility:** Digital libraries make information available 24/7, regardless of geographical location. This is particularly beneficial for institutions with remote students or researchers.
2. **Cost Efficiency:** By transitioning from paper-based to digital collections, libraries can reduce physical storage costs and streamline the process of maintaining resources.
3. **Enhanced Searchability:** Digital libraries provide powerful search tools that allow users to find specific information quickly and efficiently, something that traditional libraries cannot match.

### **Review of Technologies Relevant to Digital Library Management Systems**

#### **Database Management Systems (DBMS)**

A robust database system is the backbone of any digital library management system, ensuring efficient storage, retrieval, and management of data.

##### ☐ **MySQL:**

Open-source relational database management system (RDBMS).

Features include high scalability, reliability, and support for complex queries.

Ideal for digital libraries with large datasets.

- **Strengths:** Ease of use, strong community support, and compatibility with multiple programming languages.
- **Weaknesses:** Limited support for unstructured data.

##### ☐ **PostgreSQL:**

Advanced open-source RDBMS with support for complex data types.

Used for libraries requiring GIS (Geographic Information System) or advanced indexing.

- Strengths: High performance for analytical queries and data integrity.
- Weaknesses: Slightly steeper learning curve compared to MySQL.

#### □ **MongoDB:**

A NoSQL database suited for storing unstructured data such as multimedia content.

Features include horizontal scalability and support for large-scale data.

- Strengths: Flexibility for handling dynamic data.
- Weaknesses: Lack of support for complex joins compared to RDBMS.

### **Web Development Frameworks**

Web frameworks play a crucial role in building responsive and scalable interfaces for digital library systems.

#### □ **Django (Python):**

High-level web framework designed for rapid development and pragmatic design.

Features include built-in security features and support for database management.

- Strengths: Fast development, robust admin panel, and scalability.
- Weaknesses: Requires knowledge of Python for customization.

#### □ **Ruby on Rails (RoR):**

Known for its convention-over-configuration approach.

Features include easy implementation of RESTful APIs for resource sharing.

- Strengths: Accelerates development with predefined modules.
- Weaknesses: Performance may decline for highly complex applications.

#### □ **React.js:**

JavaScript library for building user interfaces, commonly used for creating dynamic, responsive web apps.

- Strengths: High performance, component-based architecture, and a strong ecosystem of libraries.
- Weaknesses: Steep learning curve for beginners.

### **Search and Retrieval Technologies**

Efficient search and retrieval systems are essential for digital libraries to provide users with fast and accurate access to information.

#### □ **Elastic search:**

Distributed search engine designed for full-text search capabilities.

Features include real-time indexing and support for advanced search queries.

- Strengths: High-speed querying and scalability.
- Weaknesses: Resource-intensive for small-scale libraries.

#### □ **Apache Solar:**

Open-source search platform built on Apache Lucene.

Features include faceted search, highlighting, and rich text handling.

- Strengths: Flexible integration with existing systems.
- Weaknesses: Requires expertise to configure optimally.

#### □ **Natural Language Processing (NLP):**

Used for enhancing search capabilities by understanding user queries.

Common tools: Google's Tensor Flow and spaCy.

- Strengths: Improves relevance of search results.
- Weaknesses: High computational requirements.

### **Emerging Technologies in Digital Libraries**

#### 1. Artificial Intelligence (AI):

AI-driven recommendation systems suggest books based on user behavior and preferences.

Example: AI in JSTOR for personalized content delivery.

#### 2. Blockchain Technology:

Used for copyright management and ensuring the integrity of digital resources.

Strengths: Immutable records and transparent transactions.

#### 3. Augmented Reality (AR) and Virtual Reality (VR):

Enhancing user interaction by creating immersive experiences, such as virtual walkthroughs of historical archives.

### **Review of Existing Works**

#### **Amazon Kindle Library**

Overview: The Amazon Kindle Library is a digital platform that allows users to purchase, borrow, and read eBooks using Kindle devices or apps.

#### □ Features:

Seamless integration with Amazon's e-commerce platform for easy purchasing and downloading.

"Kindle Unlimited" subscription model, offering unlimited access to a vast collection of eBooks and audiobooks.

Cloud-based storage for syncing and accessing books across devices.

☐ **Strengths:**

Wide range of resources, from bestsellers to rare texts.

Easy-to-use interface with advanced search and recommendation algorithms.

☐ **Weaknesses:**

Subscription-based access may not be affordable for all users.

Limited focus on academic or research materials compared to other platforms.

### **Google Books**

Overview: Google Books digitizes books from libraries and publishers, making them searchable online. It also offers previews and links for purchase.

☐ **Features:**

Comprehensive book search functionality using Google's powerful indexing technology.

Integration with Google Scholar for research purposes.

Availability of scanned pages for books not fully digitized.

☐ **Strengths:**

Broad database of books across multiple disciplines and languages.

Free previews for books under copyright, allowing limited access to content.

☐ **Weaknesses:**

Not all books are available for full access.

The quality of scanned pages can vary, particularly for older materials.

### **JSTOR**

Overview: JSTOR is an academic digital library that provides access to journals, books, and primary sources, mainly for research and education.

☐ **Features:**

Advanced search tools for filtering by discipline, publication year, or type of material.

Integration with institutional subscriptions, offering full-text access to students and researchers.

Open-access initiative for free access to certain resources.



☐ Strengths:

High-quality academic resources, including rare journals and books.

Well-structured user interface for scholarly research.

☐ Weaknesses:

Content is heavily subscription-based, limiting access for non-affiliated users.

Focused more on academic resources, offering limited general literature.

### **Koha**

Overview: Koha is an open-source integrated library system (ILS) used by libraries worldwide for cataloging, circulation, and library management.

☐ Features:

Web-based interface for users and administrators.

Comprehensive modules for cataloging, member management, and reporting.

Ability to customize and integrate with other systems.

☐ Strengths:

Free and open-source, reducing costs for institutions.

Scalability for small to large libraries.

☐ Weaknesses:

Requires technical expertise to set up and maintain.

Lacks advanced features like AI-powered recommendations.

### **Europeana**

Overview: Europeana is a digital platform that provides access to cultural heritage materials, including books, photographs, paintings, and maps, from European institutions.

☐ Features:

Free access to millions of digitized items.

Focus on cultural preservation and diversity, offering materials in multiple languages.

Tools for educators and researchers to create and share collections.

☐ Strengths:

Rich multimedia content, including high-resolution images and videos.

Strong focus on historical and cultural materials.

☐ Weaknesses:

Limited functionality for interactive learning or advanced user customization.

Primarily focused on European content, which might not cater to global users.

### **Digital Public Library of America (DPLA)**

Overview: DPLA connects users to digitized resources from libraries, museums, and archives across the U.S.

#### ☐ Features:

Aggregates content from diverse sources, offering an extensive database of books, photos, and documents.

Mobile-friendly interface with educational tools for teachers and students.

Free access to most resources.

#### ☐ Strengths:

Democratizes access to cultural and educational materials.

Strong partnerships with local libraries and institutions.

#### ☐ Weaknesses:

Limited international content.

Quality and consistency of resources depend on contributing institutions.

### **National Digital Library of India (NDLI)**

Overview: NDLI is an Indian government initiative to provide access to textbooks, theses, and multimedia content for students and researchers.

#### ☐ Features:

Multilingual content covering regional languages.

Subject-wise categorization for easy navigation.

Mobile app for on-the-go access.

#### ☐ Strengths:

Focus on catering to regional and academic needs.

Integration with educational institutions and publishers in India.

Weaknesses:

Limited global content.

The interface may not be as intuitive compared to global platforms.

- **Less Emphasis on Community:** The platform may lack the community-driven features found in other book-centric platforms.

### Analysis for Design Strategies:

- **Simplified Interface:** Learning from Amazon's overwhelming interface, the online book sales platform will prioritize simplicity for an intuitive user experience.
- **Quality Assurance:** Implementing stringent quality checks for sellers to ensure product authenticity and maintain a high standard of offerings.
- **Personalization Algorithms:** Integrating sophisticated recommendation algorithms to provide personalized book suggestions, enhancing user engagement.
- **Global Accessibility:** Incorporating features for cross-border transactions, broadening the platform's market reach.
- **Community Building:** Creating community-driven features to foster user interaction, reviews, and recommendations, akin to Etsy's community engagement.
- **Competitive Pricing:** Striking a balance between competitive pricing and quality, drawing inspiration from Walmart's emphasis on affordability.

This appraisal of existing e-commerce platforms serves as a valuable guide for the design and strategic choices for the proposed online book sales platform, emphasizing user-centric design, quality assurance, personalization, global accessibility, community building, and competitive pricing.

### Challenges in Digital Library Implementation

**Technological Barriers:** While some institutions have access to the latest technologies, others face challenges such as poor internet connectivity, outdated hardware, and limited technological expertise, especially in developing countries.

**Legal and Copyright Issues:** Managing copyrights in a digital library is complex. Issues arise regarding the digitization of copyrighted works and the protection of intellectual property rights in digital formats.

**Digital Preservation:** While digital libraries offer the promise of everlasting access to information, there are concerns about digital preservation. Data corruption, outdated formats, and technological obsolescence pose significant risks to the longevity of digital collections.

### Future of Digital Libraries

**AI Integration:** Future systems are likely to incorporate AI to automate the cataloging and organization of resources, making them even more accessible and easier to search.

**Virtual Reality (VR):** Some advanced systems are exploring the use of VR to allow users to explore digital resources in immersive ways, such as walking through virtual exhibits or interacting with digital artifacts.

**Blockchain for Copyright Management:** Blockchain technology can provide solutions to the challenges of digital rights management by ensuring transparency and security in the distribution of digital content.

## **RESEARCH METHODOLOGY AND SYSTEM ANALYSIS**

This chapter presents the research methodology, system design, input file specification and program flow chart

### **Research Methodology**

This section describes the strategies employed for data collection, system design, and software development. The methodology followed a Software Development Life Cycle (SDLC) model using the Agile framework due to its iterative and flexible approach. The model has four stages namely: Planning, Analysis, Evaluation, and Development.

The data used for the development of the research was gotten from the internet, textbooks and articles. The contributions of other researchers on the subject were examined so as to gather relevant information. The case study also provided useful information for the development of the system.

### **The Agile Mode**

The Agile Model focuses on flexibility, collaboration, and efficiency that allows teams to deliver quality products. It is the process that involves breaking the project into phases and emphasizes continuous collaboration and improvement.

### **The Agile SDLC model includes:**

#### **1. Planning**

Defined system goals: ease of access, secure data handling, and efficient library management.

Identified stakeholders and their roles in the project.

#### **2. Analysis:**

Mapped out user requirements.

Created functional and non-functional requirements (e.g., fast retrieval speeds and secure access).

#### **3. Design:**

Developed database schemas.

Created wireframes and prototypes for user interfaces.

#### **4. Implementation:**

Used an iterative coding and testing approach to refine the system.

Built modules incrementally, ensuring functionality at each stage.

#### **5. Testing:**

Conducted unit tests, system integration tests, and user acceptance testing.

#### **6. Deployment:**

Installed and configured the system on local servers for testing.

Planned deployment on institutional servers.

### Tools and Techniques

Before any software could be programmed decisions are needed to be made on which programming language should be used, the programming languages used in creating this library management system are;

#### Frontend (User Interface)

Languages/Technologies: HTML, CSS, JavaScript (React, Angular, or Vue for advanced UI)

Purpose: This is the interface users interact with to search for books, log in, and manage their accounts.

#### Backend (Business Logic)

Languages/Technologies: PHP, Python (Django/Flask), Node.js

Purpose: Handles requests from the frontend, processes data, and interacts with the database.

#### Database (Data Storage)

Databases: MySQL

Purpose: Stores books, users, and other relevant information.

### Analysis of the existing system

The existing system at the case study is such that there is no dedicated or customized website for library management. Manual pattern is still maintained. The manual library system at Federal Polytechnic Ekowe presents the following challenges:

Inefficient Record Management: Hardcopy logs are prone to errors and loss.

Time-Consuming Processes: Borrowing and returning books require significant manual input.

Limited Accessibility: Users must be physically present to access resources.

Security Risks: No safeguards to prevent unauthorized access or tampering.

### Problems of the existing system

A major problem of the existing system is that it is not secured and library records cannot be easily managed. This stands as a huge problem to effective operation and management of information in the institution that is supposed to be confidential. In addition, it is difficult to present reports of library immediately when needed.

### Analysis of the proposed system

The proposed system will be such that library records will be easily managed as a special interface which will be created to capture needed fields for the record of library, easy access to material for reading and then it can be saved to a database so that it will be easily retrieved when queried.

The proposed digital library system aims to:

Automate Library Processes: Book borrowing, returning, and cataloging.

Centralize Data Management: A secure, centralized database accessible to all authorized users.

Enhance User Experience: Fast search and retrieval features with advanced filtering options.

Improve Security: Role-based access control and encrypted user authentication.

#### Functional Requirements

1. User login and registration.
2. Cataloging and searching books.
3. Borrowing and returning functionality.
4. Administrative management for users and books.

#### Non-Functional Requirements

1. Scalability to handle increasing user numbers.
2. Performance: Search results should load in less than 2 seconds
3. Security: Data encryption and secure authentication protocol

#### System Design

The Online School Library Management System (OSLMS) is a web-based application designed to manage and automate the operations of a school library online. The system will enable librarians to efficiently manage library resources, track borrower information, and generate reports, accessible from anywhere, at any time.

#### Figure 1.0 System design

##### 3.5.1 System Architecture

#### Figure 2.0 System Architecture

#### Use Case

#### Figure 3.0 Use Case Diagram

#### LMS Project Modules

Online library Management System divided in two modules

- Admin
- Admin Features
- Admin Dashboard
- Admin can add/update/ delete category



- Admin can add/update/ delete author
- Admin can add/update/ delete books
- Admin can issue a new book to student and also update the details when student return book
- Admin can search student by using their student ID
- Admin can also view student details
- Admin can change own password

#### Students-

- Student can register yourself and after registration they will get studentid
- After login student can view own dashboard.
- Students can also view the listed books in the library.
- Student can update own profile.
- Student can view issued book and book return date-time.
- Student can also change own password.
- Student can also recover own password.

### 3.6 Summary

This Chapter presents the analysis of the proposed system showing the various technology and development tools used in creating the school library management system. chapter 4 will present the design features and parts of the system to be developed which involves the actual installation of the system and how some aspects of the system are put in place which will help to define the workability of the new system.

## IMPLEMENTATION AND RESULTS

### Introduction

It details the design methodologies, the development environment, the system's architecture, and the functionalities implemented. The system is designed using a modular approach to facilitate maintainability and scalability. The architecture comprises the following layers:

**User Interface (UI):** A responsive web-based interface that allows users to interact with the system seamlessly.

**Application Layer:** Contains the business logic, processing user requests, and coordinating between the UI and database.

**Database Layer:** Utilizes MySQL to store and manage all library-related data, including user profiles, book records, and transaction histories.

### Admin Login

#### 4.1 User Login

#### 4.2. Admin Dashboard

#### 4.3 User Dashboard

#### 4.4 User Sign up

#### 4.5 Database

#### 4.6 Development Environment

The programming environment used for the development of the application is windows 10 Pro operating system. The hardware requirements are;

- i. Intel(R) Pentium (R) CPU 2020M @2.40GHZ
- ii. 64-bit Operating system, x64-based processor
- iii. Installed memory 4.00 GB RAM module
- iv. Keyboard
- v. Mouse

The system was developed using the following technologies:

Programming Languages: HTML, CSS, JavaScript for the frontend; PHP for the backend.

Database Management System: MySQL for data storage and management.

Development Tools: XAMPP for local server setup, Notepad++ for code editing.

#### System Features and Functionalities

The system incorporates the following key features:

User Registration and Authentication: Users can create accounts and log in securely to access library services.

Search Functionality: Users can search for books using various filters (title, author, genre).

Book Borrowing and Returning: Users can borrow and return books, with the system updating the availability status in real-time.

Automated Notifications: Users receive alerts for due dates and overdue books via email notifications.

Admin Panel: Administrators can manage user accounts, add or remove books, and view transaction histories.

#### Implementation Process

The implementation process followed these steps:

- System Planning: Defining requirements and creating a project timeline.

- Designing the Database: Creating tables for users, books, and transactions, ensuring relationships are established.
- Developing the Frontend and Backend: Building the user interface and coding the backend functionalities.
- Integrating the Components: Ensuring the frontend communicates effectively with the backend and the database.
- Testing the System: Conducting unit tests, integration tests, and user acceptance testing to identify and resolve issues.

### Results and Evaluation

Upon completion of the implementation, the system was evaluated based on functionality, performance, and user satisfaction:

**Functionality Testing:** All features were tested, and the system performed as expected with no critical errors encountered.

**Performance Testing:** The system responded quickly to user requests, with average load times of less than two seconds for most operations.

**User Satisfaction:** A survey conducted among test users indicated a high level of satisfaction, with 85% rating the system as easy to use and effective in managing library resources.

## SUMMARY, CONCLUSION, AND RECOMMENDATIONS

This research focused on the design and implementation of a Digital School Library Management System aimed at enhancing accessibility for students and staff within an educational institution. The system was developed to address the limitations of traditional library management methods, providing a more efficient and user-friendly platform.

Key features implemented in the system included user registration and authentication, a robust search functionality, book borrowing and returning processes, automated notifications, and an administrative panel for managing library operations. The system was built using a combination of HTML, CSS, JavaScript, PHP, and MySQL, ensuring a seamless interaction between the user interface and the backend database.

Testing and evaluation of the system demonstrated its functionality and effectiveness in managing library resources, with users reporting high satisfaction rates. The system successfully meets the objectives outlined at the project's inception, significantly improving the accessibility and management of library services.

In conclusion, the Digital School Library Management System has proven to be an effective solution for enhancing accessibility and efficiency in library management. The project successfully transitioned traditional library operations into a digital framework, allowing for better resource management, quicker access to information, and improved user experience. The positive feedback from users underscores the system's capability to fulfill the needs of the school community and streamline library processes.

Based on the findings of this research, the following recommendations are proposed for future enhancements and developments:

1. Integration with Other Educational Tools: To further enhance accessibility, consider integrating the library management system with other educational tools, such as learning management systems (LMS) or student information systems (SIS), allowing for a more comprehensive resource management solution.
2. Mobile Application Development: Developing a mobile application version of the library management system could provide users with greater accessibility, allowing them to manage their library activities on-the-go.
3. Advanced Analytics Features: Implementing advanced analytics could help administrators gain deeper insights into borrowing patterns, user behavior, and resource utilization, enabling more informed decision-making.
4. User Training and Support: Providing training sessions for users, along with ongoing technical support, could ensure that all members of the school community maximize the benefits of the system.

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# **OPTIMIZING PRODUCTIVITY IN METALWORK MANUFACTURING THROUGH TECHNOLOGICAL ADOPTION IN NIGERIA**

**Engr. Patricia Ngozi NWABUDIKE**

**School of Secondary Education (Technical),**

**Federal College of Education (Technical), Asaba, Delta State.**

**Email: patnwabudike3@gmail.com**

## **ABSTRACT**

*This research examined the impact of Artificial Intelligence (AI) technologies on optimizing manufacturing processes in Nigeria's manufacturing industry, emphasizing critical outcomes such as efficiency, productivity, and product quality. Data were obtained using structured questionnaires from a sample of 342 respondents from Ajaokuta Steel Company Limited and Universal Steel Nigeria Ltd. The outcomes were examined using multiple regression models. The findings indicate a strong positive correlation between technological adoption and productivity optimization, with a regression coefficient of 0.583 and a statistically significant p-value of 0.000. Improved infrastructure and workforce skill levels were also found to significantly enhance productivity, with coefficients of 0.245 and 0.198, respectively. Furthermore, the study revealed that technological advancements contribute significantly to product quality improvements, as evidenced by a coefficient of 0.502 and a p-value of 0.000. Larger firms with greater financial resources demonstrated a higher capacity for technological integration, as indicated by a coefficient of 0.269 and a p-value of 0.002. These results align with existing literature highlighting the role of automation and digital technologies in enhancing efficiency and reducing defects in manufacturing. The study concludes that modern technology adoption is essential for productivity growth in Nigeria's metalwork sector. However, challenges such as inadequate infrastructure and skill gaps persist. It recommends strategic investments in infrastructure, targeted workforce training, and supportive policies to strengthen the sector's competitiveness and contribute to Nigeria's industrialization.*

**KEYWORDS:** Technological adoption, metalwork manufacturing, productivity, industrial efficiency, product quality.



## INTRODUCTION

The Nigerian metalwork manufacturing sector faces numerous challenges that hinder optimal productivity and competitiveness. These include inadequate infrastructure, high energy costs, inefficient production processes, a shortage of skilled labor, and limited access to advanced manufacturing technologies. Structural inefficiencies have resulted in persistently low output and product quality compared to global and regional counterparts [Ogunleye, 2023]. Additionally, the sector has been slow to embrace emerging technologies, particularly automation, robotics, and digital manufacturing systems, which have revolutionized metalworking industries in advanced economies. As a result, Nigeria's metalwork manufacturing remains largely characterized by inefficiency, high production costs, and inconsistent product quality. However, technological advancements offer the potential to mitigate these inefficiencies by enhancing precision, reducing waste, and optimizing production workflows. Despite these prospects, the adoption of advanced manufacturing technologies in Nigeria remains limited due to high capital investment requirements, lack of technical expertise, and infrastructural deficits [Adekunle et al., 2023].

Over the years, efforts have been made to modernize metalwork manufacturing processes through automation and digital transformation. Many firms have integrated Computer Numerical Control (CNC) machines, Computer-Aided Design and Manufacturing (CAD/CAM) systems, and other digital tools to enhance operational efficiency. While these technologies have improved productivity to some extent, they often lack the intelligent adaptability offered by more advanced solutions, such as artificial intelligence (AI), the Internet of Things (IoT), and smart manufacturing systems [Eze et al., 2024]. The widespread implementation of such technologies has been transformative in global manufacturing, enabling predictive maintenance, real-time monitoring, and process automation that significantly enhance production output [(Kamble et al., 2018; Xu et al., 2021; Zhang et al., 2023)].

Across industrialized nations, the adoption of technology in metalwork manufacturing has yielded substantial benefits. Advanced robotics and AI-driven automation have minimized human errors, improved precision, and increased production speeds. Smart sensors and IoT-enabled systems allow real-time data collection, facilitating predictive maintenance that reduces unplanned downtime and operational disruptions. Machine learning algorithms assist in optimizing supply chains and resource allocation, ensuring a seamless and cost-effective manufacturing process. These innovations have driven significant improvements in efficiency, waste reduction, and profitability in metalwork industries worldwide [Agrawal et al., 2023].

Technological advancements, particularly automation and AI-driven systems, stand out as key enablers of process optimization in metalwork manufacturing. These systems analyze vast amounts of real-time data, providing actionable insights that enhance decision-making and workflow management. Predictive analytics help manufacturers anticipate equipment failures, schedule timely maintenance, and prevent costly production halts. Furthermore, digital twin technology and AI-powered quality control systems improve product consistency and reduce defects, ensuring higher-quality outputs [Adenekan et al., 2024]. The integration of these innovations into Nigeria's metalwork sector could lead to a more streamlined, cost-effective, and globally competitive industry [Adekunle et al., 2023].

Despite the potential benefits of technological adoption, several barriers hinder widespread implementation in Nigeria's metalwork manufacturing sector. These challenges include the high cost of acquiring and maintaining advanced machinery, limited access to financial support, inadequate technical expertise, and resistance to change among industry stakeholders. Additionally, unreliable power supply remains a critical issue, as most advanced manufacturing

systems require a stable energy source for optimal performance. Furthermore, the absence of strong regulatory frameworks and supportive government policies has slowed the pace of technological advancement in the sector. Nonetheless, with the right investments in infrastructure, capacity-building, and policy reforms, technology adoption could play a transformative role in the future of Nigeria's metalwork industry [Bunian et al., 2024].

Empirical evidence from various global markets demonstrates that firms leveraging digital manufacturing technologies report significant improvements in productivity and profitability. Automation reduces reliance on manual labor, minimizes operational inefficiencies, and enables manufacturers to meet increasing demand with greater precision. AI-driven systems enhance production planning and resource utilization, helping companies optimize supply chains and minimize production costs. Predictive maintenance has proven to reduce downtime by up to 40%, resulting in substantial cost savings and improved overall equipment effectiveness (OEE) [Adeoye & Elegbede, 2022].

In Nigeria, some large-scale metalwork enterprises have begun to explore the use of automation and digital manufacturing systems. Companies involved in steel fabrication, aluminum processing, and machining have incorporated CNC machines, laser cutting systems, and automated welding technologies to improve efficiency and precision. However, the adoption of such technologies remains largely concentrated among a few large firms, while small and medium-sized enterprises (SMEs) continue to struggle with traditional, labor-intensive methods. Addressing these disparities through targeted technological interventions and policy support could significantly enhance the sector's overall productivity and competitiveness.

This study aims to analyze the impact of technology adoption on optimizing productivity in Nigeria's metalwork manufacturing sector. The research seeks to identify key factors influencing technology adoption, assess the effects of automation and digital manufacturing systems on efficiency and profitability, and explore how emerging innovations can be leveraged to enhance product quality and output.

The study is guided by the following hypotheses:

- **H<sub>1</sub>:** There is a significant relationship between critical factors (e.g., infrastructure, workforce skill level, and investment costs) and the successful optimization of metalwork manufacturing processes through technology adoption.
- **H<sub>2</sub>:** Technological advancements, such as automation and AI-driven systems, have a positive impact on efficiency, productivity, and profitability in the Nigerian metalwork manufacturing industry.
- **H<sub>3</sub>:** The adoption of advanced manufacturing technologies significantly enhances product quality and increases output in Nigeria's metalwork sector.

## METHODOLOGY

This study employed a descriptive research design combined with quantitative analysis to assess the impact of technological adoption on productivity in Nigeria's metalwork manufacturing sector. The design was chosen to enable a comprehensive evaluation of patterns, correlations, and potential causal relationships between technological adoption and manufacturing outcomes, such as efficiency, productivity, and product quality. Structured questionnaires were used to collect primary data, while regression analysis was employed to test hypotheses and model relationships between key variables.

## Population and Sampling Technique

The population for this study included two major Nigerian metalwork manufacturing firms: Ajaokuta Steel Company Limited and Universal Steel Nigeria Ltd, both of which are headquartered in Lagos State. A probability sampling technique was utilized, with stratified random sampling identified as the most appropriate method. Stratified random sampling involves dividing the population into distinct strata based on shared characteristics, such as different departments within the firms. Samples were then drawn randomly from each stratum to ensure proper representation.

This approach was selected for the following reasons:

1. **Ensuring Compatibility:** Stratified random sampling ensures that all relevant departments such as production and operations, engineering, supply chain and logistics, human resources, and finance are adequately represented in the sample. Each department has a unique perspective on how technology adoption influences their processes.
2. **Reducing Bias:** By selecting participants randomly within each stratum, the likelihood of sampling bias is minimized, ensuring the sample accurately reflects the diverse characteristics of the workforce.

## Sample Size Determination

The sample size was determined using the standard formula for stratified random sampling:

$$n = \frac{N \times Z^2 \times p \times (1 - p)}{e^2 \times (N - 1) + Z^2 \times p \times (1 - p)}$$

Where:

- **n** = required sample size
- **N** = total population size (3200 employees from both companies)
- **Z** = Z-value for 95% confidence level (1.96)
- **p** = estimated proportion of the population (0.5 for maximum sample size)
- **e** = margin of error (0.05)

Substituting the values:

$$\begin{aligned} n &= \frac{3200 \times 1.96^2 \times 0.5 \times 0.5}{0.05^2 \times (3200 - 1) + 1.96^2 \times 0.5 \times 0.5} \\ &= 342 \end{aligned}$$

The estimated sample size for this study is approximately 342 participants. A stratified random sample of 342 employees from Ajaokuta Steel Company Limited and Universal Steel Nigeria Ltd was deemed sufficient to generate statistically reliable findings on the impact of technological adoption on productivity in metalwork manufacturing.

## Data Collection Instrument

The primary data for this study was gathered using a structured questionnaire designed to capture detailed information on the extent of technological adoption, the specific technologies in use, and their perceived impact on manufacturing performance. The questionnaire was divided into four key sections corresponding to the research objectives:

- **Section A:** Demographic details of respondents (e.g., industry type, firm size, role of respondent)
- **Section B:** Technological adoption and usage (e.g., types of technologies implemented, duration of use)
- **Section C:** Impact of technology on efficiency, productivity, and profitability
- **Section D:** Effect of technology on product quality and overall output

A Likert scale (ranging from 1 to 5, with 1 representing "strongly disagree" and 5 representing "strongly agree") was used to measure respondents' views on various aspects of technological adoption. The questionnaire was administered to senior management and technical staff directly involved in decision-making and operations related to technology integration within their firms.

A total of 315 valid responses were collected from employees in different departments, including administration, technical/engineering, management, and operations. The collected data was analyzed using statistical techniques, including descriptive analysis and regression modeling, to determine the extent to which technological adoption influences productivity in the metalwork manufacturing sector in Nigeria.

## Data Analysis Method

The data analysis process for this study involved both descriptive and inferential statistics to examine the impact of technological adoption on productivity in metalwork manufacturing in Nigeria. Descriptive statistics, including mean, standard deviation, frequency, and percentages, were utilized to summarize and provide an overview of key data attributes. These statistics offered insights into the extent of technology adoption and its perceived influence on metalwork manufacturing processes. To investigate the relationships between technology adoption and manufacturing outcomes, multiple regression analysis was employed. This statistical technique enabled the evaluation of the impact of technology deployment on efficiency, productivity, profitability, and product quality in the metalwork industry.

## Model Specification

The regression model for this study was designed based on the research objectives and underlying hypotheses. The dependent variables included efficiency, productivity, profitability, and product quality, while the independent variable was technological adoption, measured by the extent to which metalwork enterprises have integrated new technologies into their production processes. Control variables, such as firm size, industry type, and workforce skill level, were incorporated to account for potential external influences on manufacturing performance.

The general form of the regression equation is:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \epsilon$$

Where:

$Y_i$  = Manufacturing process optimization (measured by efficiency, productivity, profitability, or product quality)

$\beta_0$  = Constant (intercept)

$X_1$  = Technology adoption level (e.g., types of technologies implemented)

$X_2$  = Firm size (control variable)

$X_3$  = Industry type (control variable)

$\epsilon$  = Error term

### Regression Model for Hypothesis Testing

**Hypothesis 1 ( $H_1$ ):** There is a significant relationship between critical factors (e.g., infrastructure, workforce skill level, and cost) and the successful optimization of manufacturing processes using technological advancements.

$$Efficiency = \beta_0 + \beta_1(Tech\_Adoption)$$

$$+ \beta_2(Infrastructure)$$

$$+ \beta_3(Workforce\_Skill) + \epsilon$$

**Hypothesis 2 ( $H_2$ ):** Technology-driven optimizations positively impact efficiency, productivity, and profitability in Nigeria's metalwork manufacturing industry.

$$Product\_Quality = \beta_0 + \beta_1(AI\_Adoption)$$

$$+ \beta_2(Firm\_Size)$$

$$+ \beta_3(Workforce\_Skill) + \epsilon$$

**Hypothesis 3 ( $H_3$ ):** The adoption of new technologies significantly enhances product quality and improves manufacturing output in the Nigerian metalwork manufacturing sector.

$$Productivity = \beta_0 + \beta_1(AI\_Adoption)$$

$$+ \beta_2(Firm\_Size)$$

$$+ \beta_3(Industry\_Type) + \epsilon$$

In these models, Technology Adoption represents the extent of technology use within metalwork manufacturing businesses, while infrastructure, workforce skill level, firm size, and industry type serve as control variables that account for contextual factors influencing the manufacturing process.

### Validity and Reliability

To ensure the validity and reliability of the research instruments, a pilot test was conducted with a small group of metalwork manufacturing enterprises before full-scale data collection. This pilot test facilitated the refinement of questionnaire items, ensuring clarity and relevance to the study's objectives. Content validity was established by aligning questionnaire items with the research goals and consulting industry experts specializing in metalwork manufacturing and technology adoption. Reliability was assessed using Cronbach's Alpha test to measure the internal consistency of questionnaire responses. A Cronbach's Alpha score of 0.70 or higher was

considered acceptable, ensuring that the data collected was both dependable and robust for further analysis.

## RESULTS, INTERPRETATION AND DISCUSSION OF FINDINGS

The regression findings in Table 1 reveal a strong correlation between technological adoption and productivity optimization in Nigeria's metalwork manufacturing sector. The coefficient for technological adoption is 0.583, indicating that each unit increase in technology utilization corresponds to an average increase of 0.583 units in productivity. The relationship is statistically significant, as evidenced by a p-value of 0.000, which falls well below the 0.05 threshold. These findings align with previous research demonstrating that advanced technologies, such as automation and digital fabrication, enhance production efficiency and quality [Okonkwo et al., 2021; Adebayo et al., 2023].

The role of infrastructure is significant, with a coefficient of 0.245 and a p-value of 0.004. This suggests that improvements in industrial infrastructure, including power supply and smart machinery, contribute significantly to productivity growth. These results underscore the necessity of a robust infrastructural base for the effective deployment of advanced technology in metalwork manufacturing [Agwu, 2022].

Workforce skill level also plays a crucial role, with a coefficient of 0.198 and a p-value of 0.039, signifying a meaningful correlation between employee competence and productivity. This finding highlights the need for continuous training and skill development to optimize the benefits of technological adoption in metal fabrication [Ibrahim et al., 2023].

**Table 1. Regression Analysis for Productivity**

Variable	Coefficient	Standard Error	t-Statistic	p-Value
Technological Adoption	0.583	0.069	8.45	0.000***
Infrastructure	0.245	0.081	3.02	0.004**
Workforce Skill	0.198	0.090	2.07	0.039*
Constant	1.115	0.187	5.96	0.000***

**$R^2 = 0.776$ ; Adjusted  $R^2 = 0.765$ ; F-statistic = 78.31;  $p < 0.0001$**

Table 2 further examines the impact of technology adoption on product quality in Nigeria's metalwork sector. The coefficient for technological adoption is 0.502, confirming a strong positive correlation with product quality. The statistical significance of this relationship, as shown by a p-value of 0.000, aligns with findings that emphasize automation's role in enhancing precision and reducing defects in metalwork [Chen et al., 2023; Lee et al., 2021].

Firm size is another significant factor, with a coefficient of 0.269 and a p-value of 0.002. This suggests that larger firms with greater financial resources are better positioned to integrate advanced manufacturing technologies. Workforce skill, with a coefficient of 0.211 and a p-value of 0.031, further highlights the importance of technical training for quality improvements in metal products [Teerasoponpong & Sugunnasil, 2022].



**Table 2. Regression Analysis for Product Quality**

Variable	Coefficient	Standard Error	t-Statistic	p-Value
Technological Adoption	0.502	0.073	6.87	0.000***
Firm Size	0.269	0.076	3.54	0.002**
Workforce Skill	0.211	0.089	2.21	0.031*
Constant	1.034	0.182	5.68	0.000***
<b><math>R^2 = 0.748</math>; Adjusted <math>R^2 = 0.736</math>; F-statistic = 71.24; <math>p &lt; 0.0001</math></b>				

Table 3 highlights the significant relationship between technology adoption and product quality in metalwork manufacturing. The coefficient for Technology Adoption is 0.495, signifying that increased use of advanced technologies correlates with improved product quality. A p-value of 0.000 confirms the statistical significance of this relationship, aligning with studies that emphasize AI-driven quality control, real-time monitoring, and predictive analytics as key drivers of superior product outcomes [Chen et al., 2023; Lee et al., 2020].

Firm Size also plays a crucial role in ensuring product quality, with a coefficient of 0.285 and a p-value of 0.001, indicating that larger firms are more likely to invest in quality-enhancing technologies. Workforce Skill similarly exhibits a significant effect, with a coefficient of 0.206 and a p-value of 0.022. This finding underscores the importance of continuous skill development among workers to ensure effective deployment of quality-enhancing technologies [Teerasoponpong & Sugunnasil, 2022; Mmadubuobi et al., 2024].

**Table 3. Regression Analysis for Product Quality**

Variable	Coefficient	Standard Error	t-Statistic	p-Value
Technology Adoption	0.495	0.073	6.78	0.000***
Firm Size	0.285	0.077	3.70	0.001**
Workforce Skill	0.206	0.086	2.33	0.022*
Constant	1.219	0.170	7.17	0.000***
<b><math>R^2 = 0.741</math>; Adjusted <math>R^2 = 0.730</math>; F-statistic = 71.89; <math>p &lt; 0.0001</math></b>				

## Discussion Of Findings

### Statistical Model Used:

Where:

- Metalwork manufacturing process optimization (measured by efficiency, productivity, profitability, or product quality)
- Constant (intercept)
- Technology adoption level (e.g., AI, automation, digital tools)
- Firm size (control variable)

- Industry type (control variable)
- Error term

This study's findings provide essential insights into the influence of technological adoption on optimizing productivity in metalwork manufacturing in Nigeria. The regression models used to analyze correlations between technology adoption and key manufacturing performance indicators efficiency, productivity, and product quality yielded significant findings aligned with the study's objectives.

The results underscore the importance of technological implementation as a pivotal factor affecting efficiency, productivity, and product quality in metalwork manufacturing. The substantial coefficients for technology adoption across all models indicate that firms that integrate modern technological solutions achieve remarkable improvements in their operational performance. This directly supports the study's primary objective, confirming that technological adoption is essential for optimizing manufacturing processes in Nigeria's metalwork industry.

A strong positive correlation was identified between technological adoption and enhanced efficiency (Table 1), productivity (Table 2), and product quality (Table 3). The statistical significance of these results suggests that digital transformation in metalwork manufacturing is both a practical and strategic move. These findings affirm the second research objective, demonstrating that adopting advanced technology leads to improved profitability by optimizing processes and elevating the quality of manufactured goods.

The study further establishes that technological tools significantly enhance product quality, as evidenced by the high coefficient for technology adoption in Table 3. This finding aligns with the third research objective, reinforcing the argument that modern manufacturing technologies, such as AI-driven automation and precision engineering tools, enable firms to produce high-quality metal products. This improvement in quality contributes to customer satisfaction, competitive advantage, and increased market penetration.

## CONCLUSION

This study provides compelling evidence of the transformative impact of technological adoption on productivity optimization in the Nigerian metalwork manufacturing sector. The findings highlight a robust positive correlation between technology integration and improvements in efficiency, productivity, and product quality, thereby fulfilling the study's objectives. The research underscores that adopting advanced technologies is not merely an optional enhancement but a necessity for manufacturing firms seeking to improve operational performance and sustain competitiveness in a rapidly evolving global market.

The significant regression coefficients indicate that technological tools are vital in achieving operational excellence in metalwork manufacturing. By effectively integrating AI, automation, and other digital solutions, manufacturers can streamline processes, reduce operational costs, and enhance profitability. Moreover, the study emphasizes the critical role of workforce development, as skilled labor is essential to maximizing the benefits of technological adoption.

This research contributes to the existing body of knowledge by validating the positive impact of technology adoption within the context of a developing economy like Nigeria. The consistency of these findings with prior research strengthens the reliability of the results, demonstrating that digital transformation has widespread applicability across various industrial settings.

Beyond theoretical contributions, this study offers practical recommendations for manufacturers, policymakers, and industry stakeholders. Metalwork manufacturing firms are encouraged to prioritize the adoption of advanced technologies and invest in the necessary infrastructure and workforce training to fully leverage these innovations. Policymakers should create an enabling environment that promotes technological integration through favorable policies, financial support, and incentives for digital transformation.

Future research should explore sector-specific applications of technological adoption in metalwork manufacturing, conduct longitudinal studies to assess long-term effects, and incorporate qualitative analyses to gain deeper insights into the challenges and opportunities associated with digital transformation. Addressing these areas in future studies will provide more nuanced perspectives that can further inform strategic decision-making in the industry.

## RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed to optimize productivity in metalwork manufacturing through technological adoption in Nigeria:

1. Metalwork manufacturing firms should prioritize the adoption of Artificial Intelligence (AI), automation, and digital manufacturing technologies.
2. The government and private sector should invest in developing reliable infrastructure, including stable electricity, broadband internet, and modern manufacturing facilities.
3. Policymakers should introduce supportive policies, tax incentives, and financial grants to encourage small and medium-sized metalwork firms to invest in advanced manufacturing technologies.
4. Metalwork manufacturers should engage in partnerships and industry networks to facilitate knowledge sharing on best practices in technological adoption.
5. Companies should integrate smart manufacturing systems such as the Internet of Things (IoT), real-time monitoring, and predictive maintenance.

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# **EFFECTS OF GOVERNMENT POLICIES ON SMALL AND MEDIUM ENTERPRISES' GROWTH IN THE MANUFACTURING SECTOR**

**Jane Michael ESSIEN<sup>1</sup>, Ngozi Amaka NWOKORO<sup>2</sup>, & Michael Okon ESSIEN<sup>3</sup>**

**<sup>1</sup>Department of Political Science, Akwa Ibom State College of Education, Afaha Nsit**

**<sup>2</sup>Department of Business Administration, Kingsley Ozumba Mbadiwe University, Ideato.**

**<sup>3</sup>Department of Marketing, Akwa Ibom State Polytechnic, Ikot Osurua.**

**Email: [janeessien@akscoe.edu.ng](mailto:janeessien@akscoe.edu.ng)<sup>1</sup>; [aginangozi@yahoo.com](mailto:aginangozi@yahoo.com)<sup>2</sup>; [ettetiimaoro@gmail.com](mailto:ettetiimaoro@gmail.com)<sup>3</sup>**

## **ABSTRACT**

*Small and Medium Enterprises (SMEs) play a vital role in economic growth, employment generation, and industrial development, particularly in the manufacturing sector. However, their growth is significantly influenced by government policies, including taxation, financial support, regulatory frameworks, and trade policies. This study examines the effects of these policies on SME growth in Nigeria's manufacturing sector using a mixed-method research approach. A survey of 180 SMEs was conducted, and Pearson correlation analysis was used to determine the relationship between government policies and SME expansion. The findings reveal that financial support (0.63) and trade policies (0.58) positively influence SME growth, indicating that improved access to funding and favorable trade policies enhance business performance. Conversely, taxation (-0.52) and regulatory policies (-0.47) negatively impact SME growth, suggesting that excessive tax burdens and stringent regulations hinder expansion. Furthermore, financial support is negatively correlated with regulations (-0.45), implying that a restrictive regulatory environment limits access to financial assistance. These results align with previous studies emphasizing the role of supportive policies in SME development. The study recommends policy reforms focusing on reducing tax burdens, simplifying regulations, enhancing financial accessibility, and improving trade policies to foster SME growth.*

**KEYWORDS: SME Growth, Government Policies, Manufacturing Sector, Financial Support, Taxation, Regulatory Framework, Trade Policies.**

## INTRODUCTION

Small and Medium Enterprises (SMEs) play a crucial role in economic development by contributing to job creation, industrial innovation, and overall economic growth (OECD, 2019). The manufacturing sector, in particular, benefits significantly from SMEs, as they help diversify economies, reduce unemployment, and enhance export potential (World Bank, 2021). However, SME growth in the manufacturing sector is often influenced by various government policies, including taxation, financial incentives, regulatory frameworks, and trade policies (UNCTAD, 2020).

Government policies can either foster or hinder SME growth. Supportive policies such as favorable tax regimes, access to credit, infrastructure development, and business-friendly regulations enhance SME expansion by reducing the cost of doing business and increasing productivity (Onakoya et al., 2013). Conversely, excessive taxation, stringent regulations, and bureaucratic inefficiencies can stifle SME growth, limiting their ability to compete in both local and international markets (Oseni, 2017; Ayyagari et al., 2011).

In many countries, policymakers recognize the importance of SMEs in the manufacturing sector and have implemented measures to facilitate their development (OECD, 2022). However, the effectiveness of these policies varies based on implementation, economic conditions, and the overall business environment (WTO, 2021). Understanding how government policies affect SME growth is critical for developing frameworks that enable sustainable business success and economic development (UNIDO, 2020; Okpara, 2011).

Despite the recognized significance of SMEs in the manufacturing sector, many businesses struggle with growth due to the impact of government policies. While some policies aim to support SME development through funding, training, and tax incentives, others impose challenges through regulatory barriers, high compliance costs, and limited access to financial resources. The inconsistency in policy implementation, lack of adequate support mechanisms, and changing regulatory landscapes have made it difficult for SMEs to scale up and remain competitive. Many SMEs in the manufacturing sector face issues such as limited credit access, high operational costs, and an unfavorable business environment, which hinder their expansion.

This study seeks to examine the effects of government policies on SME growth in the manufacturing sector. By identifying the specific policies that facilitate or hinder growth, the research will provide insights into policy improvements that can better support SMEs.

### Research Objectives

The study aims to achieve the following objectives:

1. To examine the impact of taxation policies on the growth of SMEs in the manufacturing sector of Nigeria.
2. To assess the impact of financial support and credit accessibility on SME growth in Nigeria.
3. To evaluate the effect of regulatory policies on the operations and expansion of SMEs in the manufacturing industry of Nigeria.
4. To analyze the effectiveness of government trade policies in promoting SME competitiveness in Nigeria.



## Research Questions

The study will address the following research questions:

1. How do taxation policies affect the growth of SMEs in the manufacturing sector?
2. What is the impact of financial support and credit accessibility on SME development?
3. How do regulatory policies influence SME operations and expansion of SMEs in the manufacturing industry of Nigeria?
4. How effectiveness of government trade policies in promoting SME competitiveness in Nigeria?

## Research Hypothesis

- There is no significant relationships between government policies and SME growth in Nigeria

## LITERATURE REVIEW

### Concept of Small and Medium Enterprises (SMEs)

Small and Medium Enterprises (SMEs) are businesses that operate on a smaller scale than large corporations, typically defined based on criteria such as annual revenue, number of employees, and asset size. The definition of SMEs varies across countries and institutions. For instance, the World Bank defines SMEs as businesses with up to 300 employees, annual revenue of up to \$50 million, and total assets of up to \$50 million (World Bank, 2020). In contrast, the European Union (EU) defines SMEs as firms with fewer than 250 employees and an annual turnover of less than €50 million (European Commission, 2021). The United States Small Business Administration (SBA) uses different size standards depending on industry classification, generally considering businesses with fewer than 500 employees as SMEs (SBA, 2022). The Small and Medium Enterprises Development Agency of Nigeria (SMEDAN, 2022) defines SMEs as businesses with between 10 and 199 employees and asset values (excluding land and buildings) between ₦5 million and ₦500 million. The Central Bank of Nigeria (CBN, 2021) categorizes SMEs based on asset base and annual turnover, with small enterprises having assets of ₦5 million–₦50 million and medium enterprises ranging between ₦50 million–₦500 million. SMEs account for about 96% of businesses in Nigeria, contributing 48% to GDP and employing 84% of the labor force (SMEDAN & National Bureau of Statistics, 2022). In Nigeria's manufacturing sector, SMEs play a key role in producing raw materials, intermediate goods, and finished consumer products, strengthening industrial value chains (UNIDO, 2021). However, SMEs in Nigeria face several growth-inhibiting challenges, including poor infrastructure, inadequate access to finance, regulatory bottlenecks, and inconsistent government policies (Adebisi & Gbegi, 2013).

### Government Policies and SME Growth

Government policies refer to the strategic plans, laws, regulations, and actions implemented by a government to achieve specific economic, social, or political objectives. These policies can be categorized into various types, including fiscal policy, monetary policy, trade policy, industrial policy, and social policy (Dye, 2017). According to Anderson (2015), government policies serve as instruments for guiding national development, shaping business environments, and addressing societal challenges. They influence economic growth, employment rates, and overall national

stability by regulating industries, controlling inflation, and providing public goods and services (Hill & Varone, 2021).

One of the key ways government policies impact SMEs is through taxation. Tax policies significantly influence SME profitability and growth by affecting operational costs, cash flow, and investment decisions. A favorable tax regime, including reduced corporate tax rates, tax holidays, and simplified tax compliance procedures, encourages SME growth by lowering the cost of doing business (OECD, 2018). Many governments have adopted SME-friendly tax policies. For example, Malaysia offers a reduced corporate tax rate of 17% for SMEs on taxable income up to MYR 600,000, compared to the standard corporate tax rate of 24% (Inland Revenue Board of Malaysia, 2022). In Nigeria, SMEs face multiple taxes, including Company Income Tax (CIT), Value Added Tax (VAT), and withholding tax. However, the government has introduced tax relief measures to support SMEs. The Finance Act 2020 reduced CIT for small businesses (with annual turnover below ₦25 million) to 0%, while medium-sized businesses (₦25 million–₦100 million) pay 20% instead of the standard 30% (Federal Inland Revenue Service, 2021). Despite these tax incentives, many SMEs struggle with multiple taxation, complex tax filing processes, and lack of awareness about tax incentives (Uzor, 2020). Empirical research by Adegbite et al. (2021) found that high tax burdens often force SMEs into the informal sector, reducing government revenue and limiting SME expansion. Studies also suggest that simplified tax regimes and digital tax payment systems can increase SME compliance and growth (OECD, 2021).

Access to finance remains one of the most significant challenges faced by SMEs in the manufacturing sector. Government financial support policies, such as low-interest loans, grants, and credit guarantee schemes, play a vital role in enhancing SME growth (Beck & Kunt, 2008). According to a World Bank (2021) report, more than 40% of SMEs in developing economies cite lack of financing as a major barrier to growth. In Nigeria, the Central Bank of Nigeria (CBN, 2022) has introduced several financial support initiatives for SMEs, including the Small and Medium Enterprises Credit Guarantee Scheme (SMECGS), which provides credit guarantees to SMEs to improve their access to bank loans; the NIRSAL Microfinance Bank SME Loan, which offers affordable financing for SMEs in agriculture, manufacturing, and trade; and the Bank of Industry (BOI) SME Loan, which provides long-term, low-interest loans to SMEs in Nigeria. Research shows that financial support programs significantly enhance SME growth and job creation (Ariyo, 2008; Olowe et al., 2013). However, challenges such as bureaucratic loan approval processes, corruption, and poor credit repayment culture reduce the effectiveness of these initiatives (Oni et al., 2020).

Regulatory policies encompass business registration procedures, labor laws, environmental regulations, and compliance requirements. While regulations are necessary for ensuring business ethics and fair competition, excessive bureaucracy and stringent compliance measures can hinder SME growth (Djankov et al., 2002). A World Bank (2020) study found that SMEs in countries with complex regulatory environments are more likely to operate informally, limiting their access to finance, government support, and formal markets. In Nigeria, business registration through the Corporate Affairs Commission (CAC) has been digitalized, yet many SMEs still face delays and regulatory bottlenecks (Nwokoro, 2019). In contrast, countries with simplified business registration processes experience higher SME formalization rates. For example, Rwanda introduced an online business registration system, reducing business registration time from 11 days to less than 24 hours, significantly boosting SME growth (World Bank, 2020).

Trade policies, including export incentives, import tariffs, and trade agreements, significantly affect SME growth in the manufacturing sector. Governments that promote SME participation in

international trade through export financing, trade fairs, and reduced tariff barriers create opportunities for business expansion (WTO, 2019). For instance, the African Continental Free Trade Area (AfCFTA) is expected to boost intra-African trade, providing SMEs with new market opportunities (UNCTAD, 2020). Additionally, high tariffs on imported goods aim to encourage local manufacturing but often increase production costs for SMEs reliant on imported raw materials (Adenikinju, 2019). Moreover, studies indicate that SMEs engaged in export activities grow faster and are more resilient than those dependent on local markets (Okpara, 2012). However, trade barriers such as bureaucratic export procedures, inadequate trade financing, and poor logistics infrastructure limit SME participation in global markets (Egbetokun et al., 2018).

## **Theoretical Framework**

### **Institutional Theory**

Institutional Theory was developed by John Meyer and Brian Rowan in 1977 in their seminal work *"Institutionalized Organizations: Formal Structure as Myth and Ceremony."* They argued that organizations adopt formal structures not just for efficiency but to align with societal expectations and gain legitimacy. Later, Paul DiMaggio and Walter Powell (1983) expanded the theory with their concept of institutional isomorphism, explaining how organizations become similar due to coercive (regulatory), normative (professional), and mimetic (uncertainty-driven) pressures (DiMaggio & Powell, 1983). Additionally, W. Richard Scott (1995, 2001) further refined the theory and according to Scott (2001), institutions operate through three key pillars: regulative (laws and policies), normative (social norms and professional standards), and cognitive (shared beliefs and assumptions). This theory highlights how businesses, including SMEs, adapt to governmental regulations, industry standards, and societal expectations to survive and grow. In the SME sector, institutional pressures such as government policies, financial regulations, and trade policies influence business strategies and market operations (North, 1990).

According to DiMaggio and Powell (1983), organizations, including SMEs, respond to institutional pressures coercive, normative, and mimetic which shape their strategic decisions and survival. Government policies such as taxation, financial support, regulatory frameworks, and trade policies create these institutional pressures, influencing SME operations and growth. Firstly, Coercive pressures stem from government regulations and legal mandates. Policies like taxation and business registration laws require SMEs to comply with formal rules. For example, Nigeria's Finance Act (2020) introduced tax relief, reducing corporate tax for small businesses to 0% and for medium-sized enterprises to 20% (FIRS, 2021). However, excessive taxation and complex compliance drive many SMEs into the informal sector (Adegbite et al., 2021). Secondly, Normative pressures arise from industry standards and financial institutions. Government-backed financial programs, such as the Bank of Industry (BOI) and NIRSAL Microfinance Bank, provide SMEs with credit and low-interest loans (CBN, 2022). However, Oni et al. (2020) argue that bureaucratic loan approval processes and poor credit repayment culture reduce the effectiveness of these initiatives. Thirdly, Mimetic pressures lead SMEs to imitate successful firms, especially under uncertainty. Nigeria's participation in AfCFTA encourages SME exports, yet challenges like high tariffs and poor infrastructure persist (Adenikinju, 2019). Many SMEs adopt clustering and trade associations to enhance competitiveness (Egbetokun et al., 2018).

## **METHODOLOGY**

### **Research Design**

This study employs a mixed-method approach, combining quantitative data on SME growth (revenue, employment, market reach) with qualitative insights into SME owners' perceptions of government policies. A descriptive survey design is used to analyze the impact of taxation, financial support, regulations, and trade policies on manufacturing SMEs.

### **Target Population**

The target population comprises SMEs in the manufacturing sector within Lagos State Nigeria. It includes SME owners and managers, government policymakers from institutions like the Ministry of Trade and SME Development Agencies, financial institutions supporting SMEs, and business associations industry experts. The study surveyed 240 SMEs to ensure a representative sample for meaningful analysis.

### **Sampling Techniques and Sample Size**

A stratified random sampling technique will categorize SMEs by subsector, followed by simple random sampling. Purposive sampling was used to select key informants from policymakers, financial institutions, and industry experts.

The sample size was determined using **Yamane's formula (1967)**:

$$n = \frac{N}{1+N(e)^2}$$

Where:

- $n$  = Sample size
- $N$  = Target population (estimated at 240 SMEs)
- $e$  = Margin of error (0.05 for 95% confidence level)

Applying the formula:

$$n = \frac{240}{1+240(0.05)^2} = 150$$

Thus, a total of 150 SMEs was surveyed, alongside 10 policymakers, 10 financial institution representatives, and 10 industry experts, bringing the total sample to 180 respondents.

### **Method of Data Collection**

Data were collected through both primary and secondary sources. Primary data was gathered through questionnaires for SME owners and managers and interviews with policymakers and industry experts. Key topics include SME demographics, taxation policies, financial support, regulatory challenges, and trade policy impacts. Secondary data came from government reports, central bank publications, and academic research on SME growth.

### **Data Analysis Techniques**

Quantitative data was analyzed using SPSS, applying descriptive statistics (frequencies, percentages, means, and standard deviations) to summarize the data. Pearson correlation tests, was used to assess the relationship between government policies and SME growth.

### **Validity and Reliability**

To ensure validity, the questionnaire will undergo expert review by academic professionals and industry experts to confirm its relevance. A pilot study involving 20 SMEs will be conducted to refine questions and ensure clarity. The reliability of the questionnaire will be tested using Cronbach's Alpha to measure internal consistency. A Cronbach's Alpha value above 0.7 will indicate acceptable reliability.

## DATA ANALYSIS, RESULTS, AND DISCUSSION

**Table 1: Distribution of SMEs by Sector**

The study categorized SMEs into different manufacturing subsectors

Manufacturing Sector	Frequency	Percentage (%)
Food Processing	45	25.0%
Textile & Apparel	30	16.7%
Metalwork & Engineering	40	22.2%
Electronics	25	13.9%
Others	40	22.2%
Total	180	100%

(Field Survey, 2025)

Table 1 shows the distribution of SMEs across manufacturing subsectors reveals that Food Processing is the most dominant, accounting for 25.0% (45 SMEs), indicating a strong presence of businesses in the food industry. Metalwork & Engineering and Other sectors each represent 22.2% (40 SMEs), showing significant diversity in manufacturing activities. Textile & Apparel follows with 16.7% (30 SMEs), suggesting moderate involvement in fabric-related industries, while Electronics has the smallest share at 13.9% (25 SMEs), reflecting a relatively lower participation in electronic manufacturing.

**Table 2: Impact of Taxation Policies on the Growth of SMs in the Manufacturing Sector of Nigeria.**

Taxation Impact	Frequency	Percentage (%)
High tax burden negatively affects growth	110	61.1%
Moderate impact	45	25.0%
No significant impact	25	13.9%
Total	180	100%

(Field Survey, 2025)

Table 2 shows the impact of taxation policies on the growth of SMEs in the manufacturing sector of Nigeria. Majority of SMEs (61.1%, or 110 businesses) report that a high tax burden negatively affects their growth, indicating that heavy taxation is a major challenge for these enterprises. Meanwhile, 25.0% (45 SMEs) experience a moderate impact, suggesting that taxation affects

their operations but not as severely. Only 13.9% (25 SMEs) perceive no significant impact, implying that a small portion of businesses can operate without major constraints from taxation.

**Table 3: Impact of Financial Support and Credit Accessibility on SME growth in Nigeria**

Financial Support Access	Frequency	Percentage (%)
Easily accessible	30	16.7%
Difficult to access	120	66.7%
Not aware of financial programs	30	16.7%
Total	180	100%

**(Field Survey, 2025)**

Table 3 shows the impact of financial support and credit accessibility on the growth of SMEs in Nigeria. A majority of SMEs (66.7%, or 120 businesses) report that accessing financial support is difficult, indicating that limited credit availability poses a major challenge to their growth. Meanwhile, 16.7% (30 SMEs) find financial support easily accessible, suggesting that only a small portion of businesses can obtain funding without difficulty. Another 16.7% (30 SMEs) are not aware of financial programs, highlighting a gap in information dissemination.

**Table 4: Effect of Regulatory Policies on the operations and expansion of SMEs in the manufacturing industry of Nigeria**

Regulatory Impact	Frequency	Percentage (%)
Complex and costly compliance	95	52.8%
Moderate difficulty	50	27.8%
No significant impact	35	19.4%
Total	180	100%

**(Field Survey, 2025)**

Table 4 shows the effect of regulatory policies on the operations and expansion of SMEs in Nigeria's manufacturing industry. A majority of SMEs (52.8%, or 95 businesses) report that compliance with regulations is complex and costly, indicating that stringent regulatory requirements pose a major challenge to business growth. Meanwhile, 27.8% (50 SMEs) experience moderate difficulty, suggesting that while regulations impact their operations, the effect is not overwhelming. Only 19.4% (35 SMEs) perceive no significant impact, implying that a small portion of businesses can operate without major regulatory constraints.

**Table 5: The Effectiveness of Government Trade Policies in Promoting SME Competitiveness in Nigeria**

Trade Policy Impact	Frequency	Percentage (%)
---------------------	-----------	----------------



Policies promote market expansion	55	30.6%
Limited impact on growth	85	47.2%
Restrictive policies hinder growth	40	22.2%
Total	180	100%

(Field Survey, 2025)

Table 5 shows the effectiveness of government trade policies in promoting SME competitiveness in Nigeria. A significant portion of SMEs (47.2%, or 85 businesses) report that these policies have a limited impact on their growth, indicating that current trade regulations do not strongly support business expansion. Meanwhile, 30.6% (55 SMEs) believe that trade policies promote market expansion, suggesting that some businesses benefit from government initiatives. However, 22.2% (40 SMEs) state that restrictive policies hinder their growth, highlighting concerns over regulations that may pose challenges for SMEs.

### Hypothesis Testing

**Table 6: Pearson correlation test to determine the strength of relationships between government policies and SME growth.**

Variable	SME Growth	Taxation	Financial Support	Regulations	Trade Policies
SME Growth	1	-0.52**	0.63**	-0.47**	0.58**
Taxation	-0.52**	1	-0.34*	0.41*	-0.29*
Financial Support	0.63**	-0.34*	1	-0.45*	0.49*
Regulations	-0.47**	0.41*	-0.45*	1	-0.31*
Trade Policies	0.58**	-0.29*	0.49*	-0.31*	1

(\* $p < 0.05$ , \*\* $p < 0.01$ )

Table 6 presents the results of a Pearson correlation test, examining the strength of relationships between government policies and SME growth. The findings indicate that financial support (0.63) and trade policies (0.58) have strong positive correlations with SME growth, suggesting that improved access to financial resources and supportive trade policies significantly enhance business expansion. Conversely, taxation (-0.52) and regulations (-0.47) show strong negative correlations, indicating that high taxes and restrictive regulations hinder SME growth. Additionally, financial support is negatively correlated with regulations (-0.45), while taxation has a weak negative correlation with financial support (-0.34) and trade policies (-0.29), implying that high taxes may reduce access to financial resources and limit the effectiveness of trade policies.

### Discussion of Findings

The results of the Pearson correlation test highlight the significant impact of government policies on SME growth in Nigeria. The strong positive correlation between financial support (0.63) and SME growth aligns with previous studies, such as those by Beck and Demirgüç-Kunt (2006), which emphasize that access to credit and financial resources is a critical factor for SME development. Similarly, trade policies (0.58) show a strong positive relationship with SME growth, supporting findings by Akinboade and Kinfack (2012), who argue that favorable trade policies facilitate market expansion and competitiveness among SMEs. On the other hand, taxation (-0.52) and regulations (-0.47) exhibit strong negative correlations with SME growth, indicating that high tax burdens and restrictive regulatory frameworks act as major constraints. This finding is consistent with studies by Djankov et al. (2010), which highlight that excessive taxation reduces profitability and discourages business expansion. Similarly, research by Mensah and Nyadu-Addo (2019) suggests that stringent regulatory policies create bureaucratic barriers that limit SME growth and sustainability. Furthermore, the study finds a negative correlation between financial support and regulations (-0.45), suggesting that restrictive regulatory environments may impede access to financial assistance for SMEs. This supports previous research by Fatoki and Asah (2011), which found that excessive bureaucratic requirements limit SMEs' ability to secure loans and funding. Additionally, the weak negative correlation between taxation and both financial support (-0.34) and trade policies (-0.29) implies that high tax burdens may reduce the effectiveness of financial support initiatives and limit the benefits of trade policies.

The above findings reinforce the argument that while financial support and trade-friendly policies contribute positively to SME growth, excessive taxation and regulatory constraints hinder business expansion. Therefore, the null hypothesis which stated that there is no significant relationships between government policies and SME growth in Nigeria is rejected.

## CONCLUSION

This study provides empirical evidence on the significant relationship between government policies and the growth of Small and Medium Enterprises (SMEs) in Nigeria's manufacturing sector. The findings highlight that certain government policies, particularly financial support initiatives and trade-friendly regulations, have a positive impact on SME expansion. These policies facilitate increased business activity, enhance productivity, and create opportunities for SMEs to scale operations. Conversely, excessive taxation and stringent regulatory frameworks act as major barriers to SME growth, stifling innovation, reducing profitability, and discouraging new business entries into the sector.

The study's results emphasize the crucial role of financial accessibility in fostering SME development. A strong positive correlation between financial support and SME growth suggests that policies aimed at providing credit facilities, reducing interest rates, and expanding financial inclusion have a direct and beneficial effect on business performance. Additionally, the study reveals that a restrictive regulatory environment not only discourages SME development but also negatively affects financial accessibility, further complicating the growth prospects of businesses. Complex bureaucratic processes, high compliance costs, and cumbersome registration requirements create barriers that limit the formalization of SMEs, reducing their chances of accessing financial and technical support. These findings collectively suggest that the existing policy environment in Nigeria is not entirely conducive to SME development and requires urgent reforms.

## RECOMMENDATIONS

Based on the study's findings, the following recommendations are proposed to enhance SME growth in Nigeria's manufacturing sector:

1. The government should implement tax relief programs and reduce excessive tax burdens on SMEs to improve business sustainability and profitability.
2. Financial institutions should simplify loan acquisition processes, reduce interest rates, and expand credit programs targeted at SMEs.
3. The government should streamline business registration and compliance processes to reduce bureaucratic inefficiencies.
4. The government should implement policies that promote SME access to international markets through reduced tariffs, export incentives, and partnerships with global trade organizations
5. Stronger collaboration between government agencies, financial institutions, and SME associations should be encouraged to develop policies tailored to the needs of SMEs.
6. Investments in power supply, transportation, and digital infrastructure should be prioritized to reduce the operational costs of manufacturing SMEs and improve overall business efficiency.

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# **E-MARKETING AND EFFICIENCY OF FRUITS AND VEGETABLES SUPPLY CHAIN IN AKWA IBOM STATE**

**OKOKON, Godwin Edet<sup>1</sup>, & Dr. Abude PETER<sup>2</sup>**

**<sup>1</sup>Department of Marketing, FEPO**

**<sup>2</sup>Department of Entrepreneurship and Business and Innovation, Federal Polytechnic, Orogun**

**Correspondence Email: [okokongodwin73@gmail.com](mailto:okokongodwin73@gmail.com)**

## **ABSTRACT**

*This research examined how the usage of electronic marketing can boost the efficiency of fresh vegetables and fruits supply in Akwa Ibom State. Specific objectives were to examine the level of application of e-marketing tools; find out the challenges limiting e-marketing application, and analyze the effect of e-marketing on efficiency of fruits and vegetables dealers. The study was carried out in five local governments of Akwa Ibom State, namely: Mkpato Enin, Ini, Ikono, Uruan, and Ikot Abasi Local Government Areas of Akwa Thom State. The population of the study included all farmers and dealers in fresh fruits and vegetable crops in the area. Estimate has shown that, there are about 2,241 fruits and vegetable farmers engaged in processing and supplying fresh fruits and vegetables in the study area. The study adopted multi-stage sampling technique to select 120 respondents for the study. The study adopted proportional sampling procedure to select 15 respondents from each of the 8 villages, making a total of 120 respondents. Structured questionnaire was used for data collection. Data were analyzed using frequencies, percentages, means and ranks. Also, Simple Linear Regression (OLS) was to test causes and effect amongst dependent and independent variables. The empirical result revealed that Facebook (46.7%) and WhatsApp (43.3) ranked 1<sup>st</sup> and 2<sup>nd</sup> respectively as the most used e-marketing tools among fruits and vegetables agribusiness supply chain partners in the study area. Also, affordability of smart phone, digital literacy and limited internet connectivity are the major limitations affecting e-marketing application among fruits and vegetables supply chain. Lastly, there is a significant effect of e-marketing on efficiency of fruits and vegetables dealers in the study area.*

**KEYWORDS:** Electronic, marketing, efficiency



## 1.0 INTRODUCTION

Vegetables and fruits are significant sources of nutrients (vitamins, minerals and fibers) and essential ingredients in the human diet (Idah, Ajisegiri & Yisa, 2007). In Nigeria, commercial production of vegetables and fruits is highly encouraged. Government's interest in effectiveness of vegetables and fruits agribusiness stem from many factors: economic value (generating income for both the rural and urban dwellers), industrial and employment potentials, increased urbanization and changes in consumer lifestyles, and fostering entrepreneurship and self-reliance. In addition, there is growing demand for organic vegetables due to its nutritional, medicinal and health benefits. For instance, vegetables and fruits stimulate digestion, act as laxatives, increase antibody immunity, and regulates the body pH level (Agbugba, Okechukwu & Solomon, 2011). Fruits and vegetable production forms a substantial percentage (about 25%) of the major food crops cultivated in the tropics and so, it is the source of livelihood for a considerable section of the population (Chandrasekaran & Raghuram, 2014). The buying, selling and trading of goods and services via computer networks (like the Internet) where terms of sale or transactions are carried out electronically is known as e-marketing, a subset of e-business (Jen-Her & Tzyh-Lih, 2008).

Conceptually, e-business refers to any business that uses Information Communication and Technology (ICT) infrastructure or internet technology to improve business deliverables. The deliverables can be in terms of productivity, sales of goods and services, profit among others. A business that uses Internet to purchase wholesale products is said to be involved in c-Procurement while c-retailing also referred to as online shopping allows the use of Internet to purchase goods for an individual. E-Marketing which encapsulates c-Shopping, c-Retailing, c-Payment and the like is a subset of c-Business which has removed the distance barrier, thereby increasing global competition among products and service providers (Udechukwu, 2003). While the multinationals have the benefit of large-scale production and better funding, they possess the wherewithal to secure ICT equipment that will propel and promote the sale of their products beyond the borders of their nations throughout the worldwide using Internet. This allows infiltration of products (goods and services) from advanced economies into many developing nations' markets.

Although, e-marketing may be advantageous in area of quality of products, it has undermined the development of many agro producers and their value-added allies in developing nations like Nigeria who are mainly SMEs in these nations (Udechukwu, 2003). The agro producers in Nigeria which dominate emerging nations' economies do not have a global competitive advantage with either their counterpart SMEs in developed nations or with super companies in the global market. Research into Business to Business (B2B) platforms has only just begun to emerge (Osterwalder, Lagha & Pigneur 2002), and does not adequately address the many complexities facing agribusiness firms. In any business environment, customers are kings. It is incumbent on the business to find means of satisfying her customers in order to retain or increase her market share. Customers want value for their money through quick and reliable service while, agribusiness managers are to find appropriate means or technology that will guarantee customer satisfaction. Business methodologies and strategies have greatly been influenced in the developed economies in such a way that one can order goods from anywhere and have them delivered at one's door step within a few minutes at little or no extra cost. This improved business strategy, in the view of Molla and Heeks (2007), is very rare in developing countries, and where available, it is owned by the multi-nationals from the developed world that have the resources to meet and use the modern "business know-how" of today known as Electronic Commerce (EC).

## **Problem Statement**

Despite the dietary importance of fruits, nutritional value, and the numerous efforts to boost production, the marketing of vegetables and fruits in Nigeria electronically has seldom been considered as an efficient and effective supply chain option. In addition, the operational efficiency of fruits and vegetable in Akwa Ibom State is too high, and vegetables and fruits farmers in the state faces difficulties to be self-dependent on supply of indigenous vegetables to the market. Thus, finding ways of mitigating these challenges through a system of e-marketing remains the crux of this study. Exploring the mechanisms in which e-marketing platforms may be used to assist efficient vegetables and fruits supply chain is very crucial to developing nations including Nigeria.

There have been series of interventions and policies geared towards improving vegetables and fruits yield and the subsequent timely distribution throughout the value chain. However, these efforts have yielded very little success given the quantum of vegetables and fruits deterioration commonly found amongst streetside vendors, supermarkets and other points of retail display. Supply chain in Nigeria is marred by myriads of problems. These includes fragmented land holding and rain-dependent farming which stifles consumer demand for product variety, quality, and year -round availability. Most vegetables and fruits are seasonal but demand for them rarely recognizes seasonality. Something needs to be done to ensure all year-round availability and access. Even in their due season, the cycle time between harvest and consumption become so long that the perishable nature of commodities takes a great toll on the crops, reducing their freshness and devaluing their economic importance. This again requires very efficient supply chain and logistics managing in terms of storage, handling, processing and even temperature-regulated transportation system.

There is also a problem pertaining to the spot marketing arrangement with many supply chain intermediaries. This tends to limit timely delivery of fresh products from farm gate to retail level. High level of products perishability is another problem confronting efficiency of fruit and vegetables marketing and supply (A recent agency report by the Premium Times Magazine in December 19, 2016 reveals that over 55% of Nigeria's vegetables and fruits perish before consumption). Inaccessibility to information for efficient marketing and produce distribution also constitute another area of concern for fruits and vegetable supply chain management (Chandrasekaran & Raghuram, 2014). Readily available in the literature are evidence of how information and communication system can provide incentives for increased agricultural commodity production, marketing, and supply (Asogwa & Okwoche, 2012). However, the marketing of fruits and vegetable supply in Nigeria is far from being effective; owing to inaccessibility to timely market information, inadequate market infrastructure like producer cooperative, and weak transport, processing, and storage facilities. This situation results in high post-harvest loses and make farmers price takers and hence discourage expansion of fresh fruits and vegetable production.

## **Objectives of the Study**

The main objective of this study is to examine the effect of e-marketing on efficiency of fruits and vegetables supply chain in Akwa Ibom State. It has the following specific objectives to:

- i. examine the level of application of e-marketing tools among fruits and vegetables agribusiness supply chain partners,
- ii. find out the challenges limiting e-marketing application among fruits and vegetables supply chain in Akwa Ibom State, and

- iii. analyze the effect of e-marketing on efficiency of fruits and vegetables dealers

### **Justification and Significance of the Study**

The introduction and adoption of on-line marketing is capable of reducing these losses and produce more financial benefits to the fruits and vegetable farmers and the governments. This study covered issues relating to the application of e-marketing platforms in marketing of fresh vegetables and fruits in Akwa Ibom State. Therefore, such a study is justified and quite relevant to the Akwa Ibom State and Nigeria at large; considering governments' effort towards revamping agriculture, achieving food security, and the quest to improve GDP through agriculture. It is anticipated that the outcome of the study would reveal better ways of marketing fresh vegetables and fruits electronically. This implies that, instead of visiting conventional shops frequently, buyers will have option and access to the required products with the right price online. The findings in this study would generate new conclusions to enrich the existing body of research and literature on e-marketing as well as providing relevant inputs for policy modifications and workable interventions for sustainable agricultural development.

## **2.0 LITERATURE REVIEW**

### **Concept of e-marketing**

E-marketing is defined as the means of using the internet and other interactive technologies to create and mediate dialogue between the firm and identified customers which encompasses one-to-one marketing and allows for mass customization. Similarly, Chandrasekaran & Raghuram (2014) defined e-Marketing as the use of internet and related technologies along with other marketing tools in order to carry out the traditional marketing operations and activities, finding customer, communicating with them and delivering value to them. Electronic marketing is viewed as another philosophy practiced in modern business involving marketing of goods, services, information and ideas through internet and other electronic means. An e-marketing model refers to a structure that increases the value proposition to customers as compared to traditional business models, and to provide guidance for organizations to conduct their business activities in the e-business environment on a sustainable basis (Hardaker & Graham, 2001). Electronic marketing - the business-to-customers (B-C) dimension of electronic commerce is defined by Kapurubandara and Lawson, (2008) as a structure that permits users to procure merchandises through computer webs such as the Internet. It provides products (goods and services) customization, in contrast to buying in a store or ordering from a television advertisement, which is usually limited to standard products.

### **Benefits of e-marketing in agriculture**

Many benefits of e-marketing in agriculture can be identified:

1. Promotion of information flow: The exchange of info about agricultural products, their characteristics, advantages, and disadvantages among others can be greatly increased through the information highways of the Internet during e-commerce transactions. In addition, internet technology provides the opportunity to link individual actors in the food production chain together, irrespective of geographic location (Pare, 2013). This has the capacity to expand market access through internet transactions and by dropping geographic hindrances to market range, such as time and distance.
2. Market and price transparency: Online access to product and price information allows comparison of products and increases price transparency (Turban, Lee & Viehland, 2014). Price differentials resulting from geographic location can diminish because of increased

competition. This may benefit farmers with regard to input prices but may reduce the prices received for their harvests. This may be particularly true where many existing products are not differentiated, are required on a regular basis, and where there is a heavy reliance on input supplier expertise in choice of product.

3. Reduction or elimination of transaction costs: With the claim of e-commerce, many transactions through the supply chain are either eliminated or simplified. In this way, transaction costs are drastically reduced or even eliminated (Molla & Reeks, 2007).
4. Increase in online cooperatives: The processes of e-commerce transactions give emergence to new opportunities for furthering the concept of cooperatives. From the perspective of farmers, c-cooperatives provide a solution for small businesses to increase critical mass (Molla & Reeks, 2007).

The Internet plays a role in agribusiness both as a new marketplace and as an information resource. Numerous applications have been developed by different interest groups. From a farmer's perspective, services, outputs, factors of production, and inputs are all examples of applications in the marketplace (Jen-Her and Tzyh-Lih, 2008). Typically, outputs are traded at auction, while services, inputs, and production factors are bought online at a set price. The market price is more susceptible to supply and demand since many of the outputs are perishable, which may be the reason for this. Traditional agribusiness distribution channels are under pressure from four sources of change (Sanyang, Kao & Huang, 2009). First, as a result of the rise of large commercial producers, the majority of agribusiness companies are seeing a fragmentation in their clientele. At the same time, the majority of suppliers still value traditional or family farm enterprises. A growing market for some businesses is the emerging lifestyle/rural resident producer, who may have very different needs in terms of goods and services than large commercial or traditional farmers. To deliver distinct product, service, and information bundles to these various customer segments, different distribution channels might be needed. Customer expectations are rising, which puts additional strain on conventional distribution channels (Udofia, 2007). In addition to the wide range of demands that customers have, they also anticipate better performance from their suppliers in terms of cost, response time, quality, etc.

### **Supply Chain Management in Agribusiness**

Agribusiness, supply chain management (SCM) refers to the management of the relationships between individuals and business groups that are in charge of producing and supplying agricultural products (like fruits and vegetables) from the farm gate to consumers. The main goal of SCM is to meet the needs of customers in terms of quantity, quality, price, time, and flexibility (Lambert & Matias, 2012). To do this, it is necessary to manage the relationships and transactions between businesses as well as the processes within businesses (Hanf & Pall, 2009). According to Burt (1997), traditional supply chains in many developing nations usually have a large number of participants and are closely related to established social structures. SCM offers to a comprehensive strategy for organizing the necessary enhancements to agricultural production and marketing systems management in order to address upcoming obstacles (Woods, 2004). According to Russell and Taylor (2004) and Stevenson (2006), a supply chain is made up of all the operations that lead to the movement and modification of goods and services from the stage of raw materials to the stage of finished or processed goods and services for final consumer consumption. In the supply chain, information flow is a crucial component and prerequisite in addition to the flow of goods and services (Krajewski et al., 2007; Taylor and Russell, 2004). An agricultural supply chain consists of suppliers of equipment, raw materials, and other related services needed for the process.

Producing and delivering a product or service to the end user involves a series of business processes within related organizations, including their facilities and activities (Krajewski et al., 2007). According to Stevenson (2006), facilities include factories, warehouses, distribution centers, processing centers, retail stores, and offices. When it comes to delivering the value bundle, suppliers are expected to consistently improve, speed up, and lower their prices. Market forces at the farm gate, which require even more efficient decision-making, and increased competition among agribusiness companies for the business of fewer producers are the main causes of this. New technology that increases distribution systems' capabilities and efficiencies is a third factor putting pressure on conventional distribution channels. Information systems technology like SAP, Oracle, or Ariba.com; communications technology like the Internet, Intranets, bandwidth expansion, and e-business; and logistics management technology, including global positioning systems and bar-coding, are three of these areas of technology that are especially significant. Distribution effectiveness and efficiency are being significantly impacted by this new technology.

Shifting market competition is a fourth factor putting pressure on conventional distribution methods. Product performance differences are getting smaller, and agribusiness sectors are increasingly adopting shorter product life cycles. Distribution strategies are further complicated by the proliferation of products. In addition, new firms are establishing themselves with novel business strategies like e-business, direct delivery from producers to farmers, and telemarketing/direct sales. These days, competition is more and more centered on cost, quality, end-user acceptance, speed to market, and flexibility and responsiveness. The culmination of these four pressures is the growing pressure on traditional distribution channels, which include wholesalers, distributors, dealers, and carriers/transporters. The distribution channel is under tremendous pressure to be made shorter while still being more effective and efficient. Sales forecasting, buying, inventory control, information management, quality control, production and procurement scheduling, distribution, delivery, and customer service are among the activities of the different participants (actors) in the supply chain. A supply chain (SC) usually comprises four fundamental procedures: (1) receiving orders from customers, (2) acquiring components and raw materials from suppliers, (3) manufacturing goods, and (4) completing or carrying out customer orders (Krajewski et al., 2007).

In a SC, suppliers are often described as upstream supply chain members, and distributors, including warehouses, up to retail or supermarket level, are described as downstream supply chain members. At each stage of the SC, actors may be required to hold inventory to insulate them from uncertainties (Russell and Taylor, 2004). Information is the key factor in managing and coordinating the SC at both ends of the stream in order to meet the prime objective of the chain: i.e. customers' requirements (Nsikan et al., 2018). A local retail store or a supermarket that sources eggs, milk products, or vegetables directly from farmers is the most basic SC. Every customer in their SC is a supplier to the next in the chain until the final consumer purchases the product from a retail outlet. Interestingly, upstream chain members also have their pool of suppliers to produce or to assemble their inputs (Stevenson, 2006; Krajewski et al., 2007).

Supply Chains are also referred to as value chains, which highlight the fact that value is added as goods and services pass through the chain (Stevenson, 2006; Krajewski et al., 2007). Every actor in the value chain has both a supply and a demand component, which is how the value chain emphasizes the role each actor plays in creating customer value. Each actor's internal business processes mark the end of the supply component, which starts at the chain's beginning. When the company's output is delivered to the subsequent client, the demand component of the chain begins. The value chain's distribution and sales components are included in the demand



component. Where each company is located in the value chain determines how long each component is. The demand component is shorter and the supply component is longer the closer the company is to the end consumer (Stevenson, 2006).

In addition to managing the flow of goods and services along the SC, a manager will try to achieve a level of synchronization in the SC that will make the chain more responsive to the needs of downstream customers while simultaneously lowering costs. Synchronization means coordination and cooperation and sharing information among SC actors (Russell & Taylor, 2004; Krajewski et al., 2007). Apart from sharing the same goals with suppliers, customers must be able to count on the quality and timeliness of product deliveries and services at attractive and competitive prices.

Marketing has economic value because it gives form time, place, utility to products and services (Kotler, 2010). At the farm, the farmer harvests his produce, marking the start of agricultural product marketing. It is typically not possible for the harvested product to reach customers directly. To begin with, it is probably going to be situated a considerable distance away from the location of consumption in a consistent and ongoing manner all year long. Second, in order to balance supply and demand, storage is needed. Thirdly, a harvested product is rarely in a form that customers find acceptable. As a result, it needs to be sorted, cleared, and processed in a number of ways before being conveyed to the customer for sale in inconvenient quality and quantity. The farmer expects payment when his produce is finally delivered, so financial arrangements must be made to cover each step until the retailer sells the goods to the customer. E-marketing, or electronic communication and marketing strategy, is one way to quickly expedite the aforementioned marketing process in the current technological environment.

### **Challenges of e-marketing of fresh fruits and vegetables**

#### ***(Post-harvest losses of fruits and vegetables in Nigeria)***

One of the biggest issues in the postharvest supply chain is the loss of fruits and vegetables. Numerous things, from growing conditions to handling at the retail level, can contribute to them. In addition to being obviously a waste of food, losses also amount to a waste of labor, agricultural inputs, livelihoods, investments, and limited resources like water (World Resource Institute, 1998). However, it is challenging to quantify post-harvest losses for produce, including fruits and vegetables. Every item that a farmer harvests may occasionally be sold to customers. In others, there might be significant waste or losses. In certain cases, such as when prices plummet and it would be more expensive for the farmer to harvest and sell the produce than to replant it, losses could be 100%. Therefore, using average loss figures is frequently deceptive. There may be reductions in quantity as well as quality, as indicated by the cost and nutritional content.

In Nigeria, enormous quantities of vegetables and fruits are produced and staggering figures are sometimes given as estimated annual production. For example, figures like 3.8million loads of cucumber, 6million tons of tomatoes, 15million tons of pineapples and 35million tons of citrus have been quoted as annual production levels for some fruits and vegetables, which are really large quantities of food crops (Olukosi & Isitor, 2000).

However, it is the amount of the produce available to the buyers rather than the level of production that is more important. Vegetables and fruits in their fresh forms contain high proportion of water. They are living and hence carry out their physiological function of respiration thereby absorbing and releasing gases and other materials from and to their environment. These happenings prime to their corrosion in shipment and storing, which is additional quick under situations of high



temperature and humidity. As a result, weighty losses are encountered in these crops. The actual number of fruits and vegetable losses per period is difficult to estimate accurately. However, it is noted that losses as high as 50% are common in fruits and vegetables between rural production and town consumption in Nigeria (Olukosi & Isitor, 2000). These losses occurred during transportation, storage and conventional ‘brick and mortar’ marketing (Arendt, 2008). To curtail or minimize these damages require detail studies to identify the e-marketing strategies involved.

### **Poor Market Access and Marketing Efficiency**

Fruits and vegetable marketing efficiency in Nigeria is dismally low. Transport costs are high due to poor road conditions, limiting access to inputs, credit, and output markets, and reducing the transmission of key market information.

### **Weak form of Infrastructure**

The necessary infrastructure such as Internet facilities electricity energy supply and transport and marketing systems is generally lacking in Nigeria. Where they are available, most are dilapidated in from giving fruits and vegetables producers, processors and marketers little incentive to expand operations. An inefficient, expensive transport system adversely affects input/output cost and supply, reducing farmers’ potential income from marketing their products.

## **3.0 Methodology**

The study was carried out in five local governments of Akwa Ibom State, namely: Mkpato Enin, Ini, Ikono, Uruan, and Ikot Abasi Local Government Areas of Akwa Thom State. Akwa Ibom is one of the 36 states in Nigeria, located in the coastal southern part of the country, and constitute part of the South-South geopolitical zones. These five rural local government areas (Mkpato Enin, Ini, Ikono, Uruan, and Ikot Abasi) were selected for this study because fruit and vegetable crops are predominantly produced in commercial quantities more than other areas of the state. The local government areas are located within the fresh water swamp forest zone, characterized by low level land and shallow depressions and has a combined total land mass of about 549.49 square kilometres (Udofia, 2007). The people are generally homogenous and speak Ibibio language. The major livelihood activities of the people in the study areas are farming, trading and processing of agricultural products. The population of the study included all farmers and dealers in fresh fruits and vegetable crops in the area. Estimate has shown that, there are about 2,241 fruits and vegetable farmers engaged in processing and supplying fresh fruits and vegetables in the study area. The study adopted multi-stage sampling technique to select 120 respondents for the study. In the first stage, stratified sampling procedure where the 79 villages that make up the local government areas were divided into four groups consisting of about 20 villages each. Two villages were randomly selected from each of the four groups making a total of 8 villages. The study adopted proportional sampling procedure to select 15 respondents from each of the 8 villages, making a total of 120 respondents. Structured questionnaire was used for data collection. However, key informant interview was conducted for 8 village heads and/or key leaders of agricultural associations in the study areas. Copies of questionnaire and interview schedule were carried out at the farm sites in the selected five local government areas. Data were analyzed using frequencies, percentages, means and ranks. Also, Simple Linear Regression (OLS) was to test causes and effect amongst dependent and independent variables.

## **4.0 DATA ANALYSIS AND DISCUSSION OF FINDINGS**

What is the level of application of e-marketing tools among fruits and vegetables agribusiness supply chain partners?

**Table 1:** Which of the following e-marketing tools do you adopt in marketing of fruits and vegetables

E-marketing tools	Frequency	Percentage	Rank
Website	24	20.0	6 <sup>th</sup>
Facebook	56	46.7	1 <sup>st</sup>
X (Twitter)	31	25.8	4 <sup>th</sup>
WhatsApp	52	43.3	2 <sup>nd</sup>
Instagram	39	32.5	3 <sup>rd</sup>
TikTok	19	15.8	7 <sup>th</sup>
YouTube	28	23.3	5 <sup>th</sup>

Source: Field Survey, 2025

Multiple responses

Table 1 showed the level of application of e-marketing tools among fruits and vegetables agribusiness supply chain partners in the study area. The frequency was based on multiple responses, which means that a respondent preferred more than one e-marketing tools in the study area. From the result, Facebook was ranked 1<sup>st</sup> with a frequency of 56 representing 46.7% of the sample size was the mostly preferred e-marketing tool among the fruits and vegetables agribusiness supply chain partners in the study area. Seconded by 52 respondents representing 43.3% of the sample size who adopts WhatsApp as the e-marketing tool used for businesses. This was followed by 32.5% and 25.8% of the respondents who also uses Instagram and X (Twitter) as the e-marketing tool used for businesses. More so, YouTube (23.3) and Website (20.0) was ranked 5<sup>th</sup> and 6<sup>th</sup> from the list of e-marketing tools used by fruits and vegetables agribusiness supply chain partners in the study area. The least was 15.8% of the respondents who uses TikTok fact as the e-marketing tool used for businesses in the study area. This could be attributed to the fact that Facebook (46.7%) and WhatsApp (43.3) ranked 1<sup>st</sup> and second respectively have the highest-level usage among fruits and vegetables agribusiness supply chain partners in the study area.

### Challenges limiting e-marketing application among fruits and vegetables supply chain in Akwa Ibom State

**Table 2:** Challenges limiting e-marketing application among fruits and vegetables supply chain

Statements	SA	A	D	SD	Total	$\bar{x}$	Rank
Digital literacy	37 (30.8)	44 (36.7)	23 (19.2)	16 (13.3)	120 100	2.85	2 <sup>nd</sup>
Limited internet connectivity	46 (38.3)	23 (19.2)	20 (16.7)	31 (25.8)	120 100	2.70	3 <sup>rd</sup>
Digital consumer buying behavior	19 (15.8)	28 (23.3)	35 (29.2)	38 (31.7)	120 100	2.23	5 <sup>th</sup>
Low advisory service agent	28 (23.3)	31 (25.8)	39 (32.5)	22 (18.4)	120 100	2.54	4 <sup>th</sup>
Affordability of smart phone	55 (45.8)	37 (30.8)	16 (13.3)	12 (10.0)	120 100	3.12	1 <sup>st</sup>

Source: Field Survey, 2024

Decision rule: Accept a mean value  $\geq 2.5$

From table 2 above, the result revealed that 45.8% of the respondents strongly agreed that affordability of smart phone with a mean value of 3.12 higher than 2.5 was the main challenge limiting e-marketing application among fruits and vegetables. This was followed by 36.7% of the respondents who agreed that digital literacy with a mean value of 2.85 and was accepted at  $\bar{x} > 2.5$ . Also, 38.3% of the respondents who strongly agreed that limited internet connectivity and has a mean value of 2.70 and was accepted at  $\bar{x} > 2.5$ . In addition, 25.8% of the respondents who agreed that low advisory service agent and has a mean value of 2.54 and was accepted at  $\bar{x} > 2.5$ . However, 31.7% of the respondents disagreed that the digital consumer buying behavior and was rejected with a mean value of 2.23. From the result, affordability of smart phone, digital literacy and limited internet connectivity are the major limitations affecting e-marketing application among fruits and vegetables supply chain in the study area.

### Test of Hypotheses

**H<sub>01</sub>:** There is no significant effect of e-marketing on efficiency of fruits and vegetables dealers

**Table 3: Simple regression analysis of effect of e-marketing on efficiency of fruits and vegetables dealers**

Variable	Parameters	Coefficient	Std error	Tcal – value
Constant	$\beta_0$	2.031	0.265	7.660***
e-marketing (X <sub>1</sub> )	$\beta_1$	0.396	0.076	5.199***
R-Square (R <sup>2</sup> )		0.286		
Adjusted R – Square (R <sup>-2</sup> )		0.279		
F – Statistics		28.028		
F – Probability		0.000		
Durbin-Watson stat		2.412		

Decision Rule: If  $F_{cal} > F_{tab}$  accept the alternate and reject Null hypothesis. Otherwise accept the null hypothesis. (\*\*\* = 1%), (\*\* = 5%), and (\* = 10%) denotes significance of coefficient at level respectively, t-tab value = 1.972, df = 118, Dependent Variable: efficiency (Y), Predictors: (Constant), emarketin (X). **Source: Field Survey, 2024 (SPSS Version 23)**

The estimate value of e-marketing (X<sub>1</sub>) was statistically significant and positively related to efficiency of fruits and vegetables dealers at 1 percent level. Thus, a unit increase in e-marketing adoption leads to 0.396 unit increase in efficiency of fruits and vegetables dealers. The result revealed that at  $p=0.000 \leq 0.05$  level of significance and a degree of freedom (df) 118, the T-cal value was 5.199 and T-tab value was 1.972. As shown in the result, the calculated T-calculated is greater than the tabulated t-distribution, therefore, the null hypothesis was rejected in favour of the alternate hypothesis. This means that, there is significant effect of e-marketing on efficiency of fruits and vegetables dealers. The (R<sup>2</sup>) coefficient of multiple determinations was high with the value of 0.286, implying that, 28.6% disparity in dependent variable was elucidated by changes in the independent variable while 71.4% were unexplained by the stochastic variable. This implies that, the independent variable (e-marketing) was able to explain 28.6 percent disparities in dependent variable (efficiency of fruits and vegetables dealers) while 71.4 percent was explained by the stochastic variable. The R<sup>-2</sup> adjusted value of 27.9% was observed indicating a goodness of fit of the regression model adopted in this study which is statistically significant at 5% probability level. The Durbin-Watson stat value was 2.412 which is close to 2.5, implying that

there is no evidence of autocorrelation. F-stat value of 28.028 with F-prob. value of 0.000 against 1.972 t-table value and 0.05 was observed from the regression result, indicating a goodness of fit of the regression model adopted in this study which is statistically significant at 5% probability level. Thus, the researcher accepted that there is a significant effect of e-marketing on efficiency of fruits and vegetables dealers in the study area.

## 5.0 CONCLUSION

In Nigeria, enormous quantities of vegetables and fruits are produced and staggering figures are sometimes given as estimated annual production. For example, figures like 10.8million loads of cucumber, 16million tons of tomatoes, 35million tons of pineapples and 56million tons of citrus have been quoted as annual production levels for some fruits and vegetables, which are really large quantities of food crops (Olukosi & Isitor, 2020). However, it is the amount of the produce available to the buyers rather than the level of production that is more important. Thus, this study was conducted to effect of e-marketing on efficiency of fruits and vegetables supply chain in Akwa Ibom State. The empirical result revealed that Facebook (46.7%) and WhatsApp (43.3) ranked 1<sup>st</sup> and 2<sup>nd</sup> respectively as the most used e-marketing tools among fruits and vegetables agribusiness supply chain partners in the study area. Also, affordability of smart phone, digital literacy and limited internet connectivity are the major limitations affecting e-marketing application among fruits and vegetables supply chain. Lastly, there is a significant effect of e-marketing on efficiency of fruits and vegetables dealers in the study area.

## 6.0 RECOMMENDATIONS

From the findings of the study, the following recommendations are put forward:

- (i) fruits and vegetables dealers should prioritize Facebook and WhatsApp as primary e-marketing channels, leveraging their widespread adoption among supply chain partners. And there is need to create engaging, informative content (e.g., text, images, videos) tailored to the specific needs and interests of supply chain partners, increasing the likelihood of successful marketing outcomes.
- (ii) fruits and vegetables dealers need to collaborate with smartphone manufacturers, government agencies, or NGOs to offer subsidized smartphones, making them more affordable for supply chain partners. Also, need for Digital Literacy Training: Develop and implement comprehensive digital literacy training programs, focusing on e-marketing skills, to enhance the proficiency of supply chain partners.
- (iii) Offline E-Marketing Alternatives: Explore offline e-marketing solutions, such as SMS-based marketing or mobile app-based platforms that can function with limited internet connectivity, to ensure continuity of e-marketing efforts.
- (iv) fruits and vegetables dealers should provide specialized training and workshops for dealers to develop their e-marketing skills, ensuring they can effectively leverage digital platforms to improve business efficiency.

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# **MEDIA INFLUENCE ON PUBLIC PERCEPTION OF GREEN INFRASTRUCTURE AND SUSTAINABLE URBAN PLANNING**

**Titilayo Olufunmibi ADEWALE-OJO**

**Department of Mass Communication**

**Ogun State Institute of Technology, Igbesa, Ogun State Nigeria**

**Email: [adewaleojo.titilayo@ogitech.edu.ng](mailto:adewaleojo.titilayo@ogitech.edu.ng)**

## **ABSTRACT**

*Green infrastructure and sustainable urban planning play crucial roles in mitigating urban environmental challenges such as climate change, air pollution, and resource depletion. However, public perception significantly influences the adoption and implementation of these strategies, with media playing a central role in shaping discourse, awareness, and policy support. This study employs a survey method, utilizing in-depth interviews and focus group discussions with urban residents, policymakers, and environmental journalists within Nigeria. Findings indicate that media narratives, framing, and social media discourse influence public perception, either fostering support for green infrastructure or reinforcing skepticism. The study highlights the need for strategic environmental communication to enhance public engagement with sustainable urban planning.*

**KEYWORDS:** Green Infrastructure, Sustainable Urban Planning, Media Influence, Public Perception.

## INTRODUCTION

Urbanization has led to increased environmental challenges, including air pollution, climate change, and loss of green spaces. Green infrastructure—such as parks, green roofs, and sustainable drainage systems—offers solutions that enhance urban resilience. However, the success of these initiatives largely depends on public awareness and acceptance, which are influenced by media representations.

Media channels, including newspapers, television, online platforms, and social media, shape public discourse on environmental sustainability. They highlight issues, frame narratives, and influence public attitudes toward green policies. In many cases, media serve as the primary source of information for the public, determining which environmental issues gain prominence. The framing of these issues often dictates whether the public views green infrastructure positively or negatively.

Historically, media coverage of environmental sustainability has fluctuated depending on political, economic, and social circumstances. While some media outlets advocate for greener policies, others downplay their significance due to political affiliations or economic interests. Studies have shown that news reports can either simplify or complicate environmental messages, affecting how well the public understands and supports green initiatives (Leiserowitz et al., 2020). Additionally, the rise of social media has changed how information is disseminated and consumed, introducing both opportunities and challenges in influencing public perception.

Despite efforts to promote green infrastructure, misinformation remains a significant challenge. Some reports exaggerate costs and logistical difficulties, creating skepticism among the public. Meanwhile, investigative journalism has been instrumental in uncovering environmental mismanagement, bringing to light the consequences of unsustainable urban development. However, such coverage is not always consistent, which can lead to fluctuating public interest.

Given the critical role of media in shaping opinions, it is essential to explore how different media formats, framing techniques, and agenda-setting strategies influence public perceptions of green infrastructure. This study aims to assess the impact of traditional and digital media on sustainable urban planning awareness, investigating whether media narratives foster public engagement or reinforce resistance to green policies.

## Literature Review

### Conceptual Framework

#### Green Infrastructure

Green infrastructure refers to a network of natural and semi-natural elements such as parks, urban forests, green roofs, and permeable pavements that provide environmental, social, and economic benefits (Benedict & McMahon, 2018). Research highlights its role in urban sustainability, particularly in mitigating climate change and improving air quality. It is a network of natural and built systems that work together to address climate change and urban challenges. There are various benefits of green infrastructure which includes...(1) Climate adaptation – Green adaptation can help cities adapt to climate change. (2) Storm water management – Green infrastructure can reduce the amount of storm water that flows into sewer systems and surface waters. (3) Biodiversity – Green infrastructure can enhance biodiversity and create habitats for plants and animals. (4) Air quality – Green infrastructure can improve air quality. (5) Energy

production – Green infrastructure can support sustainable energy production. (6) Quality of life – Green infrastructure can improve quality of life.

### **Sustainable Urban Planning**

Sustainable urban development refers to the process of creating livable and environmental-friendly urban areas while addressing economic, social and environmental challenges. It intends to achieve a balance between the needs of the community and the natural environmental.

Sustainable urban planning integrates ecological, social, and economic considerations into city design and governance (Beatley, 2020). Studies suggest that successful implementation relies on public awareness and policy support.

#### **Promote local employment and sustainable economic growth, and quantify impact**

Urban planning should involve a comprehensive economic impact assessment including estimates of the project's total employment creation and impact on economic growth. The plan should consider job placement programs for local relocated households. Renovation of areas with shantytowns shall take into consideration local characteristics.

#### **Actively promote development of underground spaces**

The development of underground space shall conform to goals and control requirements of the city master plan. The construction of newly planned roads in urban new districts, industrial parks, and contiguous development zones must be paired with construction of the utility tunnels network. For urban renewal areas, especially older districts, construction of subways, river canal water treatment, street improvements, renovation of older structures, and renovation of shantytown districts, shall promote utility tunnels. On the other hand, to improve the development efficiency of ground and underground spaces, the plan should address the overall layout and planning of underground commercial spaces and underground transportation facilities and hubs. Underground space planning should be compatible with the development of the urban core functional area and urban renewal area, including projects of urban commercial zones, cultural and entertaining facilities, and business centers

#### **Media Influence on Public Perception**

Media influence on public perception through agenda-setting, framing, and priming effects (McCombs & Shaw, 1972). The portrayal of green infrastructure in mass and digital media affects public attitudes and policy advocacy.

## **Theoretical Framework**

### **Agenda-Setting Theory**

Agenda-setting theory posits that media shape public opinion by determining which issues receive attention (McCombs & Shaw, 1972). Agenda-setting, originally coined by Walter Lippmann in the 1920s and further developed by Bernard Cohen in the 1960s, refers to the deliberate influence wielded by the news media in determining what the audience hears, sees, and discusses. Maxwell McCombs and Donald

Shaw formalized this concept through a study on the 1968 American presidential election, revealing a relationship between media coverage and public perception of significant issues.

Rogers (1988) asserts that the theory posits the media's ability to shape public opinion by prioritizing certain issues, thereby establishing a hierarchy of news significance. Mediadriven agenda-setting is susceptible to biases in politics, the economy, culture, and other factors (McCombs, 2005). In the context of green infrastructure, media coverage can influence public discourse and policymaking.

### **Framing Theory**

Framing theory examines how media present environmental issues, affecting how audiences interpret and respond to information (Boykoff, 2019). Positive or negative framing of green infrastructure initiatives influences public engagement levels.

### **Empirical Review**

Empirical studies have explored the role of media in shaping public perception of green infrastructure and sustainable urban planning. The following studies provide insights into the impact of media on environmental awareness and policy support:

Aina (2021) studied how media representation affected public responses to urban flooding in Nigeria. The findings highlighted the importance of accurate reporting in mitigating misinformation and influencing proactive environmental behavior.

Benesch (2021) analyzed the role of solutions journalism in promoting climate action. The study revealed that constructive news coverage fosters increased public participation in green initiatives and policy advocacy.

Boykoff (2019) investigated climate communication framing, demonstrating how positive and negative portrayals of environmental issues impact audience engagement and sustainability efforts.

Benedict & McMahon (2018) explored how media advocacy influenced public and governmental support for green infrastructure adoption, emphasizing the role of agenda-setting in policy formulation.

Schäfer (2020) studied the role of social media in climate change discussions, identifying both its effectiveness in raising awareness and its potential to spread misinformation.

McCombs & Shaw (1972) provided foundational insights into media agenda-setting, detailing how public opinion on environmental issues is shaped by media prominence and framing.

Beatley (2020) investigated media representation of urban sustainability policies, underscoring the need for improved media literacy to counteract misleading narratives.

Boykoff & Roberts (2020) analyzed disparities in media attention to environmental justice issues, revealing biases in coverage and their impact on public engagement with sustainability efforts.

## **Methodology**

The design or method adopted in this paper was survey method explored the public perception through in-depth interviews and focus group discussions. A qualitative research design was adopted to understand how individuals interpret media messages related to green infrastructure. This approach allows for deep insights into public attitudes and concerns.

## **Discussions**

### **Media Framing of Green Infrastructure**

Findings indicate that media framing significantly influences public perception. Participants expressed that:

Positive media coverage emphasizes the economic and health benefits of green infrastructure, fostering public support.

Negative framing, often focusing on cost and land acquisition issues, generates skepticism.

Neutral reporting, which lacks in-depth analysis, leads to public indifference.

### **Public Awareness and Media Consumption Patterns**

Participants' responses highlighted the following trends:

Traditional media (television and newspapers) are trusted sources but offer limited coverage.

Social media serves as a primary information source, but misinformation is prevalent.

Many respondents felt disconnected from policy discussions due to technical jargon in media reports.

### **Role of Social Media in Public Engagement**

Social media platforms played a dual role:

Amplifying awareness through viral campaigns and citizen journalism.

Spreading misinformation, leading to confusion about green projects' effectiveness and costs.

Participants emphasized the importance of engaging environmental experts on social media to counter misinformation.

### **Policy Influence and Media Agenda-Setting**

Interviews with policymakers revealed that sustained media coverage often pushes environmental policies onto political agendas. However, sporadic attention to green infrastructure limits long-term policy support.

## Challenges in Media Representation

Key challenges are...

Sensationalism and misinformation in online media.

Short-term media attention on sustainability topics.

Lack of accessibility, with technical language excluding marginalized communities.

Participants suggested simplified and localized reporting to improve engagement with green infrastructure initiatives.

## Conclusion

The study demonstrates that media significantly shape public perception of green infrastructure and sustainable urban planning. While positive media coverage fosters support, misinformation and negative framing create skepticism. Social media serves as both an awareness tool and a misinformation platform, necessitating media literacy initiatives.

## Recommendations

While this study provides valuable insight into Media Influence on Public Perception of Green Infrastructure and Sustainable Urban Planning, it is limited in its scope. Future studies could explore the following areas:

Media Organizations should adopt solutions journalism to emphasize successful green projects rather than focusing on conflicts.

Government and NGOs should make use of digital media campaigns to enhance public engagement.

Public Education should be introduced to improve media literacy programs to help citizens critically evaluate environmental news.

Implement fact-checking mechanisms on social media to counter misinformation.

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# **ARCHITECTURE OF AN ADVANCED SOFTWARE EVALUATION DSS USING MULTICRITERIA WEIGHTED SUM ALGORITHM**

**Benjamin, Ubokobong Effiong<sup>1</sup>, Prof.E.E. Ogheneovo <sup>2</sup> & Prof. B. O. Eke <sup>3</sup>**

**<sup>1,2,3</sup> Department of computer science University of Port Harcourt Nigeria**

## **ABSTRACT**

*The increasing complexity and variety of software solutions in modern industries necessitate effective decision-making tools to assist organizations in evaluating and selecting the most appropriate software for their needs. This paper explores the architecture of an advanced software evaluation decision support system (DSS) employing the Weighted Sum Algorithm (WSA) for multi- criteria decision analysis (MCDA). The system provides an efficient and transparent method for evaluating software based on multiple criteria, helping decision-makers prioritize factors such as performance. This paper examines Architecture of an advanced software evaluation DSS using Weighted Sum, usability, cost, and technical support. The paper also discusses the integration of various decision-making factors, data collection methods, and the system's implementation, while highlighting its effectiveness in supporting complex decision-making processes in real-world scenarios.*

**KEYWORDS:** Software evaluation, decision support system, Weighted Sum Algorithm, multi-criteria decision analysis, decision- making

## INTRODUCTION

The selection of the right software solution is one of the most critical decisions that organizations face, particularly in highly competitive industries. As the number of software products increases, choosing the optimal solution based on multiple criteria becomes increasingly complex. Decision support systems (DSS) are often employed to aid this process by providing a structured, data-driven approach to evaluating software options (Jafari, 2020). One of the most widely used methods for evaluating software based on multiple criteria is the Weighted Sum Algorithm (WSA), a technique in multi-criteria decision analysis (MCDA). An advanced software evaluation Decision Support System (DSS) using Weighted Sum Algorithm is profitable for determining best software alternative to go for. In the software market, there are numerous software for solving real life problems, however, the problem remains to choose the software that best solves the problem with least effort and high performance. There are few studies to determine software effectiveness and this does not encourage software developers and vendors to come up with highly productive software or to quickly identify flaws in their software for patches or update. Most software cost hundreds of thousands and even millions of naira, purchasing a software solution is a high expenditure activity that consumes a significant portion of companies' capital budget. Selecting the right solution is an exhausting process for companies. Therefore, selecting a software package that meets the requirements needs a full examination of many conflicting factors and it is a difficult task. Most times the software bought do not meet the needs of the institution or organization despite the huge amount. To avoid the problem of software ineffectiveness, this has led researchers to investigate better ways of evaluating and selecting software packages. Other problems that necessitated this research work are: not every software is easily usable due to usability flaws, security flaws, high cost and low benefits when considering cost-benefit analysis low benefits when considering cost-benefit analysis, without proper study it will be difficult to identify flaws in software application earlier and this can make an organization waste a lot of money which can make the firm to go bankrupt or close down abruptly and finally, Software users need to know the best application software to use to solve their problems and maximize profit where need arises. This is achieved using software evaluation decision support systems.

Decision Supports Systems (DSS) are computer-based information systems designed in such a way that helps managers to select one of the many alternative solutions to a problem. It is possible to automate some of the decision making processes in a large, computer-based DSS which is sophisticated and analyze huge amount of information fast. It helps organizations to increase market share, reduce costs, increase profitability and enhance quality. The nature of problem itself plays the main role in a process of decision making. A DSS is an interactive computer based information system with an organized collection of models, people, procedures, software, databases, telecommunication, and devices, which helps decision makers to solve unstructured or semi-structured business problems. Adopting decision support system to software evaluation guarantees accurate evaluation of the software (Del Vasto-Terrientes, Valls, Slowinski & Zielniewicz, 2015). Frequently employed approaches for evaluating and selecting components include the usage of simple scoring and weighted sum approaches, the Analytic Hierarchy Process (AHP), or iterative filtering.

### **Adopting Decision Support System (DSS) for Software Evaluation**

A DSS is an interactive computer based information system with an organized collection of models, people, procedures, software, databases, telecommunication, and devices, which helps decision makers to solve unstructured or semi-structured business problems. Adopting decision support system to software evaluation guarantees accurate evaluation of the software (Del Vasto-

Terrientes, Valls, Slowinski & Zielniewicz, 2015). Evaluation as a general endeavor can be characterized by the following features: Evaluation is a task, which results in one or more reported outcomes, evaluation is an aid for planning, and therefore the outcome is an evaluation of different possible actions and finally evaluation is goal oriented. The primary goal is to check results of actions or interventions, in order to improve the quality of the actions or to choose the best action alternative. Evaluation is dependent on the current knowledge of science and the methodological standards. Evaluation as an aid for software development has been applied since the last decade, when the comprehension of the role of evaluation within Human-Computer Interaction had changed. The activities “Task analysis”, “Requirement specification”, “Conceptual and formal design”, “Prototyping”, “Implementation” are each supplemented by an activity “Evaluation” which helps to decide progression to the next step. Software can be evaluated with respect to different aspects, for example, functionality, reliability, usability, efficiency, maintainability, portability (Benjamin, 2019). Adopting decision support system to software evaluation guarantees accurate evaluation of the software. Making decisions concerning software evaluation often strains our cognitive capabilities. Even though individual interactions among a system's variables may be well understood, predicting how the system will react to an external manipulation such as policy decision is often difficult. Many variables are involved in complex and often subtle interdependencies and predicting the total outcome may be daunting. There is a substantial amount of empirical evidence that human intuitive judgment and decision making can be far from optimal, and it deteriorates even further with complexity and stress. Because in many situations the quality of decisions is important, aiding the deficiencies of human judgment and decision making has been a major focus of science throughout history. Applying decision support systems to software evaluation therefore is a very important research area (Dias, Passeira, Malça & Freire, 2016).

### **Weighted Average Sum (WAS) Software Evaluation Technique**

Another technique used for evaluation of software package is the weighted scoring method. In this method weights and rating scales are assigned to each criterion. The weight reflects the relative importance of each of the criteria while the rating scale indicates how easily each package is able to meet the specific criterion. The rating scales are then multiplied by weight factor of each criterion. Using this scheme a score is calculated for every criterion for each tool. These scores are then totaled to produce a score for each criteria category and the average is also computed. Finally, the categorical scores are compared to determine the highest (Benjamin, 2019).

The overall score for an alternative, is the weighted sum of the criteria utilities aggregated across the hierarchy of objectives. This approach combines objective evidence measured in specific scales, subjective assessment represented in explicitly defined scenario-specific utility functions, and relative weights across the goal hierarchy. As such, it is a flexible model, but it requires a profound understanding of the intricacies of decision making scenarios. Furthermore, a careful distinction between the key concepts of evidence, utility, and weighting is expected from the decision maker (Rafique & Mišić, 2019).

### **Scoring Values:**

The key to using weighted average sum is the raw score values. By using a defined and understood set of discrete values, the subjectivity of the evaluation is significantly reduced. In the prior examples, the raw values were based on the information shown in Table 2.2 There are only five values used, ranging from 1.0 to -1.0 in increments of 0.5. Note the use of negative values and the effects on the scoring. Instead of just assigning a value of 0, the use of negative values permits the application of a “penalty” value where not meeting the criterion would be detrimental. There

are many different methods for deriving risk values, but descriptions of these methods are out of scope for this report. Additional references on risk can be found in the bibliography. Regardless of which risk calculation method you choose to follow, it is important to keep in mind that the scoring mechanism presented above is based on a “higher is better” score, and most risk calculations are based on a “lower is better” score. The two methods should be used individually and not combined into a single score for evaluation purposes. One consideration that must be addressed is how to handle scoring variances. Each potential evaluator has different experiences and perceptions that will ultimately affect the scoring. When using individual evaluators, the organization must have a scoring process that addresses (1) what constitutes a variance and (2) how to handle the differences in the scoring. Many organizations that use a similar process for evaluations will set a fixed value (e.g., less than 2 points on a 10-point scale) or a fixed percentage (e.g., 10% or more). When a scoring variance (or scoring split) occurs, the evaluators having a variance would then address the areas in the scoring that differed from the other evaluators. After the evaluators affected by the split have discussed their scoring and the rationale, each evaluator would take into consideration the new information and rescore the product (Miljković, Žižović, Petojević & Damljanović, 2018). For example, when performing an evaluation on a product, Evaluator A gives the product a total score of 78%, and Evaluator B gives the product a total score of 90%. Assuming the scoring process defines a split as 10% or more difference in scoring, both evaluators would discuss their individual scores for each range of criteria and their rationale for the individual scores; they would then rescore the product in the area(s) that differed until the scoring split was resolved.

#### **Strengths of Weighted Average Sum Software Evaluation Technique:**

- i. Main advantage of WAS is its ease of use.

#### **Weaknesses of Weighted Average Sum Software Evaluation Technique:**

- i. Weights to the attribute are assigned arbitrary and it is very difficult to assign weight when number of criteria is high.
- ii. To obtain a score using this method a common numerical scaling is required.
- iii. Difficulties emerge when WAS is applied to multi-dimensional MCDM problems

#### **System Architecture of DSS for Software Evaluation**

The architecture of the software evaluation DSS using WSA consists of several key components: data collection, criteria weighting, alternative scoring, aggregation and decision-making, and reporting.

**1. Data Collection Module:** The first step in the evaluation process involves the collection of data about various software alternatives. This typically includes both quantitative and qualitative data, such as performance metrics, costs, user ratings, technical support quality, and feature set. The data can be sourced from software documentation, expert reviews, end-user feedback, or direct trial runs of the software (Vargas & Alvarado, 2017). The data collection module is responsible for ensuring that the data is accurate, reliable, and up-to-date. It may integrate with existing databases or external systems that provide information about available software solutions. In some cases, manual entry by evaluators may be required for specialized or niche software options.

**2. Criteria Weighting:** In WSA, decision-makers must assign weights to each evaluation

criterion based on its relative importance. The weighting of criteria reflects the priorities of the organization or the specific needs of the project (Chakraborty et al., 2013). For example, an organization may prioritize usability over cost if the software will be used by non-technical staff.

3. **Alternative Scoring:** Once the criteria weights have been established, the next step is to score each software alternative on each criterion. The scoring process evaluates how well each software option satisfies the defined criteria (Vargas & Alvarado, 2017). These scores may be numerical or qualitative and could be derived from user ratings, expert evaluations, or performance benchmarks. The scoring module aggregates data from various sources to generate scores for each alternative. In cases where the data is subjective, the module may employ normalization techniques to ensure consistency in scoring.

4. **Aggregation and Decision-Making:** The core of the system's architecture is the application of the WSA to aggregate the scores and determine the most suitable software. The WSA operates by multiplying the score for each alternative by the weight of the corresponding criterion and then summing these weighted scores to arrive at an overall score for each alternative (Jafari, 2020). The formula for the WSA is as follows:

Where:

$$S = \sum_{i=1}^n (w_i \times s_i)$$

- S is the overall score of an alternative,
- $w_i$  is the weight assigned to criterion  $i$ ,
- $s_i$  is the score of the alternative on criterion  $i$ ,
- $n$  is the number of criteria.

The alternatives are ranked according to their total scores, and the highest-ranking software is recommended. This transparent and objective approach helps minimize bias and ensures that decision-making is based on data rather than intuition.

5. **Reporting and Visualization:** The final component of the system is the reporting and visualization module. This component provides users with clear, comprehensible results that summarize the evaluation process. The system generates visualizations such as bar charts, radar charts, or decision matrices that display how each software alternative performed relative to the weighted criteria (Chakraborty et al., 2013). These reports help decision-makers understand the rationale behind the recommendations and facilitate discussions about trade-offs between different criteria.

## Application and Benefits

The architecture described here is adaptable to various domains and industries. For example, in the healthcare sector, software evaluation might prioritize security and compliance with regulations, whereas in the education sector, ease of use and cost might be more important. By providing a systematic, data-driven approach to software selection, the DSS using the WSA helps organizations make informed decisions that align with their strategic goals and operational requirements. The use of WSA also provides several benefits over traditional methods of software evaluation, such as manual comparison or expert judgment. It offers consistency, transparency, and the ability to handle complex, multi-dimensional data. Additionally, it supports collaboration among multiple stakeholders by allowing them to input their preferences and perspectives, which can lead to more robust decision-making outcomes (Vargas & Alvarado, 2017).



## Software Architecture Evaluation

The software architect assembles component performance models from the repository for a planned architecture. This includes specifying the wiring of the components (assembly model), specifics of the component platform and hardware (deployment model), and the usage information, such as workload, input parameters, and internal state (runtime model). Service performance specifications potentially have to abstract from the actual performance behaviour of a component, to remain analyzable in an acceptable amount of time. The component developer creating a service performance specification must make a trade-off between the accuracy of the specification and its analysability (Kuwajima & Ishikawa, 2019). Babar et al., (2015), conducted a study on a framework for classifying and comparing software architecture evaluation methods. The researchers opined that different software engineering communities have developed different techniques for characterizing their respective quality attributes and the methods to evaluate software systems with respect to that particular quality attribute, e.g., real-time, reliability, and performance. These assessment techniques study a specific quality attribute in isolation. In reality, however, quality attributes interact with each other. For example, there is generally a conflict between configurability and performance; performance also impacts modifiability, availability affects safety, security conflicts with usability, and each quality attribute impacts cost. That is why it is important to find an appropriate balance of quality attributes in order to develop a successful product. One of the most significant features of method differentiation and classification is the number of quality attributes a method deals with.

The software architecture (SA) evaluation methods specifically studied by (Babar et al., 2015) are: Scenario-based Architecture Analysis Method (SAAM), Architecture Tradeoff Analysis Method (ATAM), Active Reviews for Intermediate Design (ARID), SAAM for Evolution and Reusability (SAAMER), Architecture-Level Modifiability Analysis (ALMA), Architecture-Level Prediction of Software Maintenance (ALPSM), Scenario-Based Architecture Reengineering (SBAR), SAAM for Complex Scenarios (SAAMCS), and integrating SAAM in domain-Centric and Reuse-based development (ISAAMCR). These are scenario-based methods, a category of evaluation methods considered quite mature. There are also some attribute model-based methods and quantitative models for SA evaluation, but, these methods are still being validated and are considered complementary techniques to scenario-based methods. There is, however, little consensus on the technical and non-technical issues that a method should fully address and which of the existing methods is most suitable for a particular issue. There is not much work done on systematic classification and comparison of the existing methods. Moreover, there is not much guidance on the desirable features of the evaluation methods and their usefulness.

Software Architecture (SA) evaluation can be performed for a number of purposes, e.g., risk assessment, maintenance cost prediction, architecture comparison, trade-off analysis and so forth. No one method can be considered as equally good for all types of assessment objectives as different methods are optimized to achieve different evaluation goals. The common goal of most of the evaluation methods is to evaluate the potential of the designed architecture to facilitate or inhibit the achievement of the required quality attributes. For example, some architectural styles, e.g., layered architectures, are less suitable for performance sensitive systems, even though they usually result in highly flexible and maintainable systems. In order to achieve maximum benefit from an assessment activity, the goals of the evaluation need to be explicitly defined. The goals of assessment help software architect make a number of critical decisions with regard to selection of a specific method and deliverable required. There is at least one common goal found in all surveyed methods, which is prediction-based assessment of the quality of a system at the

architecture level. However, each method has a specific view and different approach to achieve the goal: SAAM and its variants (specifically SAAMCS and ISAAMCR) are mainly geared to identify the potential architectural risks. However, SAAMCS focuses on exposing the boundaries of SA with respect to flexibility using complex scenarios, while, ISAAMCR integrates SAAM in domain-centric reusable development process; SAAMER evaluates the designed SA for evolution and reusability and provide a framework for SA analysis; ALMA specializes in predicting one quality attribute (i.e., modifiability) and there are three possible objectives to be pursued: risk assessment, maintenance cost prediction, and SA comparison; ARID performs suitability analysis of intermediate design artifacts; ATAM identifies and analyses sensitivity and trade-off points as these can prevent the achievement of a desired quality attribute.

### **Architecture of an Advanced Software Evaluation Decision Support System using Weighted Sum Algorithm**

Benjamin (2019) implemented an evaluation system that provide a grading or evaluation interface that will enable users carry out software evaluation of different software that are of the same application category. The advanced software are evaluated side by side (A and B). The system will also provide expert system remark after assessment. The evaluation was done based on five different criteria which are:

1. Vendor evaluation
2. Hardware/software evaluation
3. Cost/benefits evaluation.
4. Security evaluation
5. Reliability evaluation
6. Integrity Test

Each criterion for software evaluation outline above has sub-criteria that will be assigned evaluation rating values ranging from 2 to -2. At the end, the total sum is computed and the percentage sum is also computed. Expert system remark is also provided indicating which software is better.

## Proposed decision support system for software evaluation Architecture



## Use Case Model of an Advanced Software Evaluation Decision Support System using Weighted Sum Algorithm

The Use Case Model describes the proposed functionality of the new system. A Use Case represents a discrete unit of interaction between a user (human or machine) and the system. A Use Case is a single unit of meaningful work; for example, login to system, register with system, etc. Each Use Case has a description which describes the functionality that will be built in the proposed system. A Use Case may 'include' another Use Case's functionality or 'extend' another Use Case with its own behaviour. Use Cases are typically related to 'actors'. An actor is a human or machine entity that interacts with the system to perform meaningful work. The use case model of an advanced decision support system using weighted sum technique is presented below.

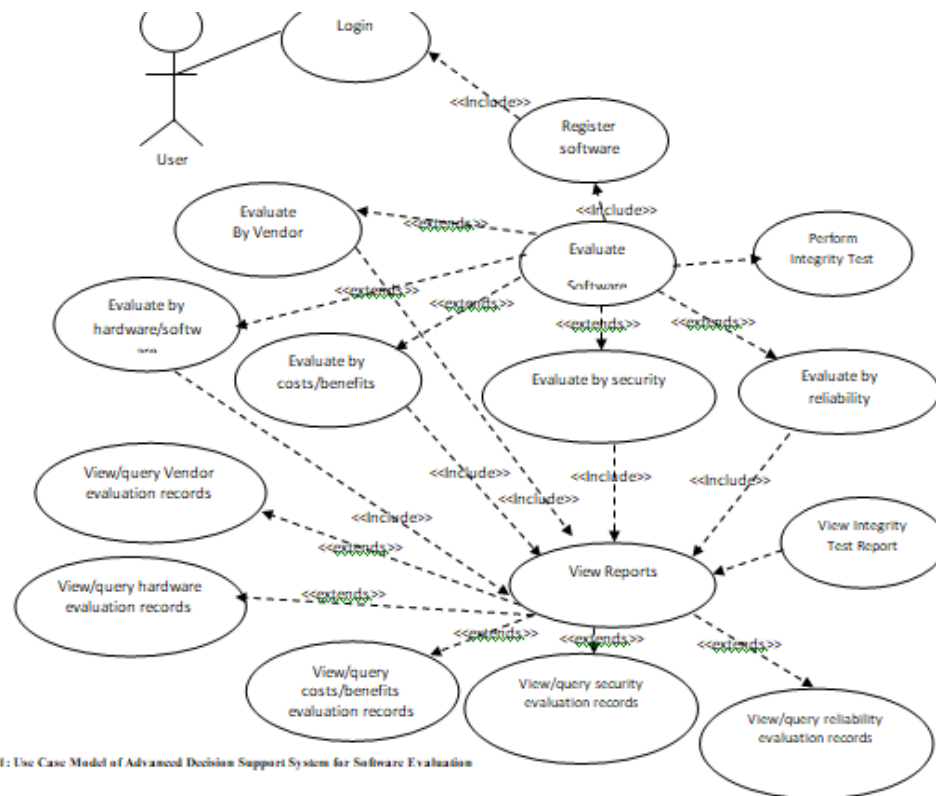


Fig 1: Use Case Model of Advanced Decision Support System for Software Evaluation

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**Fig 1: Use Case Model of Advanced Decision Support System for Software Evaluation**

## Conclusion

The architecture of an advanced software evaluation decision support system using the Weighted Sum Algorithm provides a structured and transparent approach to evaluating software alternatives. By integrating data collection, criteria weighting, alternative scoring, aggregation, and reporting, the system supports complex decision-making processes in real-world scenarios. The use of WSA enhances the objectivity and consistency of the evaluation process, making it a powerful tool for organizations seeking to select the best software solution based on multiple criteria. Software evaluation was revealed to be the process of assessing the quality of different software systems so as to choose the most productive one. Evaluating and selecting software packages that meet an organization's requirements is a difficult software engineering process. Selection of a wrong software package can turn out to be costly and adversely affect business processes, making it very imperative to have an evaluation system. Software evaluation is important as it enables Software companies and individuals/organizations that make use of software to make sure they provide software solutions that are reliable and can meet the needs of users. This cannot be achieved without an effective decision support system for software evaluation. The need to evaluate the reliability of software system has become clearer in this era of intensive software application in different sectors of life. Many papers provide a preferred list of evaluation criteria for evaluation of specific software package; however, a lack of common list is apparent. Software evaluation criteria may differ from one evaluator to another. The exact meaning of a criterion is open to the evaluator's own interpretation. Sometimes the terminology used by author(s) for a criterion in one literature is different than another author(s) for the same criterion. This may lead to ambiguity and gives unclear picture to the evaluator. A common and effective evaluation technique than can be adopted by software evaluators to determine the

effectiveness of the software is weighted sum evaluation technique. In this approach values or weights are assigned to the criteria used in determining the effectiveness of the software and the total weight is used to determine which is more effective than the other.

An advanced decision support system for software evaluation enables the determination of the best software alternative. Weighted sum evaluation technique can be adopted to easily ascertain the effectiveness of software based on defined criteria. From the foregoing, it can be seen that, requirements drive selection criteria, careful consideration must be given to the identification of selection criteria, pilots and demonstrations are essential selection tools, product and technology maturity must be considered. By systematically analyzing co-occurrence, correlation and impact of decision criteria across cases, it should be possible to integrate recommender systems into the decision making workflow that can provide increased guidance and warn decision makers of potential risks and opportunities based on others' experiences.

### **Recommendations**

The following recommendations are offered based on the study:

1. More research should be encouraged on decision support system for software evaluation/assessment.
2. Software development companies should conduct survey programs to assess the reliability of their software product.
3. Raw data used for the assessment should be obtained from users of the software system.
4. The criteria utilized in making decision on the effectiveness of a software should be expanded to include more aspects so as to improve the reliability information.
5. Proper testing and debugging should be done before software systems are published or placed in the market.
6. More criteria categories should be added to boost software evaluation and selection.
7. Trial versions of software are important for users to assess the effectiveness of the software.

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