

ORGANIZATIONAL POLITICS AND THE PERFORMANCE OF DEPOSIT MONEY BANKS IN KWARA STATE, NIGERIA

BY

Abu Zekeri, A. A. Salau & Abdulbaki Abdulrazaq

Department of Business and Entrepreneurship, Kwara State University, Malete

E-mail: zekeriabu2007@yahoo.com, abdulazeer.salau@kwasu.edu.ng & abdulbakiabdulrazaq0@gmail.com

Abstract

Organizational politics has remained a pervasive challenge in many corporate environments, often undermining employee morale and institutional efficiency, particularly in the Nigerian banking sector. This study investigated the effect of organizational politics on the performance of deposit money banks in Kwara State, Nigeria, with a specific focus on how tribalism and gender discrimination, used as proxies for organizational politics, affect organizational performance. A descriptive survey research design was adopted, and data were collected using a structured questionnaire administered to a purposive sample of 86 employees drawn from five selected banks within the state. The study employed multiple regression analysis to evaluate the relationship between the variables. Findings revealed that tribalism significantly and negatively affects organizational performance ($R^2 = 0.520$, $F = 69.216$, $p < 0.05$), with both ethnic profiling and favouritism showing significant negative beta coefficients ($\beta = -0.842$, $p = .000$; $\beta = -0.625$, $p = .003$, respectively). Similarly, gender discrimination also significantly undermines performance ($R^2 = 0.621$, $F = 65.010$, $p < 0.05$), with all its indicators—career development discrimination, gender pay gap, and sexual harassment—exerting statistically significant negative effects. The study concludes that unchecked organizational politics in the form of tribal and gender biases compromise efficiency, fairness, and productivity in the banking sector. It recommends the implementation of inclusive HR policies, gender equity initiatives, robust anti-discrimination frameworks, and continuous staff training to foster a merit-driven and equitable work environment.

Keywords: Organizational Politics, Tribalism, Gender Discrimination, Performance

Introduction

Organizational politics has emerged as a significant factor influencing organizational performance. Organizational politics encompasses behaviors that are self-serving and often detrimental to organizational goals, including favoritism, manipulation, and the pursuit of personal agendas over collective objectives. These political behaviors can undermine meritocracy, leading to decreased employee morale and overall performance. In many organizations worldwide, manifestations of organizational politics are evident through practices such as tribalism and gender discrimination. Tribalism, characterized by preferential treatment based on ethnic affiliations, can lead to divisions within the workplace, affecting collaboration and productivity (Agha, 2021). Similarly, gender discrimination, which includes unequal opportunities and biases against individuals based on gender, hampers the utilization of the full talent pool, thereby affecting organizational efficiency and performance (Pepple et al., 2024).

These issues are particularly pronounced in Africa due to the continent's diverse ethnic compositions and deeply rooted cultural norms. Studies have shown that in various African countries, including Nigeria, tribal affiliations often influence hiring decisions, promotions, and access to resources within organizations (Agha, 2021). Gender discrimination is also prevalent, with women frequently underrepresented in leadership positions and facing systemic barriers to career advancement (Pepple et al., 2024). It is worth noted that organizational politics can also have positive outcome in organization. It outcome most often depends on the way and manner of its engagement among managers and subordinates. Cacciattolo (2015) suggests that organizational politics, though generally seen as negative, sometimes it can result to positive outcomes especially when aligned with organizational efficiency.

Focusing on the Nigerian banking sector and that of the Kwara State in particular, these dynamics are equally pertinent. The state's diverse ethnic composition and socio-cultural practices contribute to the entrenchment of tribalism and gender biases within organizational settings, including deposit money banks. These practices potentially hinder optimal performance by fostering environments where merit is secondary to ethnic and gender considerations. Given this backdrop, it becomes imperative to investigate how organizational politics, particularly through the lenses of tribalism and gender discrimination, impacts the performance of deposit money banks in Kwara State.

Statement of the Problem

Organizational politics, particularly tribalism, have emerged as a major challenge undermining the performance and cohesiveness of workplaces in Nigeria's banking sector. Tribalism often manifests through preferential treatment in hiring, promotions, team assignments, and access to resources, primarily based on ethnic affiliations rather than merit or competence (Adegbite & Salami, 2022). In the context of deposit money banks in Kwara State, the multi-ethnic composition of staff and clients presents both an opportunity and a risk for organizational integration. When tribal sentiments influence administrative decisions, employees from perceived minority tribes may experience marginalization, which affects morale, trust, and productivity (Olayemi & Musa, 2023). This systemic favoritism erodes team spirit and fosters internal rivalry, ultimately diminishing organizational performance. Empirical evidence suggests that tribalism not only breeds resentment but also limits innovation and collaboration among employees, which are critical for banking efficiency (Mofokeng & Dlamini, 2022). This necessitates the need for this study to examine how tribalism influences organizational performance in deposit money banks in Kwara State.

Equally concerning is gender discrimination, a persistent form of organizational politics that continues to restrict equal participation of women in leadership, decision-making, and performance evaluations within the banking sector. Despite formal policies promoting gender equality, subtle and overt discriminatory practices such as biased task assignments, pay gaps, limited promotion opportunities, and exclusion from strategic roles remain prevalent (Müller & Schneider, 2023). In the Nigerian context, cultural and organizational norms have historically relegated women to subordinate roles, thereby limiting their contributions to organizational growth and innovation (Wanjiku & Otieno, 2021). Hence, this study will also evaluate the effect of gender discrimination on organizational performance in selected deposit money banks in Kwara State.

Conceptual Review

Organizational politics has been a focal point in organizational behavior studies, with various scholars offering definitions that highlight its multifaceted nature. Understanding these definitions is crucial, especially when examining how specific political behaviors like tribalism and gender discrimination impact organizational performance. Organizational politics is often described as the strategic behavior individuals employ to gain advantage within an organization. According to Amegbe (2023), it encompasses power struggles, maneuvering, and self-interest that significantly affect employee attitudes and productivity. This perspective underscores the manipulative aspects of organizational politics, where personal agendas can override organizational goals. Another definition by Mustafa and Murat, as cited in Olusegun (2019), characterizes organizational politics as informal, parochial, typically divisive, and illegitimate behavior aimed at displacing legitimate power. This view emphasizes the covert and often detrimental actions that disrupt formal organizational structures and processes.

Cacciattolo (2015) offers another perspective, suggesting that while organizational politics is generally seen as negative, it can sometimes lead to positive outcomes if aligned with organizational efficiency. This definition acknowledges that political behavior isn't inherently harmful but becomes problematic when it serves self-interest at the expense of collective goals. These varying definitions converge on the idea that organizational politics involves actions aimed at personal gain, which can disrupt organizational harmony and performance.

Tribalism

Tribalism within organizations refers to the preferential treatment of individuals based on shared ethnic or cultural affiliations, often at the expense of meritocracy and inclusivity. This phenomenon is particularly pronounced in multi-ethnic societies like Nigeria, where ethnic identities significantly influence organizational dynamics and decision-making processes. Various scholars have explored the concept of tribalism in organizations. Umeh et al. (2024) describe tribalism as the manifestation of ethnic favoritism in organizational practices, leading to systemic inequalities and discrimination. Similarly, Agbede and Oparinde (2024) highlight how tribal affiliations can overshadow professional qualifications, resulting in biased recruitment, promotion, and resource allocation. These definitions underscore the detrimental impact of tribalism on organizational fairness and efficiency.

In the Nigerian banking sector, tribalistic behaviors are evident in several forms. One prominent manifestation is the ethnic profiling of banks, where institutions are perceived as being aligned with specific ethnic groups based on the composition of their leadership and workforce. For instance, Fidelity Bank is often labeled as an "Igbo bank," GTBank as a "Yoruba bank," and Jaiz Bank as a "Hausa bank," reflecting the dominant ethnicities of their top executives and board members (Nwagboh, 2022). This perception is reinforced by recruitment practices that favor candidates from the same ethnic background as the existing leadership, leading to homogeneous work environments and limiting diversity. Another form of tribalism in the banking sector is the preferential treatment of clients and stakeholders based on ethnic affiliations. Banks may prioritize services for customers from the same ethnic group or allocate resources in a manner that favors their ethnic counterparts. Such practices not only alienate clients from other ethnic backgrounds but also hinder the bank's ability to operate equitably and efficiently across diverse markets. The relationship between tribalism and performance in the banking sector is complex and multifaceted. Tribalistic practices can lead to a lack of diversity, which stifles creativity and innovation. A homogenous workforce may suffer from groupthink, reducing the organization's adaptability and problem-solving capabilities. Moreover, when employees perceive that promotions and rewards are based on ethnic affiliations rather than merit, it can lead to decreased motivation, job dissatisfaction, and high turnover rates (Umeh et al., 2024).

Gender Discrimination

Gender discrimination in the workplace refers to the unequal treatment or perceptions of individuals based on their gender, leading to disparities in hiring, promotion, compensation, and other employment aspects. This discrimination can manifest overtly or subtly, often rooted in societal norms and organizational cultures that perpetuate gender biases. Various scholars have explored the concept of gender discrimination. Ajede and Onyeonoru (2021) define it as the systemic barriers that hinder women's career advancement, particularly in male-dominated industries. They emphasize that these barriers are not solely due to overt discrimination but also stem from organizational structures and cultures that favor male career trajectories. Similarly, the concept of second-generation gender bias highlights subtle forms of discrimination, such as the expectation for leaders to be assertive—a trait traditionally associated with men—which can disadvantage women who exhibit collaborative leadership styles.

In organizational settings, gender discrimination manifests in various forms. One prevalent form is the "glass ceiling," an invisible barrier that prevents women from ascending to top leadership positions. Despite constituting a significant portion of the workforce, women are underrepresented in executive roles. For instance, in Uganda's banking sector, while women make up over 51% of employees, only 24% hold chief executive roles, and 31% are part of management committees (Uganda Bankers Association, 2024). Another form is the gender pay gap, where women earn less than their male counterparts for similar roles. In Australia, major banks like Morgan Stanley, UBS, and Bank of America reported gender pay gaps exceeding 40%, significantly higher than the national average of 19% (Financial Times, 2023).

Sexual harassment is also a pervasive issue. A notable case involves a managing director at Citigroup who filed a lawsuit alleging years of sexual harassment and the bank's failure to protect her from abuse, highlighting a culture of pervasive gender discrimination within the organization (Reuters, 2024). In the banking sector, gender discrimination has tangible impacts on organizational performance. Studies have shown that gender-diverse leadership teams contribute to better financial outcomes. Oyidih (2023) found that board gender diversity positively affects the financial performance of listed deposit money banks in Nigeria, suggesting that inclusive leadership can enhance decision-making and organizational effectiveness.

Organizational Performance

Organizational performance is a multifaceted concept that encompasses the efficiency and effectiveness with which an organization achieves its objectives. Over the years, scholars have offered various definitions to capture its complexity. According to Medhi (2021), organizational performance refers to the extent to which an organization fulfills its goals through the optimal utilization of resources. Oleabhiele (2019) emphasizes that performance is not solely about outcomes but also involves the processes and behaviors that lead to those outcomes. In the context of the banking sector, performance is often assessed through financial indicators such as return on assets (ROA), return on equity (ROE), and risk-adjusted returns, as well as non-financial metrics like customer satisfaction and employee engagement (Adekanmbi & Ukpere, 2023).

Several factors enhance organizational performance, particularly in the banking industry. Strategic planning is paramount; it involves setting clear goals, developing strategies to achieve them, and aligning resources accordingly. A study by Nzewi and Ojiagu (2015) found a strong positive correlation between strategic planning and bank performance, suggesting that banks with well-defined strategic plans tend to perform better. Corporate governance is another critical factor. Effective governance structures, including the presence of non-executive directors and robust risk management practices, have been linked to improved bank performance in Nigeria (Olayemi et al., 2023). Conversely, larger board sizes and excessive independence without proper coordination may negatively impact performance.

Employee-related factors also play a significant role. Employee engagement and job satisfaction are imperative for achieving high organizational performance. Engaged employees who are satisfied with their jobs are more likely to be productive, innovative, and committed to organizational goals (Oleabhiele, 2019). Compensation and benefits are critical in this regard; competitive remuneration packages can motivate employees and reduce turnover rates (Putra et al., 2020). Organizational culture and leadership styles further influence performance. A positive organizational culture that promotes diversity, innovation, and open communication fosters higher employee engagement and performance (Almerri, 2023). Supportive and transformational leadership styles have been linked to improved employee performance in the banking sector (Park et al., 2022).

Organizational Politics and Performance

The relationship between OP and organizational performance has been extensively studied, revealing complex dynamics that can significantly impact both individual and organizational outcomes. Recent research indicates that OP negatively affects organizational performance by undermining individual performance. In a study focusing on the Jordanian public sector, Al-Okaily et al. (2024) found that OP significantly and negatively influenced organizational performance, with individual performance mediating this relationship. This suggests that OP diminishes individual performance, which in turn hampers overall organizational effectiveness. Similarly, in the context of Thai local administrations, perceived organizational politics (POP) was found to negatively impact job satisfaction and increase job stress, leading to reduced employee engagement and job performance. The study highlighted that job satisfaction and employee engagement mediated the relationship between POP and job performance, emphasizing the indirect pathways through which OP affects organizational outcomes.

In the tourism and hospitality industry in Egypt, Al-Romeedy and Khairy (2024) demonstrated that POP negatively correlates with employee job performance and positively correlates with workplace stress and counterproductive work behavior (CWB). These findings underscore the detrimental effects of OP on employee well-being and performance, which can cascade into broader organizational challenges. Moreover, research by Castanheira (2022) revealed that OP leads to emotional exhaustion and reduced authenticity among employees, which negatively impacts performance and increases deviant behaviors. These psychological mechanisms further elucidate how OP can erode organizational integrity and effectiveness. Within the Nigerian banking sector, Uche-Esezi-Obilor (2023) identified that poor implementation of sound corporate governance and prevalent organizational politics contributed to suboptimal corporate performance. The study emphasized the need for fairness, accountability, responsibility, and transparency to mitigate the adverse effects of OP. Collectively, these studies illustrate that organizational politics adversely affects performance through various pathways, including diminished individual performance, increased stress, reduced job satisfaction, and the proliferation of counterproductive behaviors. Addressing OP requires comprehensive strategies that promote transparency, equitable resource allocation, and inclusive decision-making to foster a more conducive environment for organizational success.

Theoretical Review

This study is anchored on Social Exchange Theory (SET) which was first proposed by sociologists such as Homans (1958) and Blau (1964), is a foundational theory in organizational behavior that explains human relationships in terms of cost-benefit analyses and reciprocal exchanges. The basic assumptions of SET rest on the idea that social relationships are shaped by reciprocal interdependence. Individuals are not motivated solely by economic gains, but also by psychological and social rewards that come from mutual trust, respect, and fairness (Molm, 2010; Colquitt et al., 2021). The theory assumes that when individuals perceive a fair exchange—such as equitable treatment across gender or ethnic groups—they feel obligated to reciprocate with positive behaviors, such as increased performance, engagement, and commitment to organizational goals. In contrast, when there is a perceived imbalance in this exchange, such as when employees experience tribal favoritism or gender-based bias, it leads to negative emotional reactions and withdrawal behaviors that ultimately affect organizational performance (Shore et al., 2021).

Another assumption of the theory is the principle of reciprocity and trust as a key driver in maintaining healthy organizational dynamics. Positive organizational politics, such as inclusivity and merit-based promotion, can foster a culture of fairness and trust, thereby enhancing employee morale and productivity (Liu et al., 2020). However, political behaviors like tribalism and gender discrimination disrupt the social contract between employee and employer, creating perceptions of injustice and organizational inefficacy (Chernyak-Hai & Rabenu, 2018). This breakdown in trust discourages employees from reciprocating with discretionary effort, resulting in diminished organizational performance. Social Exchange Theory remains highly relevant to this study because it provides a clear framework for understanding how perceptions of fairness, respect, and equity—or the lack thereof—affect employees' willingness to contribute to organizational success. By anchoring this study on SET, the research gains a theoretical basis for exploring how political behaviors such as tribalism and gender discrimination influence performance outcomes in deposit money banks in Kwara State. The theory helps explain why employees respond negatively to perceived political favoritism and discrimination, and why such behaviors may undermine overall performance in the banking sector. Its focus on reciprocity, perceived organizational support, and mutual trust aligns directly with the performance metrics being assessed in this research.

Empirical Review

Several researchers across continents have contributed to existing knowledge on organizational politics and performance-related variables. In a study by Müller and Schneider (2023), titled *Gender and Ethnic Discrimination in European Banking Institutions: Implications for Organizational Performance*, investigated how discriminatory workplace politics affect organizational efficiency in Germany and Switzerland. The researchers adopted a mixed-method approach combining quantitative surveys with qualitative interviews. The population consisted of bank

employees from 10 institutions, from which 420 respondents were randomly sampled. Data were analyzed using structural equation modeling (SEM). The study found that female and minority employees faced subtle but consistent exclusion from informal decision-making networks, leading to lower levels of engagement and productivity. The researchers concluded that invisible political dynamics related to gender and ethnicity created barriers to performance. They recommended inclusive leadership training and internal audits on diversity practices.

Also, Olayemi and Musa (2023) conducted a study titled Influence of Organizational Politics on Employees' Job Commitment and Performance in Commercial Banks in Lagos State. The study aimed to examine the influence of gender and ethnic favoritism on employee performance and commitment. The researchers adopted a descriptive survey design, drawing from a population of 2,000 employees from 10 commercial banks. A simple random sample of 400 was selected. Data were analyzed using SPSS regression models. The study found that tribal favoritism and gender discrimination reduced employee commitment and led to higher turnover intentions. The authors concluded that political favoritism undermines institutional credibility and contributes to a toxic work culture. They recommended strengthening internal grievance mechanisms and ensuring transparency in recruitment and promotion processes. Similarly, Adegbite and Salami (2022), in their research titled Workplace Politics and Organizational Performance in Selected Banks in Ibadan Metropolis, sought to determine the relationship between internal politics and overall performance indicators such as service delivery and customer satisfaction. The study employed a survey research design with a target population of 1,500 staff members. A sample of 300 was selected using convenience sampling, and analysis was conducted using multiple regression and descriptive statistics. Findings revealed that gender discrimination in decision-making roles and tribal favoritism in staff promotion created perceptions of injustice and reduced employee productivity. The researchers concluded that organizational politics, when driven by non-meritocratic values, stifles institutional growth. They recommended leadership accountability and inclusion policies as strategic responses.

In their study titled The Impact of Organizational Politics on Employee Performance in Multinational Corporations, Carter and Keeling (2022) examined how internal political behaviors such as favoritism and power play influence performance among employees in Fortune 500 companies in the United States. The study employed a descriptive survey design with a population comprising employees of five multinational corporations across three states. A stratified random sample of 350 employees was selected, and data were analyzed using multiple regression analysis. The findings revealed that political behaviors such as tribal favoritism and gender bias significantly decreased employee morale and productivity, particularly in middle and lower management tiers. The study concluded that unchecked organizational politics can undermine teamwork, cause employee disengagement, and erode organizational performance. It is recommended to implement transparent HR policies and inclusive leadership practices to minimize political behaviors and enhance organizational effectiveness. In South Africa, Mofokeng and Dlamini (2022) conducted a study titled Workplace Politics and Employee Performance in the Financial Sector of Johannesburg. The objective was to assess how political behaviors, particularly tribal affiliations and gender exclusion, influence staff output. The study adopted a cross-sectional survey design with a population of 1,500 employees across six commercial banks. Using a purposive sampling technique, 300 participants were selected. Data were analyzed using Pearson correlation and regression analysis. The results showed that employees who perceived tribal favoritism in promotions and team selection had lower motivation and trust in the institution. The authors concluded that such political biases reduce loyalty and innovation, especially in diverse teams. They recommended establishing anonymous complaint channels and ensuring fair policy enforcement across departments.

In Kenya, Wanjiku and Otieno (2021) explored The Effects of Organizational Politics on Employee Performance in the Banking Sector in Nairobi County. The study focused on the roles of tribal favoritism and gender discrimination as independent political variables. Adopting an explanatory survey design, the researchers targeted 800 employees of five leading banks. A sample size of 250 was selected using stratified sampling, and data were analyzed using multiple linear regression. The study found a strong negative relationship between perceived political favoritism and task performance. The authors concluded that gender-based disparities in job assignments and leadership

opportunities compounded the negative effects of tribal favoritism. The study recommended institutional culture change initiatives and equity audits to promote merit-based practices.

Methodology

The research adopted a quantitative research design using a structured questionnaire as the major instrument for data collection. The total population for this study is made up of the operational level staff of Guaranty Trust Bank (GTBank), Fidelity Bank, and Jaiz Bank in Kwara State which were considered because of their recognition as Nigeria banks which high ethnic profiling as Fidelity Bank is often labeled as an "Igbo bank," GTBank as a "Yoruba bank," and Jaiz Bank as a "Hausa bank," reflecting the dominant ethnicities of their top executives and board members as observed by (Nwagboh, 2022) evidencing the prevalence of political behaviours within the banks. Data gathered from the headquarters of the Bank in Kwara State revealed that they have a staff strength of 41, 32, and 36 respectively, making a total of 109. These 109, therefore, constitute the population members for this study. The required study sample for the study is estimated using the Taro Yameni formula for sample size determination will be adopted. The study sample is determined as follows:

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

Where: N = Population size, n = sample size, and e= level of precision

Therefore:

$$n = \frac{109}{1+109(0.05)^2} = \frac{109}{1+109 \times 0.0025} \quad n = \frac{109}{1.2725} = 86$$

Based on the above presented estimation, a sample size of eighty-x (86) was selected from the total population of one hundred and nine (109).

Guaranty Trust Bank Plc

$$\frac{41}{109} \times 86 = 32.4$$

Fidelity Bank

$$\frac{32}{109} \times 86 = 25.2$$

Jaiz Bank

$$\frac{36}{109} \times 86 = 28$$

Therefore, the total population and estimated sample selected from each of the organizations discussed above is summarized in the following:

Table 3.1: Population and Sample Size

Estimates	GTBank	Fidelity Bank	Jaiz Bank	Total
Population	28	38	36	169
Sample	20	27	25	119

Source: Researcher's Population & Sample Size, 2025

The sampling techniques adopted for the selection of the estimated sample size from the total population was a stratified sampling technique. The reason for the adoption of this technique is that population members are spread across the 3 selected Banks from which the required sample size will be determined. The research instruments

adopted for this study is a structured questionnaire. This questionnaire was titled “Organizational Politics and the Performance of Deposit Money Banks in Kwara State Questionnaire (OPDDBQ). This questionnaire is structured in nature and contains specially structured question items adapted from various scales developed for measuring the individual proxies that are used for measuring the variables of interest, to answer the proposed research questions, and the test the hypotheses formulated.

The validity of the research instrument is ascertained using face and content validity since a draft copy is submitted to some research experts, who used their expertise in research in accessing the instrument to ascertain that all variables that are germane to this study are well structured enough to draw necessary data from the audience without any difficulty or misunderstanding. However, as for the reliability test, Cronbach’s Alpha statistical tool utility of the Statistical Package for Social Sciences (SPSS) shall be used for this study. According to Chelsea (2015), using Cronbach’s Alpha test of reliability, coefficients not less than .70 are acceptable as an indication that the instrument is reliable and has a high level of internal consistency. Meanwhile, Cronbach’s Alpha test conducted estimated coefficients of .783 and .826 for organizational politics and performance variables, respectively, indicating that the instrument has a high level of internal consistency and reliability. The data gathered were analyzed using multiple regression analysis as an inferential statistical tool. This is to ensure that evidence-based inferences were drawn and reasonable conclusions were made based on the findings.

The study model specifications that guide this study are presented as follows:

HO₁: Tribalism has no significant effect on organizational performance in deposit money banks in Kwara State.

Model 1

$$\begin{aligned}Op &= f(\text{Tr}) \\Op &= f(\text{Tr}_1, \text{Tr}_2) \\Op &= \beta_0 + \beta_1\text{Tr}_1 + \beta_2\text{Tr}_2 + e_i\end{aligned}$$

Where: Op = Organizational Performance Tr = Tribalism Tr₁ = Ethnic Profiling
Tr₂ = Ethnic favouritism β₀ = Intercept e_i = error term or stochastic term

HO₂: Gender discrimination has no significant effect on organizational performance in deposit money banks in Kwara State.

Model 2

$$\begin{aligned}Op &= f(\text{Gd}) \\Op &= (\text{Gd}_1, \text{Gd}_2, \text{Gd}_3) \\Op &= \beta_0 + \beta_1\text{Gd}_1 + \beta_2\text{Gd}_2 + \beta_3\text{Gd}_3 + e_i\end{aligned}$$

Where: Op = Organizational Performance Gd = Gender Discrimination
Gd₁ = Career Development Discrimination Gd₂ = Gender Pay Gap
Gd₃ = Sexual Harassment β₀ = Intercept
e_i = error term or stochastic term

Results and Discussions

In this section, the results of the various hypotheses tested and their corresponding interpretations are presented. Efforts are made to draw relevant inferences from the data to arrive at the study conclusion.

Test of Hypothesis One

HO₁: Tribalism has no significant effect on organizational performance in deposit money banks in Kwara State.

Table 2: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.721	.520	.509	3.24418

Source SPSS Output, 2025

Data presented in the model summary (Table 2) presents an R value of .721, indicating a strong correlation between tribalism and organizational performance in deposit money banks in Kwara State. The R Square value of .520 suggests that 52% of the variation in organizational performance can be explained by the two indicators of tribalism—ethnic profiling and ethnic favouritism. These results show that tribalism is a substantial predictor of organizational performance. This implies that over half of the changes in performance levels of deposit money banks can be attributed to tribalistic tendencies within the organizations, emphasizing the need for strong institutional policies that promote inclusivity and equity.

Table 3: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1456.213	2	728.107	44.989	.000 ^b
Residual	1343.787	83	16.184		
Total	2800.000	85			

Source SPSS Output, 2025

The ANOVA table (Table 3) reveals a statistically significant F-value of 44.989 with a p-value of .000, which is less than the standard alpha level of .05. This confirms that the regression model significantly predicts the dependent variable, and that tribalism, as measured by ethnic profiling and ethnic favouritism, contributes meaningfully to changes in organizational performance. The total sum of squares (2800.000) is split between regression (1456.213) and residual (1343.787), confirming that the model accounts for a substantial portion of the total variance in performance. This result reinforces the validity of including tribalism indicators in organizational performance models, stressing that tribalism is not a trivial issue but a real and measurable influence on organizational outcomes in the banking sector.

Table 4: Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	27.511	1.748		15.737	.000
Ethnic Profiling (Tr1)	-0.842	0.215	-0.456	-3.916	.000
Ethnic Favouritism (Tr2)	-0.625	0.202	-0.371	-3.094	.003

Source SPSS Output, 2025

As presented in the coefficients table (Table 4), both proxies of tribalism have a statistically significant and negative impact on organizational performance. Ethnic Profiling (Tr1) has a coefficient of -0.842 ($p = .000$), indicating that a

unit increase in ethnic profiling leads to a significant decrease in performance. Similarly, Ethnic Favouritism (Tr2) has a coefficient of -0.625 ($p = .003$), showing a notable negative impact. Both predictors have negative standardized Beta values, confirming an inverse relationship with performance. Implication: These findings highlight that discriminatory practices rooted in tribal bias deteriorate organizational effectiveness. Management must therefore actively discourage tribal favoritism and profiling to foster a performance-driven and equitable work environment.

HO₂: Gender discrimination has no significant effect on organizational performance in deposit money banks in Kwara State.

Table 5: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.788	.621	.607	2.98415

Source SPSS Output, 2025

The model summary (Table 5) for Hypothesis Two shows an R value of .788, which indicates a strong positive correlation between gender discrimination and organizational performance in deposit money banks in Kwara State. The R Square value of .621 means that 62.1% of the variance in organizational performance is explained by the three proxies of gender discrimination: career development discrimination, gender pay gap, and sexual harassment. These results show that gender discrimination significantly explains a large proportion of the changes in performance levels, implying that addressing discriminatory gender practices is vital for improving operational effectiveness and overall institutional performance.

Table 6: ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	1737.310	3	579.103	43.053	.000 ^b
Residual	1062.690	79	13.451		
Total	2800.000	82			

Source SPSS Output, 2025

The ANOVA result presented in Table 6 reveals a highly significant F-value of 43.053 with a p-value of .000, which is below the conventional alpha threshold of 0.05. This confirms that the regression model is statistically significant and that the independent variables—proxies for gender discrimination—are jointly good predictors of organizational performance. The statistical significance of the model supports the rejection of the null hypothesis and confirms that gender-based discriminatory practices are not trivial concerns but critical variables that influence organizational outcomes. Institutions that fail to curb gender discrimination may inadvertently hinder their own performance and growth.

Table 7: Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	29.873	1.612		18.531	.000
Career Development Discrimination (Gd1)	-0.754	0.173	-0.442	-4.359	.000
Gender Pay Gap (Gd2)	-0.611	0.169	-0.391	-3.616	.001
Sexual Harassment (Gd3)	-0.538	0.162	-0.329	-3.321	.002

Source SPSS Output, 2025

The coefficients table (Table 7) shows that all three proxies of gender discrimination have statistically significant and negative effects on organizational performance. Career Development Discrimination (Gd1) has the strongest negative effect with a coefficient of -0.754 ($p = .000$), meaning that increases in this form of discrimination significantly reduce performance. Gender Pay Gap (Gd2) also negatively impacts performance ($B = -0.611$, $p = .001$), while Sexual Harassment (Gd3) has a significant negative coefficient of -0.538 ($p = .002$). All three predictors have negative Beta values, confirming an inverse relationship with performance. The implication of this is that gender discrimination in the form of career stagnation, unequal compensation, and harassment significantly deteriorates the effectiveness and morale of employees. If left unaddressed, these issues could lead to decreased productivity, higher turnover, and reputational damage. Consequently, banking institutions must prioritize gender equity policies and practices to optimize employee contributions and improve overall organizational performance.

Discussion of Findings

The study investigated the effects of organizational politics on organizational performance of deposit money banks in Kwara State, Nigeria. The findings from Hypothesis One reveal that tribalism, measured through ethnic profiling and ethnic favouritism, significantly and negatively affects organizational performance. The model explains 52% of the variance in performance ($R^2 = .520$), with both ethnic profiling ($\beta = -0.456$, $p = .000$) and ethnic favouritism ($\beta = -0.371$, $p = .003$) contributing significantly to the decline in performance. These findings imply that workplace practices driven by tribal affiliations hinder objective decision-making and reduce productivity. This answers the first research question and achieves the first objective, which sought to examine how tribalism affects performance. This outcome aligns with the findings of Abubakar and Bello (2021), who emphasized the detrimental impact of ethnic bias on employee morale and productivity in Nigerian organizations. Similarly, Ojo and Adebayo (2020) found that ethnic favouritism erodes fairness and efficiency in the banking sector.

For Hypothesis Two, the results demonstrate that gender discrimination, measured by career development discrimination, gender pay gap, and sexual harassment, significantly and negatively affects organizational performance, explaining 62.1% of the performance variance ($R^2 = .621$). All three predictors had negative coefficients and were statistically significant ($p < .01$). This supports the second research question and confirms the second objective, which sought to determine how gender discrimination impacts performance. The findings imply that discriminatory practices against women and other gender minorities in promotion, pay, and workplace safety reduce institutional effectiveness and limit inclusive growth. These findings align with the studies of Udu and Agwu (2022), who observed that gender-based disparities negatively affect employee engagement and commitment in Nigerian financial institutions. Likewise, findings by Salisu and Ilesanmi (2023) affirm that addressing gender bias enhances team cohesion and organizational productivity in the banking sector.

Conclusion

Based on the study findings, it was concluded that tribalism and gender discrimination significantly and negatively influence organizational performance in deposit money banks in Kwara State. The evidence from the regression analyses shows that both ethnic profiling and favouritism, as indicators of tribalism, undermine equity, objectivity, and teamwork, leading to a decline in productivity. Similarly, gender discrimination—manifested through career development barriers, pay inequality, and sexual harassment—erodes employee morale, limits capacity utilization, and disrupts effective service delivery. These conclusions are justified by the strong statistical significance of the models, with R^2 values of .520 and .621, respectively, indicating that a substantial portion of performance variance can be attributed to the independent variables. The findings emphasize that the existence of bias and discrimination in workplace practices hampers the banks' ability to function as merit-based and inclusive institutions. Justifiably, when employees are judged or treated differently based on tribe or gender rather than competence and contribution, organizational goals are compromised. This study, therefore, affirms that addressing both tribalism and gender discrimination is not only a moral obligation but a strategic imperative for enhancing performance and institutional

sustainability in the Nigerian banking sector. Therefore, organizational politics is a statistically significant negative influence on the performance of an organization.

Recommendations

Considering the study conclusions, the following recommendations were made:

1. There is need for Banks to develop and enforce human resource policies that promote inclusiveness and prevent ethnic or tribal bias in hiring, promotions, and decision-making processes.
2. Financial institutions should implement gender equality initiatives, including mentorship programs for women, unbiased promotion structures, and gender-sensitive training, to bridge development gaps.
3. Banks should create confidential channels through which employees can report incidents of ethnic favouritism and gender discrimination, backed by strict penalties for offenders.
4. Regular training on workplace diversity, anti-discrimination laws, and inclusive leadership should be provided to all staff to reshape attitudes and foster a culture of respect and equality.

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LABELLING AND MORAL PANIC IN THE MEDIA

BY

Yahaya, Abdul-Lateef Bolaji

Department of Mass Communication, The Polytechnic, Igbo-Owu, Ilorin

Email: yahayaabdullateefbolaji@gmail.com

Abstract

This study explores the critical intersection of media, labeling, and moral panic in Nigeria's evolving socio-political landscape. In a context marked by insecurity, ethnic tension, and institutional distrust, media outlets serve not merely as conveyors of information but as architects of social reality. The research addresses the pressing issue of how Nigerian media construct and reinforce deviant labels, contribute to public fear, and influence behavior and policy. The significance lies in the media's growing power to shape national discourse, legitimize stereotypes, and deepen societal fractures. The study pursued four main objectives: to examine the media's role in labeling deviance; to explore how narratives generate moral panic; to analyze how portrayals influence motives, means, and opportunities for crime; and to assess the impact on institutional and moral control mechanisms. Using a qualitative research design, the study relied on secondary data—including scholarly articles, media content, and policy literature—analyzed thematically to extract patterns and correlations. Findings revealed that Nigerian media consistently label marginalized groups, particularly Fulani herders, as threats. These narratives fuel moral panic, amplify public fear, and justify coercive state responses. Moreover, glamorized portrayals of criminality contribute to deviant aspirations and behavior, while media cynicism toward public institutions erodes civic trust and internalized moral norms. The study concludes that media influence in Nigeria is both consequential and transformative. It recommends the implementation of ethical journalism standards, media literacy initiatives, and inclusive policy reforms to mitigate labeling, reduce fear-based governance, and foster a more cohesive and just society.

Keywords: attack, fear, Nigeria, public, terrorism

Introduction

Labeling theory emerged in the 1960s as a transformative perspective in criminology, challenging the dominant positivist approaches by arguing that deviance is not inherent in any act but is instead the result of societal labeling processes. This perspective brought critical attention to the social construction of crime and the power dynamics involved in defining deviance (Greer & McLaughlin, 2022). Rather than viewing criminals as inherently deviant, the theory posits that societal reactions, especially from institutions like the media and the justice system, play a crucial role in assigning deviant identities. These labels can influence individuals' self-concept and future behavior, often reinforcing criminal identities through marginalization and exclusion. Moral panic theory evolved closely alongside labeling theory, with scholars highlighting how media and societal institutions can exaggerate threats, thereby constructing certain individuals or groups as deviant "folk devils." This framework has become increasingly relevant in the age of digital media, where rapid information dissemination can escalate public fear (McRobbie & Thornton, 2021; Hamilton, 2020). Media-induced moral panics often result in calls for punitive action and policy changes, even when the underlying threats are exaggerated or misrepresented.

The global perception of terrorism was dramatically altered after the events of September 11, 2001, but more recent studies continue to emphasize how terrorism is not just a security issue, but also a sociopolitical construct shaped through media representation. In Nigeria, the rise of Boko Haram has not only challenged state security but also fueled widespread fear and panic through relentless media coverage (Okonkwo & Adeoye, 2023; Johnson et al., 2023). Terrorism in this context is not merely understood through acts of violence but through the lens of public

perception shaped by media narratives. These portrayals often involve ethnic and religious profiling, such as the frequent labeling of Fulani herders as terrorists. This reinforces stereotypes and contributes to social fragmentation. Media narratives shape public perception and policy responses, often amplifying societal divisions and fear (Chukwuma & Bamidele, 2021). Once a group is labeled as deviant, they are more likely to be perceived as a persistent threat, which perpetuates cycles of discrimination, stigmatization, and social exclusion. Contemporary research argues that acts of terrorism function as instruments of political messaging, using fear to influence broader audiences. These acts are amplified by media outlets, which inadvertently contribute to the spread of panic and the stigmatization of entire communities (Ojo & Ibrahim, 2022; Akinyele & Musa, 2023). Furthermore, the media's agenda-setting power can prioritize security narratives over nuanced discussion, thereby narrowing the scope of public discourse and hindering reconciliation efforts.

In Nigeria, this phenomenon has been particularly visible. Despite various counter-terrorism initiatives, ongoing attacks across the country—especially in the Northeast and in Abuja—have kept the public in a state of anxiety. This persistent insecurity fuels moral panics, as amplified by news coverage and public discourse (Lee & Nwosu, 2024). Such panic has concrete social consequences, including public support for aggressive security policies, increased inter-ethnic distrust, and the erosion of civil liberties. Therefore, understanding labeling and moral panic within Nigeria's media landscape is crucial. These theories help explain how media narratives shape national consciousness, influence policy, and perpetuate societal fear. They also highlight the need for responsible journalism and inclusive media practices that challenge stereotypes and promote balanced reporting.

Objectives of the Study

The study sought to; (1) examine the role of media in constructing and reinforcing social labels associated with crime and deviance in Nigeria. (2) explore how media narratives contribute to the formation and escalation of moral panic among the Nigerian public. (3) analyze how media portrayals shape the motives, means, and opportunities for deviant and criminal behavior. (4) assess the impact of media representations on the erosion of social and institutional control mechanisms in Nigerian society.

Literature Review

Conceptual Framework

The concept of moral panic has been significantly developed in recent years to reflect the complexities of modern society. Building upon Cohen's foundational work, recent scholars like Ellis and Symons (2021) and Haines (2022) emphasize five critical characteristics that signal a moral panic: concern, hostility, consensus, disproportionality, and volatility. These criteria continue to be vital in identifying moral panics, particularly in an era of instantaneous global communication and algorithmic news distribution. Despite its utility, the concept has faced critiques over time. Scholars like Morton and Blake (2023) argue that the traditional idea of disproportionality assumes a privileged perspective over what constitutes an objective reality, while volatility is increasingly questionable in the age of continuous digital surveillance and social media echo chambers. This shift suggests that moral panics today may be less fleeting and more embedded in ongoing cycles of outrage and media amplification.

The widespread use of the term "moral panic" in mainstream media has led to its dilution. Journalists and politicians often deploy the term to critique or justify public reactions without critically engaging with its theoretical implications (James & Edeh, 2021). For instance, the media's sensationalist coverage of youth crime and terrorism has sometimes incited fear that is not proportionate to actual threats, thereby contributing to the stigmatization of certain social groups. Modern case studies show that moral panic still functions as a powerful lens to understand public reactions to social deviance. The case of youth gang violence in South African urban centers and religious extremism in Northern Nigeria have both been analyzed through this framework (Ahmed & Ojo, 2023). In these

instances, public and political responses have often been guided more by emotional and media-driven narratives than by empirical evidence.

Contemporary Applications

Recent literature also highlights how terrorism remains a potent catalyst for moral panic. Acts of terrorism, especially in developing nations, are often interpreted not just as violent events but as existential threats to national identity and stability. Scholars such as Obi and Suleiman (2022) argue that the framing of terrorism in media coverage often simplifies complex sociopolitical grievances into a dichotomy of good versus evil, thus exacerbating ethnic and religious tensions. Further, terrorism is increasingly conceptualized as a communicative act intended to influence audiences through fear, often with extensive help from the media (Adesina & Bakare, 2023). This understanding aligns with studies showing that the repeated broadcast of violent imagery can normalize public anxiety and shift policy toward more authoritarian responses.

Labeling theory remains foundational in explaining how individuals and groups come to be defined as deviant. In the Nigerian context, the media have played a central role in labeling ethnic minorities, particularly Fulani herders, as inherently violent or criminal (Ibrahim & Okafor, 2024). This labeling does not just reflect existing social biases but also intensifies them, influencing everything from interpersonal trust to national policy. Moreover, research by Bello and Hassan (2021) reveals how such labeling fosters what they term "media-induced marginalization," where communities internalize and respond to the stigmatizing labels, often through alienation or radicalization. This suggests a feedback loop between labeling, marginalization, and deviant behavior that is often overlooked in public discourse. The literature underscores the evolving yet persistent relevance of moral panic and labeling theories in understanding how societies interpret deviance. These frameworks are especially pertinent in contexts like Nigeria, where media narratives wield enormous influence over public sentiment and policy decisions.

Theoretical Framework

A strong sense of mastery and self-esteem continues to be recognized as essential to individual psychological well-being and life satisfaction. Contemporary studies confirm that diminished perceptions of control over life circumstances and reduced self-worth contribute to feelings of hopelessness, disengagement, and a lower quality of life (Ahmed & Eze, 2021). Low self-efficacy not only impacts mental health but can also lead to social withdrawal, affecting broader patterns of community engagement and resilience. Recent research by Tanaka and Bello (2023) builds on this idea, demonstrating that individuals who perceive themselves as having low personal control are more susceptible to external labeling and stigmatization, particularly in environments where systemic inequalities persist. These insights have important implications for understanding how societal structures interact with personal identity and behavioral outcomes.

Labeling theory has retained its relevance in contemporary criminology by shifting focus to the dynamic interactions between societal institutions and individuals. It emphasizes how definitions of deviance are socially constructed and applied, often reflecting existing power hierarchies (Ibrahim & Chen, 2022). Rather than viewing criminal behavior as solely the result of individual pathology, labeling theory considers how being tagged as "deviant" can influence future behavior, reinforce marginalization, and perpetuate cycles of criminalization. The theory's foundational claim—that deviance is not inherent in an act but is a result of the societal response to it—remains central. This is echoed in recent findings that show media representations and law enforcement practices disproportionately label minority groups as deviant, impacting both public perception and institutional treatment (Okonkwo & Lewis, 2021).

Contemporary scholars such as Adeyemi and Thomas (2024) also critique what they term the "expanded" or "imperialistic" version of labeling theory. This version assumes that all crime is relative and purely a social construct, without accounting for the material harm caused by certain behaviors. While the relativist stance offered valuable critiques of mainstream criminology, recent research seeks to balance this by integrating labeling theory

with empirical data on victimization, systemic inequality, and psychological outcomes. Furthermore, new work by Odum and Rivera (2022) explores how the social control mechanisms described in labeling theory can themselves become sources of deviance. They argue that punitive responses to labeled individuals often exacerbate their alienation and push them further toward antisocial behavior—a feedback loop reinforced by institutional bias and lack of rehabilitative support.

Overall, the theoretical framework for this study draws upon these updated interpretations of labeling theory, connecting them with insights from psychological research on self-concept and mastery. This integrated approach provides a comprehensive lens through which to analyze how media narratives and societal labels contribute to the construction of moral panic and perceived deviance, particularly in the Nigerian context.

Methodology

The study was conducted in Ilorin metropolis, which had witnessed several social vices like cultism, drug abuse, ritual killings, abductions and kidnapping in different parts of the city over the past two years. The study took place between the months of October and November, 2021. Literature review was adopted using both theoretical and conceptual frameworks as the main instrument. The data used in the study comprised secondary data. The secondary data were sourced from literatures.

Findings and Discussion

In an era where media serve as the primary lens through which many individuals understand the world, the construction of social reality is heavily influenced by what is reported, how it is framed, and which voices are amplified. This study's findings reveal a compelling narrative: Nigerian media, rather than passively mirroring social conditions, actively shape perceptions of crime and deviance. Through their language, tone, and selection of coverage, media institutions become powerful agents of social labeling, moral panic, and behavioral normalization, with far-reaching implications for individual identities, public policy, and national cohesion.

Role of Media in Constructing and Reinforcing Social Labels Associated with Crime and Deviance in Nigeria

The Nigerian media play a central role in shaping public understanding of who or what constitutes a threat. Through selective coverage, sensational headlines, and repetitive framing, media outlets reinforce social labels, especially those linked to marginalized communities. Fulani herders are consistently portrayed as violent aggressors, a trend which has crystallized into a national stereotype (Okonkwo & Lewis, 2021). Such media constructions transform isolated incidents into perceived patterns of group behavior, resulting in a distorted public consciousness.

This labeling process mirrors what Ibrahim & Chen (2022) describe as the institutionalization of deviance, wherein consistent media narratives normalize and entrench societal biases through repeated, coded messaging. Even in the absence of objective evidence, labeled identities are difficult to reverse. They become socially durable, influencing not only public sentiment but also state practices including law enforcement profiling, judicial bias, and discriminatory policy-making. Moreover, the reduction of complex socio-political conflicts to ethnically driven crime narratives deepens existing divisions and fosters hostility between groups.

How Media Narratives Contribute to the Formation and Escalation of Moral Panic Among the Nigerian Public

Moral panic, as conceptualized in this study, is not spontaneous but constructed through a synergy of emotional storytelling, fear-based imagery, and binary framing. Nigerian media frequently use alarmist tones when reporting crimes linked to herders, youth gangs, or insurgent groups, with little verification or balance. According to Obi & Suleiman (2022), these techniques create a feedback loop where public anxiety fuels more intense media coverage, and vice versa. This accelerates the panic cycle and heightens emotional responses to crime. These media-induced

panics are not ephemeral. Ahmed & Ojo (2023) contend that moral panics in Nigeria evolve into long-standing cultural scripts that inform national security policy. The findings support this view, revealing how public panic over perceived deviance catalyzes curfews, military operations, and expanded surveillance—all targeted disproportionately at labeled communities. Instead of resolving insecurity, such reactions institutionalize fear, perpetuate stereotypes, and normalize state overreach. The repetition of this cycle feeds a collective mindset of suspicion, insecurity, and fatalism.

How Media Portrayals Shape the Motives, Means, and Opportunities for Deviant and Criminal Behavior

The media influence not only how crime is perceived but also how it is enacted. Glamorous portrayals of affluence obtained through dubious means—ranging from internet fraud to armed robbery—create aspirational figures among disaffected youth. Ahmed & Eze (2021) describe this as the anomic gap, where societal pressure to achieve success collides with a lack of legitimate means. When the only visible symbols of success are linked to deviance, young people may rationalize crime as an acceptable or necessary path. The media also inadvertently provide a blueprint for crime. Detailed descriptions of criminal operations, loopholes in law enforcement, and even visual aids in video journalism contribute to what Odum & Rivera (2022) term “criminal instructional.” The normalization of deviance through film, social media, and music videos expands perceived opportunities for unlawful gain while diminishing the fear of consequences. The study found a strong correlation between sensationalist media content and the spread of copycat crimes, especially in urban areas with high youth unemployment. In such environments, crime becomes performative and imitative, influenced by digital content that rewards notoriety. The media are thus not merely chroniclers of crime but co-authors in the scripting of deviance.

Impact of Media Representations on the Erosion of Social and Institutional Control Mechanisms in Nigerian Society

When the media repeatedly showcase dysfunctional institutions—corrupt police, indifferent politicians, failing courts—it undermines public trust in the rule of law. Adeyemi & Thomas (2024) suggest that such representations lead to internal disinhibition, where citizens begin to perceive moral boundaries as flexible or irrelevant. This internalization of cynicism erodes social controls once maintained by moral consensus and institutional legitimacy. The study observed that persistent media cynicism toward public institutions correlates with decreased civic engagement and increased social withdrawal. Citizens exposed to such narratives are less likely to report crimes, participate in community security, or comply with legal expectations. This absence of both external (legal) and internal (moral) controls creates fertile ground for deviance and societal fragmentation. Furthermore, media portrayals that glorify violent resistance or criminal ingenuity—especially through film and music—redefine societal heroes and villains. Law enforcers are portrayed as either buffoons or tyrants, while outlaws are framed as rebels or saviors. This inversion of moral coding fundamentally alters the population’s normative compass, making deviant behavior more appealing or acceptable.

Conclusion

This study reveals that Nigerian media play a decisive and multidimensional role in shaping public perceptions of crime, deviance, and morality. Through persistent labeling, they create lasting social identities that inform prejudice and policing. Through emotional and exaggerated reporting, they escalate moral panic, prompting hasty and often unjust state interventions. Through glamorized or instructional portrayals, they shape the psychological and tactical landscape of deviance. And through cynical or dramatized depictions of institutions, they erode trust, weaken civic responsibility, and destabilize moral boundaries.

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ASSESSMENT OF OPERATIONS AND CHALLENGES OF WASTE MANAGEMENT OPERATORS IN ILORIN METROPOLIS

BY

Yusuf O.R.

**Department of Environmental Health Science, Federal University of Health Sciences,
Ila-Orangun, Osun State, Nigeria**

Email: deentech06@gmail.com

Abstract

This paper examined the operations and challenges of wastes management consultants in Ilorin metropolis of Kwara State, Nigeria. Waste management has become a source of livelihood to thousands of Nigeria and the sector continue to be lucrative due to ubiquitous nature of wastes. It is a fact that managing solid waste effectively and efficiently is no easy undertaking. Companies dealing in solid waste management face several challenges. This study addressed issues relating to operational capabilities of wastes management consultants and challenges facing them. A cross-sectional study was conducted among the registered wastes consultants working in Ilorin metropolis, Kwara State. The sampling technique employed was total sampling using the record of all registered wastes consultants with Kwara State Environmental Protection Agency (KWEPA). The study utilized quantitative research method, using structured questionnaires to gather data from 30 respondents among the waste management consultants operating in the area. The data was analysed using statistical package for social science for descriptive (t-test) at 5% level of significance. Examined were their operational capabilities through the number of functioning trucks, experience, coverage and impediments to effective service deliveries. The research shows that wastes contractors are not well equipped with modern wastes transportation facilities. Also, it was discovered that commercial wastes contractors face problems of multiple charges being paid to government purse. Poor sensitization and awareness among the general public were found to be among major challenges of wastes contractors. Inadequate enforcement of proper wastes disposal through the wastes contractors is another challenge of the waste contractors.

Keywords: Wastes contractor, transportation, disposal, KWEPA, metropolis.

Introduction

Waste management are the activities required to take care of waste from its inception to its final disposal. These include but not limited to collection, transportation, treatment and disposal of waste together with monitoring and regulation [1,2]. Waste collection and transportation are basic components of wastes management techniques. Furthermore, as the wastes generations continue to increase due to increase in population, change in economic situation and way of life, effective collection, transportation and safe disposal of wastes are imperative [3,4]. One of the main challenges is the increasing amount of waste production due to population growth, consumerism, and industrialization [1]. Traditionally, the task of management of municipal solid wastes rest on the municipal or local government authorities, but inadequacies of proper wastes management plan, paucity of funds and corruption have made the various state government in the country to take up the municipal waste management especially at various state capitals. Accurate wastes generation record is not available for Kwara State, but it is estimated that over one hundred and thirty thousand tons of refuse are generated annually in Ilorin metropolis [2,9,10,].

Among the major causes of poor solid waste collection, transportation and treatment/disposal programme is a weak cost recovery system. This means there is no effective mechanism for collecting payments to cover the costs of the waste collection system. If the users of a service (the householders and businesses) do not pay for the waste collection and disposal service – either directly or through the local authority – then there will be no funds available to pay wages, maintain the equipment or invest in new equipment and facilities [4,5]. Private sector organisations

can be better equipped than governmental organisations to collect payments and manage the finances. If they become involved in providing the waste management services, this spiral of declining services can be reversed [4,10,11]. There have been very little studies on assessment of private sector wastes management companies' operations and their challenges especially in Kwara State and North-Central regions of Nigeria. Private companies may also have more experience of waste collection and access to better equipment than local government, resulting in better service provision. This arrangement, where the public and private sectors work together, is called a **public-private partnership** or **private sector participation** as applicable in Lagos State. For example, a private sector company may be paid to collect wastes and to collect payments from individual businesses and residents. If several companies are competing for the same PPP contract this should result in lower costs [5,12].

PSP in Lagos are as results of privatization of solid waste collection which has given rise to the spring up of quite large number of operators in the state. Among the contractors, 67% were from the low income area in Alimosho LGA, 20% from the medium income area in Ikeja LGA, and 13% from the high income area in Eti-Osa LGA. All are operating in different size or capacity in terms of manpower and available equipment. The strength and quality of staff with available facilities are often an indication of firm's waste collection capacity. All the firms have offices in their locations; hence it becomes easier for their customers and monitoring agencies to locate them in case of difficulties in service provisions [19]. In Addis Ababa, private sector operators became eligible to obtain permits to take part in waste collection, transport and treatment when the Solid Waste Management Proclamation was published in 2007 [5,6]. By April 2011, 524 firms in Addis Ababa had been permitted to collect solid wastes, employing 5800 people [6,18]. Over the four years, the proportion of the city's waste collected had risen from 60% to 80%, providing waste collection services to an additional 600,000 people. Many of these private sector operators are 'micro-enterprises'. Under these PPP schemes, the planning and administration is the responsibility of the kebele authorities, who remain owners of the service [20,22].

Methodology

Study Area

The city of Ilorin lies on latitude North 8°30' and longitude East 4° 35' near the southern fringe of the savannah and forest zone. Ilorin is the capital city of Kwara State located in the North-central region of Nigeria, although dominated by Yorubas, it is classified as North-central state due to its emirate system of traditional rule. As of the 2006 census, it had a population of 777,667, making it the 7th largest city by population in Nigeria [3]. A large part of the province is located on grass plains with undulating landscapes which are well watered and highly agricultural. By the southern Nigeria provincial borders, at an elevation of 1,500 feet, there is a watershed with a river generally running from west to east and flowing into the River Niger [13,14]. The ecology of the region plays an important role in people's decisions to settle in a particular area. It has a mean annual rainfall of 1,318 mm (51.9 inches), which allows inhabitants to practice arable farming. The mild climate has also attracted northern pastoralists to the region. Ilorin city is the commercial and administrative center of Kwara State. It is made up of four local government areas (Ilorin South, Ilorin West, Ilorin East and Asa) [14].

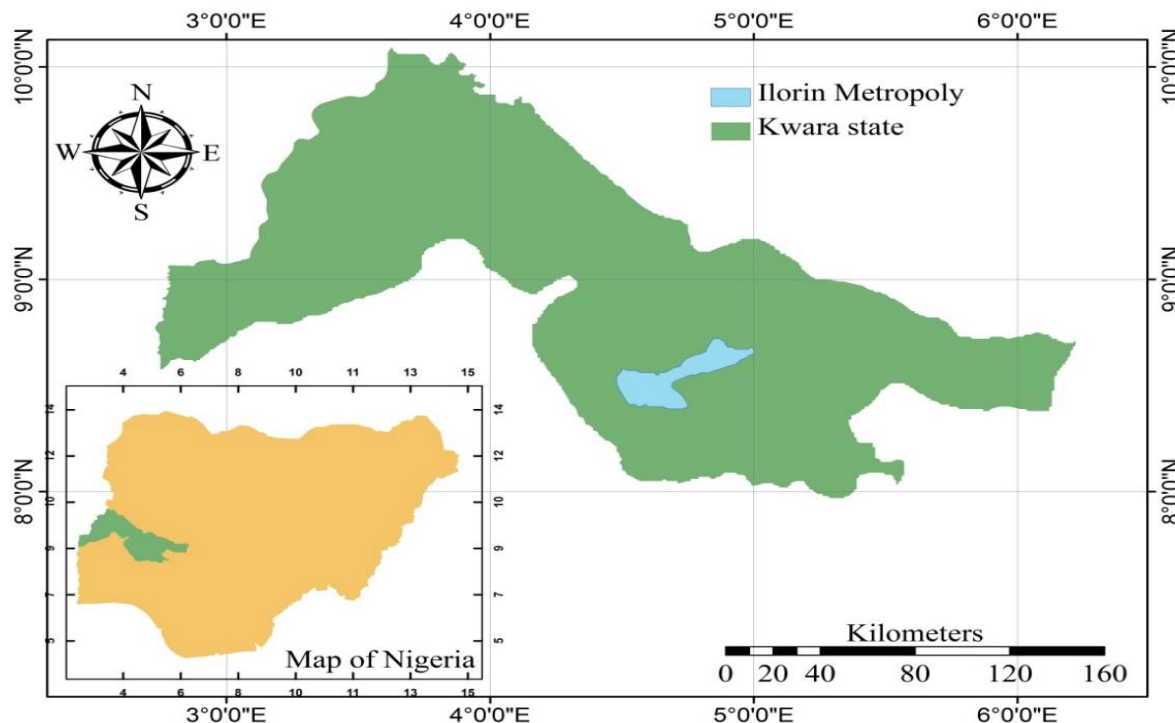


Figure 1: Map of Kwara State showing the study area. Adapted from Sawyerr *et al.*, [5].

Sampling Techniques

The technique employed in the study was total sampling methods, relying on record of registered wastes contractors with the ministry of environment and forestry but thirty of them were available to administer with questionnaires. Majorly there two categories of waste contractors working with the Kwara State Government, the social wastes contractors and commercial wastes contractor both are captured in the research. Thirty (30) respondents covering both social and commercial wastes contractors were administered with questionnaires out of the total number of thirty-eight (38) registered contractors as at the time of data collection.

Data Instrument

The instrument used for this study was structured questionnaire. The questionnaires were interviewer-administered to the wastes contractors and where necessary the questions were translated to Yoruba language. Both open-ended and closed-ended questions were included in the questionnaire. The questionnaires were administered to the commercial wastes contractors at the point of their monthly meeting while the those of two (2) social wastes contractors were administered at their respective offices. All the participants were informed of the aims of the research before the study started, this was done to facilitate the data collection processes and to obtain their consents.

Data Analysis

Data was analysed using SPSS 23, using descriptive statistic such as mean, frequencies, charts and graphs.

Results

Socio-Demographic Characteristics of respondents

Presented below are the results of the respondents based on their age, marital status, educational level and tribal status respectively.

Table 1: Demographic Characteristics of the Wastes Contractors

Variables	Frequency	Percentages
Sex		
Male	26	86.6
Female	4	13.4
Age		
21-30 years	2	6.7
31-40 years	21	70.0
41years-above	7	23.3
Marital status		
Single	6	20.0
Married	23	76.7
Divorced	1	3.3
Tribes		
Yoruba	30	100.0
Igbo	-	
Hausa	-	
Educational Background		
Primary	4	13.3
Secondary	6	20.0
Tertiary	19	63.3
Islamiyyah	1	3.3

In table 1 above, the socio-demographic characteristics of wastes contractors in Ilorin metropolis showed that majority of respondents are men between the ages of 31 – 40years with 70.0% with the least being ages 21-30years constitute 6.7%. Also, distribution of respondents according to gender showed that wastes contractors in Ilorin are majorly male with population of 26 which constitute 86.6% of the total respondents. Tribal or ethnic distribution of respondents showed that all of the registered waste contractors belong to Yoruba tribe. The marital status of respondents showed majority to be married with 76.7%, unmarried constitute 20% of the population, while 3.3% are divorced.

Operations of wastes management contractors in Ilorin metropolis.

The wastes management policy in Kwara State is a dual policy of combination of Social and commercial wastes management policy. Information from the state ministry of Environment revealed that the Kwara State Environmental Protection Agency is in charge of overseeing the day to day operation of the contractors. The social wastes management is restricted to the major roads in the capital city which comprises of three local governments (Ilorin west, part of Ilorin East and part of Ilorin South). The work of social wastes management is

contracted out to two private contractors, while the commercial wastes management is being handled by thirty-six (36) contractors registered with Ministry of Environment and Kwara Environmental Protection Agency.

The responsibilities of social wastes contractors are to clear wastes in public places from streets in the metropolis and the evacuation of central wastes storage on various streets in the metropolis. The payment of social wastes contractors is the responsibility of the state Government while their activities is monitored by government agencies.

The commercial wastes contractors are people that take wastes evacuation as a vocation, they are registered by the state ministry of Environment and forestry but under supervision of Kwara State Environmental Protection Agency.

Table 2: Operational Information of Licensed Wastes Contractors

Types of was licenced to evacuate	Frequency	Percentage
Household wastes	27	90
Medical and special wastes	3	10
Total	30	100
	Frequency	Percentage
Number of trucks		
1 Truck	20	66.7
2 Trucks	8	26.7
Above 2 trucks	2	6.6
Total	30	100.0
	Frequency	Percentage
Types of wastes trucks		
Open truck	5	16.7
Tipping truck	19	63.3
Compactor	6	20.0
Total	30	100.0
	Frequency	Percentage
Your trucks covered always		
Yes	27	90.0
No	3	10.0
Total	30	100.0

Source: Author's field report 2023

The table above showed that majority of wastes contractors 27 which is 90% of the total registered wastes consultants are licensed to manage household wastes while only 3 which is 10% of wastes contractors are licensed to manage bio-medical and hospital wastes. Furthermore, in terms of operational truck most of the contractors has only one operational vehicle. The total number of 20 out of 30 wastes contractors which is 66.7% of their population relied on the service of a single truck. Wastes contractors with two working trucks are next with population of 8 which is 26.7% of the total population. The type of trucks commonly used for wastes evacuations are majorly tipping trucks, this is alluded to by the number of wastes contractors 19 which used them that constitute 63.3 % out of total number of 30 wastes contractors. Also the next most used types of vehicle after tipping trucks is the compacting with 6 different consultants which 20% of companies having one or more compactors. The remaining 5 contractors which are 16.7% of the total number of the consultants use open trucks for daily evacuation of wastes in the state.

Challenges facing Wastes Management Contractor in Ilorin Metropolis

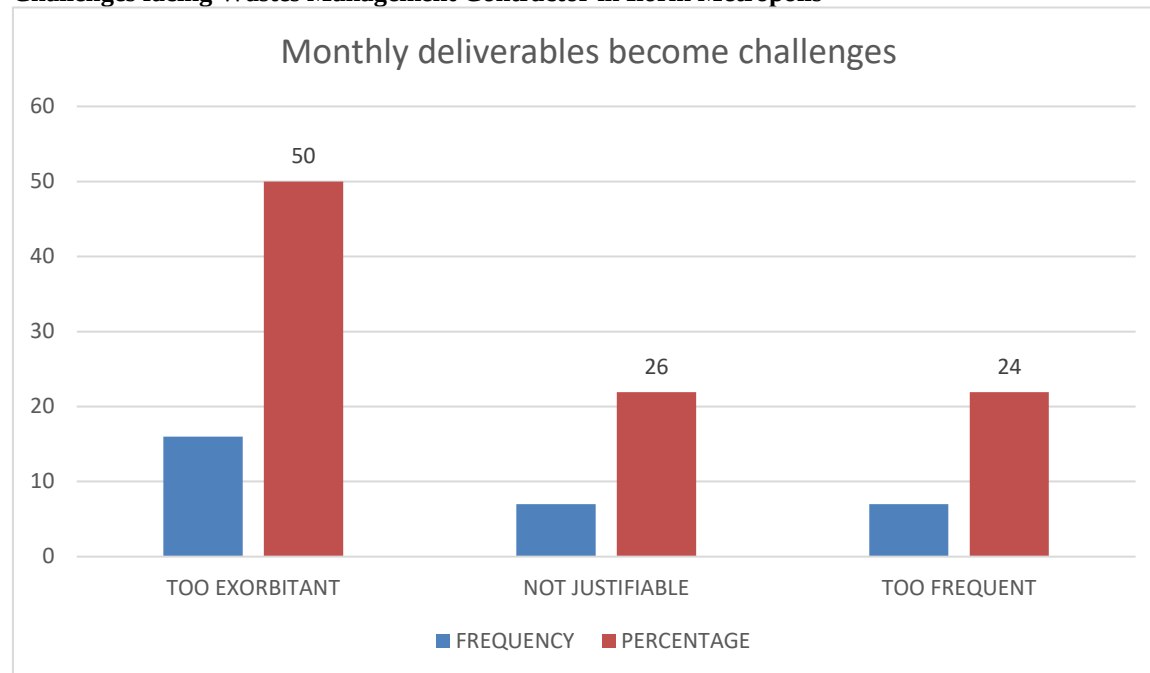


Figure 1: Monthly deliverable paid by the contractors

Monthly deliverables are amount paid into the purse of the state government through the Kwara State Internal Revenue Service (KWIRS). The money is evaluated by the Kwara Environmental Protection Agency and recommended to the KWIRS based on areas of coverage allocated to each contractor. The above chart explained the perception of the wastes contractor to the monthly fees (deliverable) payable to the purse of the state government. Majority of the wastes contractors 15 which is 50% of respondents felt that the monthly deliverables are too expensive. Also, 26% of contractors that is 8 believed that the amount allocated to their company is not justifiable in terms of area of coverage and patronage. The remaining 24% believed that the payment of deliverable every month is too frequent and not helping their businesses.

Poor Wastes Management Sensitization.

Low level of environmental and health education poses a serious challenge to wastes management. Among the issues identified as factor militating against effective wastes management and patronage of waste contractors is poor sensitization. The chart below seeks to ascertain if lack wastes sensitization constitutes a problem for waste contractors in the metropolis. Majority of the wastes contractors 67% believed that poor sensitization on wastes is a problem which usually lead to indiscriminate wastes disposal and eventually make their tasks difficult.

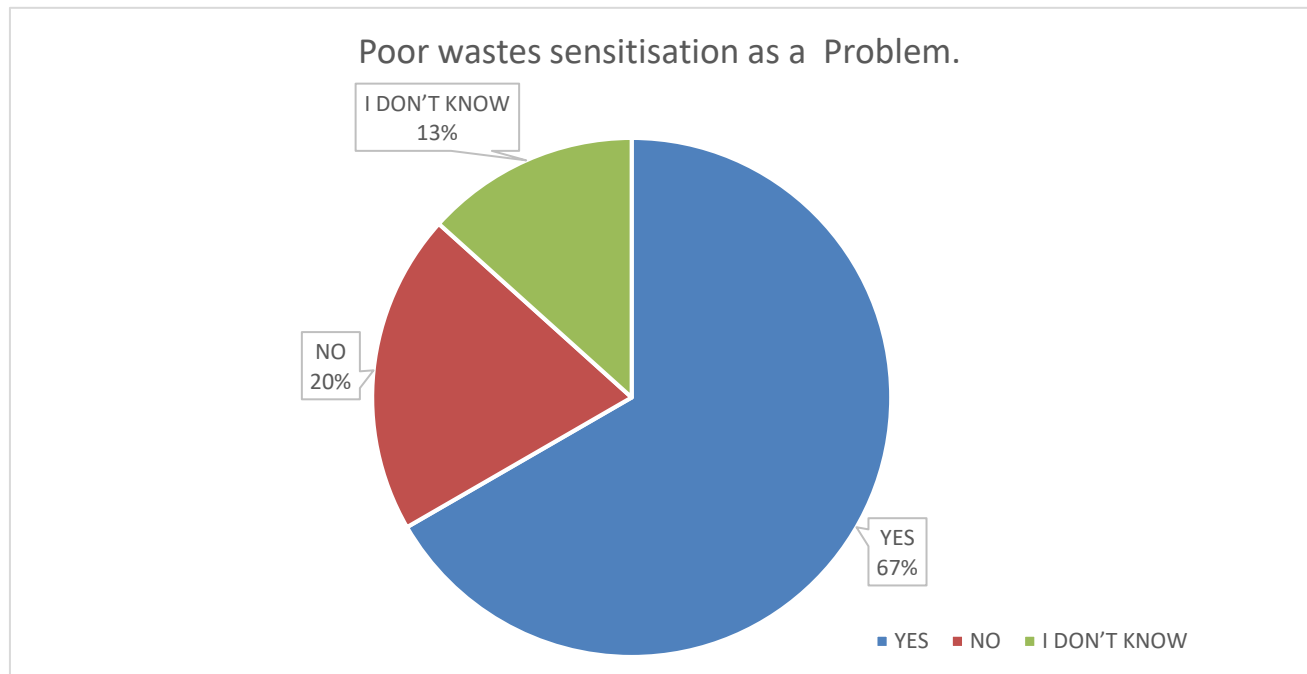


Figure 2: Wastes management sensitisation

20% of the respondents don't agree that poor wastes sensitization constitutes impediments to execution of their jobs. The remaining 13% are indifferent as they don't know either if poor wastes sensitization is affecting their wastes management activities or not.

Poor enforcement of waste disposal with wastes contractors

The institutional framework and laws that gave the state ministry of environment and agency some supervisory roles, among those agencies are given in the chart below and the wastes contractors' awareness of the environment health enforcer. Among those presented below are the Kwara State Internal Revenue Service (KWIRS), the agency that is responsible for enforcing payment of monthly deliverables and payment of the yearly renewal fees for each contractors. The next is the Kwara Environmental Protection Agency (KWEPA) they are responsible for implementation of all wastes management strategies among other duties. They also oversee the operation of all wastes consultants. The last is Ministry of Environment and Forestry (MOE), they are the policy maker in all activities that has to do with the environment.

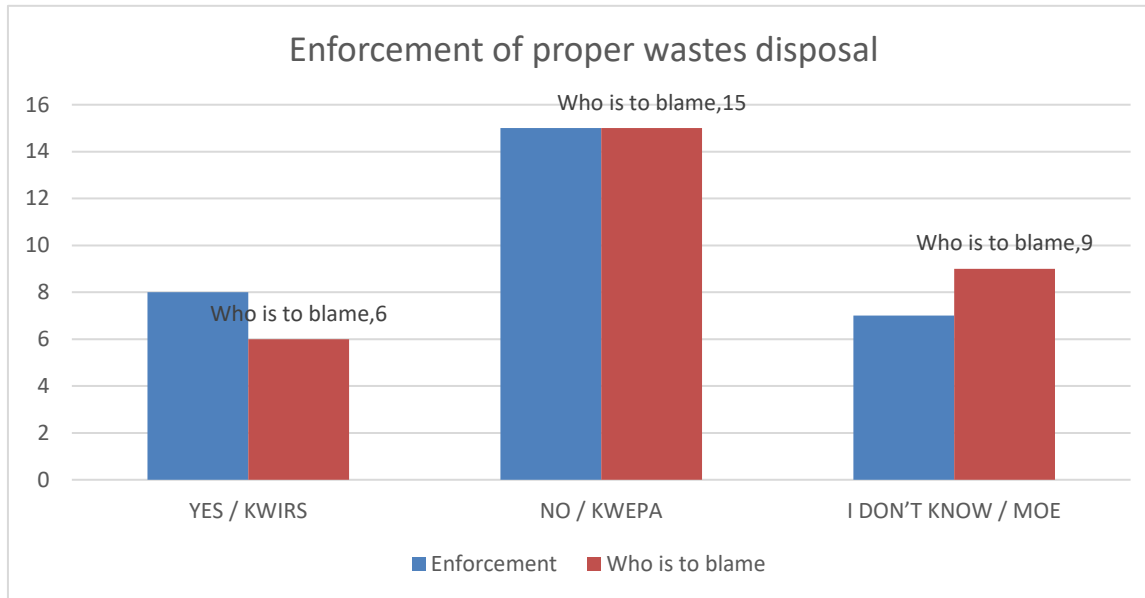


Figure 3: Poor enforcement of Waste disposal

Majority of respondents of the respondents as can be seen above opined that the Kwara State Environmental Protection Agency is to be blamed for poor enforcement of proper wastes management and poor patronage by the residents. Total number of 15 respondents which constitute 50% of the total population of the study fall into this group. This is closely followed by ministry of environment and KWIRS is the least blamed for poor enforcement of proper wastes disposal.

Discussion

Operational Capabilities

Operational capabilities of wastes contractors are determined by the equipment and manpower availability. The research shows that wastes contractors are not well equipped with modern wastes transportation facilities. It was discovered that majority of them 66.7% (20) relied on a single truck most of which are old rickety trucks. Also, most of them 63.3% operate with open tipping trucks which expose their workers and the public to hazards of wastes. These are in agreement with Adebola [21] and Yusuf *et al* [16] who concluded that vehicle challenges and the use of inappropriate wastes trucks are major problem with solid waste management in their study. There are many challenges facing waste contractors, key among the challenges of commercial wastes contractors are multiple charges being paid to government purse. Most of waste contractors frowned at the monthly deliverable paid to government cover through the KWIRS. 50% of the contractors believed the monthly payment is too much, while 26% thought the payment is unjustifiable. This is in agreement with the submission of Mba and Nandi [12] and Adebola *et al*. [21]. Poor sensitization and awareness among the general public were indicated as major challenges. The general lack of awareness regarding waste issues lead to poor patronage of the wastes contractors and foster indiscriminate wastes disposal around the town. This is in agreement with the findings of Shittu *et al*. [15], Yusuf *et al*. [16] and supported by Kaoje *et al*. [17].

Enforcement of proper wastes disposal through the wastes contractors is another challenge and majority of the contractors 50% put the blame on the government agency overseeing the wastes management sector i.e. Kwara State Environmental Protection Agency for poor awareness and enforcement of residents to comply with using commercial wastes contractors. This is similar to the result of findings of Rauf *et al.* [8] and Shittu *et al.* [15]

Conclusion

The research has been able to unveil some operational inadequacies with government registered waste contractors and this is largely due to the fact that majority are driven to begin wastes management as means of economic empowerment with little or no training in wastes handling and the technical requirement for wastes management. The regulatory organisation are also not living up to the expectation in the enforcement of our environmental laws. The government policy of making wastes management as means of revenue generation is another impediment that is worth mentioning and this has contributed to the failure of enforcement of the environmental law as government as the agency of the government are working hard to improve the government revenue rather than protection of the environment and health of the people. In all of these challenges facing the wastes management contractors in Kwara State, few of the recommendation below will assist in improving the operational efficiency of the contractors and ensure a health and clean environment for all.

Recommendations

1. The usage of inappropriate vehicles for waste transportation must be prohibited.
2. Registered wastes contractors can be supported with vehicle loans from the government to enhance their productivity.
3. Government agencies in charge of enforcement and compliant should improve on their monitoring activities to detect illegal contractors and check excesses of some registered wastes contractors.
4. The government evacuation trucks can serve as backup for any private contractor with vehicular issues and such contractor must be made to pay for such service.
5. Waste management contractors should be appointed based on their capacity, expertise and the process must be devoid of politics.

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CHOLERA OUTBREAK IN GENGELE COMMUNITY NORTHERN NIGERIA: THE PROBLEM AND MANAGEMENT OF REOCCURRENCE OUTBREAK

BY

Mohammed Yushau

Department of Public Health, Faculty of Health Science, Al-Hikmah University, Ilorin

E-Mail: yushau4103@gmail.com

Abstract

Cholera is a prominent indicator of a lack of social progress and one of the infectious diseases caused by *Vibrio cholera* that continues to threaten public health worldwide, especially in communities with inadequate water treatment, poor sanitation, and hygiene practices. The study aims to assess lack of information on causes, problems and management cholera outbreak. The population of this study covers the residents of Gengele Community in Adamawa State 307 participants were selected using multistage sampling technique, respondent were selected using a self-administered questionnaire to collected data using. Findings outcome the respondents fell within age 26-40 years 62.3% and 55% were female. 258 were cognizant that cholera outbreak associated with consuming contaminated food and water, 276 were agreed that limited access to hygiene services facilitate the spread of the bacteria and familiar with illness signs and symptoms. 234 express a strong sense of concern about the current insecurity and potential threat of insurgency and unplanned urbanization, underlying problem of cholera outbreak, 287 suggest that quick response to inequality in access to health facilities with boreholes in cholera hotspots and other social development facilities as means of disease management. The statistical analysis given that P-value is 18.72 and 12.36 which is < critical value 21.02 and 16.92 respectively therefore null hypothesis rejected, Conclusions drawn from the study is that the residents have a relatively robust knowledge about the cholera signs and symptoms, the residents' willingness to participate in case surveillance and reporting any signs and symptoms of cholera for immediate response. It is recommended to establish community engagement, strengthen the security of the region, and create access to hygiene services, (WASH) and health facilities by the government, NGO and religious institutions.

Keywords: Cholera, outbreak, hygiene, *Vibrio-cholera*

Introduction

For a long time, infectious diseases have been raging throughout the African nations; in addition, they have been identified as one of the leading causes of mortality. Since 2010, the number of mortalities linked to communicable diseases, such as cholera, has decreased by 1% annually (United Nations, 2020). The World Health Organization WHO (2017) predicts that before 2050, the number will occasionally rise and that the figures will probably fluctuate. The acute watery diarrheal sickness known as cholera, which is caused by *Vibrio-cholerae*, has emerged as a serious global health concern. With the exception of a significant epidemic that swept throughout Asia in 1992 and saw the development of the O139 serogroup, *Vibrio cholerae* serogroup O1 classical biotype was mostly responsible for the large-scale outbreaks that occurred over the course of seven recorded pandemics (Harris et al., 2018) The El Tor biotype first appeared during the outbreak of the seventh pandemic in 1961 and spread throughout most of Asia. In the 1970s, it swept west, touching Africa, the Middle East, and the former USSR before landing in Latin America in the early 1990s. Most recently, it caused outbreaks in Hispaniola in 2010. (Harris et al., 2018) In Nigeria, the first documented outbreak of cholera was in late 1970 with an estimated 22, 931 cases and 2, 945 deaths (Reliefweb, 2021). Beyond this, Nigeria has continued to witness outbreaks of cholera of various proportions in several regions of the country until date.

Nigeria is among the top three global hotspots for cholera cases at the moment. Due to elements like flooding, restricted access to hygienic services, and contaminated water, the spread of cholera and other waterborne illnesses is probably going to get worse (Reliefweb, 2021) Not only that, the armed banditry in the Northwest and Northeast including Adamawa, destroyed also uprooted millions of people, making it harder for them to get food and clean water, due to the current circumstances, cholera epidemics in the area have become more severe, resulting in recurrent outbreaks that are marked by high hospitalization rates, high mobility, and fatalities. Due to reporting and access concerns, it is difficult to pinpoint the exact cholera load in these two districts due to the nature of the hostilities. (Marin et al., 2023)

The recent estimates, there are over 2.9 million cases of cholera worldwide each year, with 95,000 fatalities. Africa is the most affected region, accounting for 68% of deaths and 60% of cases. (WHO, 2017) As of June 2024, 30 states in Nigeria had registered 1,141 suspected cases of cholera since January 2024. The 10 states that recorded 90% of the cases are mostly located in the southern Nigeria. According to molecular research. Using amplified fragment length polymorphism, two clusters have been found thus far (AFLP): Groups I and II. Cluster I mostly consist of strains from the 1960s and 1970s based on alterations in the clonal structure, whereas Cluster II includes strains from the 1980s and 1990s and showed a temporal pattern of change in the clone. The strains from the African Continent show this the most. (Marin et al., 2023)

The use of culture-based diagnostic techniques is constrained in many cholera-prone areas in northeastern Nigeria due to low or inappropriate laboratory capacity, unstable security circumstances, limitations on movement, lack of necessary resources, the high population in the camps and insufficient funding to the humanitarian response plans and WASH (Charnley, et al., 2022) However, the research found that a lack of knowledge about the causes, issues, and management of cholera outbreaks is especially concerning because these local communities may be the ones most severely impacted by insecurity, poor personal hygiene, inadequate health facilities, and contaminated primary water sources. Disease outbreaks are unavoidable in Adamawa State because the majority of the population, especially in Gengele Community, are rural areas with little to no access to modern amenities. In order to close the knowledge gap regarding the impact of cholera outbreaks on public and individual health and to promote healthy living, the primary goal of this study is to identify the issues surrounding the management of the outbreaks in Gengele Community, Mayo-Belwa Local Government Area, and Adamawa State, Nigeria.

Methodology

The cross-sectional survey was conducted at Gengele Community Mayo-Belwa local government of Adamawa State. Adamawa state has in general a population of 4,902,100 people of which 49.4% are females and 50.6% are males. The state has 122.7/square kilometres density with a total area of 39,940 square kilometers. Adamawa has a diverse ethnic background with rich cultures. The Adamawa state about 601 kilometers from the country's capital, Abuja, adamawa has 21 local government include, Mayo-Belwa which approximately occupied by a population of 204,200 as of 2016 (Nigeria Population Commission, 2023). Gengele Community is a settlement in Mayo-Belwa local government. Descriptive design was adopted for the study and a questionnaire was used to elicit necessary information from the respondents. The population unit of the study consists indigene and residents of Gengele Community who are between the ages of 18-60 years. The Multi-stage sampling technique was used in sample selection of the 307 who participated voluntarily, the predominant language spoken in the selected community is Hausa. Therefore, the questionnaire was translated into Hausa language. The questionnaire was pilot-tested prior to data collection. Data obtained was analyzed and presented in the frequency table, percentages, and chi-squared analysis. Anonymity and confidentiality of information were maintained. The study is a cross sectional survey to assess the problem and management of cholera outbreak. The flexible nature of quantitative methods allows for exploration of the complex phenomenon and subjective knowledge of individuals in their natural context of cholera outbreak in Gengele Community.

Results

Table 1 Demographic Characteristics of the Respondents

Parameters	Frequency and percentage	
Age: 18 – 25 years	25	(8.1%)
26 – 40 years	191	(62.3%)
41 – 60 years	86	(28%)
Above 60 Years	5	(1.6%)
Total	307	(100%)
Gender: Male	169	(55%)
Female	138	(45%)
Total	307	(100%)
Education level:		
No formal Education	146	(47.6%)
First Leaving Certificate	76	(24.8%)
O Level certificate	71	(23.1%)
First degree	11	(3.6%)
Post graduate	3	(0.9%)
Total	307	(100%)
Religion: Islam	141	(46%)
Christianity	166	(54%)
Total	307	(100%)
Monthly Income		
Less than N50,000	172	(56%)
N51000 – N200,000	69	(22.5%)
N201,00 – N500,000	38	(12.4%)
N501,000 above	28	(4.1%)

Total	307	(100%)
Marital Status: Single	25	(8.2%)
Married	182	(59.4%)
Divorced	70	(22.7%)
Separate	30	(9.7%)
Total	307	(100%)
Occupation: Unemployed		
Civil/Public Servant	34	(11%)
Self Employed	28	(9.1%)
Apprenticeship/ Student	166	(54%)
Total	79	(26%)
	307	(100%)

Table 1. Presents the demographic characteristics, the majority of the respondents fell within the 26-40 years age group (62.3%) the gender distribution of the respondents was slightly increase towards males with (55%) The respondents had diverse educational backgrounds. The largest group was those with no formal education, accounting for (47.6%), those with First Leaving Certificates (24.8%), Secondary education qualification stood at (23.1%), and first degrees (3.6%) Most of the respondents were married, representing (59.3%) followed by those who were divorced (22.7%). Base on monthly income the respondents showed that the largest group (56%) earned below N50, 000 per month and the smaller proportion are earning N501, 000 above were (9.1%) The largest group was self-employed individuals, comprising (54%), this was followed by artisans/ students/apprenticeships (26%) as indicated in the able above.

Table 2: Respondents' Problems of cholera out break

Statements	SA	A	D	SD
I am aware that Cholera is an acute diarrhoeal infection caused by ingestion of food or water contaminated with the bacterium <i>Vibrio cholerae</i> .	168 (55%)	90 (29.2%)	21 (6.8%)	28 (9%)
I know that Cholera is an indicator of inequity, lack of social development and limited access to hygiene services	152 (49.5%)	106 (34.5%)	23 (7.5%)	26 (8.5%)
I understand the potential health risks	162	82		

associated with consuming contaminated food or water.	(52.8%)	(26.7%)	33 (10.7%)	30 (9.8%)
I am familiar with the signs and symptoms of Cholera illnesses caused by ingestion of contaminated food or water	160 (52%)	86 (28%)	25 (8%)	36 (12%)
I know & understand that disease tends to spread more easily due to poor drainage systems, water hygiene sanitation (WASH) practices	106 (34.5%)	128 (41.7%)	38 (12.4%)	35 (11.4%)
I understand that Cholera can cause severe acute watery diarrhoea and the severe forms of the disease can kill within hours if left untreated health.	164 (53.4%)	131 (42.6%)	7 (2%)	5 (2%)
I have received some educational or awareness-raising information about the effects cholera outbreak	72 (24%)	53 (17%)	105 (34%)	77 (25%)

Table 2 shows that a significant number of respondents (55% strongly agree and 22.9% agree) are aware that cholera is caused by consuming food or water contaminated with the bacterium *Vibrio cholerae*, and that (49.5% strongly agree and 34.1% agree) that cholera is an indicator of inequity, lack of social development, and limited access to hygiene services; they also understand the potential health risks associated with consuming contaminated food or water (52.8% strongly agree and 26.7% agree); they were generally aware of the signs and symptoms of cholera illnesses, and a large number of respondents (34.1% strongly agree and 41.7% agree) with the statement that cholera outbreaks due to poor drainage and WASH practices. 41.7% of respondents agreed with the statement, and 34.1% strongly agreed. Additionally, the majority of respondents (42.6% agree and 53.4% strongly agree) were aware that cholera can induce vomiting and severe watery diarrhea, which can be fatal within hours if treatment is not received. However, a lesser percentage of respondents had received some instructional or awareness-raising information regarding the effects of the cholera outbreak (24% strongly agree and 17% agree). When asked about the role of insecurity in northern Nigeria, the majority of respondents (54.3% strongly agreed and 39.1% agreed) said that insurgency banditry had displaced millions of people and that a key issue of recurrence was the lack of access to clean water, food, and hygiene facilities. Unplanned urbanization, conflict and climate changes was also cited as problems of recurrent outbreak of cholera by a greater percentage of respondents (49% agreed and 31.5% strongly agreed).

Table 3: Management of cholera outbreak

Statement	SA	A	D	SD
Community should be actively involved in surveillance and reporting any signs and symptoms of cholera illness, for immediate response	35 (11%)	33 (11%)	111 (36%)	128 (42%)
Targeting personal hygiene and water treatment as well as emergency responses will control the outbreak	160 (52.1%)	88 (28.7%)	23 (7.5%)	36 (11.7%)
I am willing to support and participate in initiatives aimed at preventing and management of the outbreak in my community.	172 (56%)	71 (23%)	24 (8%)	40 (13%)
I believe simple measures such as, use of soap and hand washing promotion (fruits and vegetables), boiling the water for drinking, cooking and other purposes can eradicate the cholera outbreak.	158 (51.5%)	102 (33.2%)	21 (6.8%)	26 (8.5%)
Finding lasting solutions to the ongoing insurgency and banditry, proper disposal of infected materials, sewages and drainage systems	171 (55.7%)	120 (39.1%)	5 (1.6%)	11 (3.6%)
Immunization with currently available cholera vaccines be used in conjunction with the usually recommended control measures in areas where cholera is endemic as well as in areas at risk of outbreaks.	160 (52.1%)	88 (28.7%)	36 (11.7%)	23 (7.5%)
I am confident that my community can work together to find effective solutions to the issue of cholera outbreak reoccurrence	170 (55.4%)	76 (24.7%)	27 (8.8%)	34 (11.1%)

Findings in Table 3 indicate that the majority of respondents (42% strongly disagree and 36% disagreed) that community should not involve in surveillance and reporting any signs and symptoms of cholera. Majority of respondents (52.1% strongly agree and 28.7% agreed) that personal hygiene and water treatment as well as quick emergency responses will control the outbreak. The majority of respondents (38% strongly agree and 42% agree) were willing to support and participate in initiatives aimed at preventing and management of the outbreak in their community. Similarly, majority of the respondents (51.5% strongly agreed and 32.2% agreed) confident that simple measure, such as use of soap and hand washing promotion (fruits and vegetable), boiling the water for drink can eradicate cholera outbreak in their community. Finally, a significant proportion of the respondents (55.4% strongly agreed and 24.7% agreed) were confident that there community has the ability to work together to find effective solutions to the issue of cholera outbreak reoccurrence as indicate in table 3.

Hypothesis

Table 4 Contingency Table: Age and understanding of problem and management of cholera outbreak

Age	Strongly Agree	Agree	Disagree	Strongly Disagree	Row Total
18 – 25	8	11	4	2	25
26 – 40	65	58	39	29	191
41 – 60	41	22	11	12	86
Above 60 Years	2	3	0	0	5
Column Total	116	94	54	43	307

The data in table 4 above shown that calculated chi-square value (12.36) is less than the critical value (16.92), the null hypothesis is rejected, hence, the alternate hypothesis is accepted, and therefore there is statistically significant relationship between age and understanding problem and management of cholera outbreak.

Table: 5 Contingency Table Gender and understanding of problem and management of cholera outbreak

Gender	Strongly Agree	Agree	Disagree	Strongly Disagree	Row Total
Male	49	47	31	42	169
Female	37	50	21	30	138
Column Total	86	97	52	72	307

The finding in table 5 state that chi-square value of (15.31) is higher than the critical value of (7.81) therefore, the null hypothesis is rejected, hence, it can be concluded that there is statistically significant association between the respondents' Gender and understanding problem and management of cholera outbreak.

Table 6: Contingency Table Education Qualification and understanding of problem and management of cholera outbreak

Educational Qualification	Strongly Agree	Agree	Disagree	Strongly Disagree	Row Total
No formal Education	30	27	41	48	146
First Leaving Certificate	23	11	27	15	76
Senior Secondary	31	23	9	8	71
HND/Bachelor	11	0	0	0	11

Post graduate	3	0	0	0	3
Column Total	98	61	77	71	307

The calculated chi-square value (18.72) is less than the critical value (21.02), the null hypothesis is rejected, hence, the alternate hypothesis is accepted, and therefore there is statistically significant relationship between Education qualification and understanding problem and management of cholera outbreak.

Discussion of Findings

The research revealed a number of characteristics that are important in the management of cholera outbreaks, such as civil unrest and terrorism-related activities that hinder access to clean water (as indicated in table 3) and inadequate environmental sanitation. According to another study that qualitatively evaluated Mozambique's resistance to cholera intervention, this result is consistent. Démolis et al., (2018). Contribute to the current corpus of research on community viewpoints regarding environmental and public health issues associated to cholera outbreak management techniques, and offer insightful explanations of the problem and management of cholera outbreaks.

According to table 2, the study's findings on residents' prevalent attitudes toward personal hygiene, water, sanitation, and hygiene practices are linked to risks that are in line with studies that have found that community concern is a motivating factor for advocacy and participation in environmental assessments (Abdulrahim et al., 2022; Elimian, et al., 2020). Communities are frequently prompted to take an active role in resolving issues when they see a threat to their environment or well-being. Residents of the Gengle neighborhood have voiced a great deal of concern about the possible effects of water and food contamination quality as well as hygiene services, which shows that they understand how serious the problem is and want to protect the health of their community.

Additionally, studies that have examined the impact of perceived vulnerability on risk perceptions and related health behaviors are in line with the perception of personal and ancestral risk resulting from the close proximity to consuming food and water contaminated with the vibrio cholerae bacteria (OCHA., 2022) People's perceptions of risk are often elevated and they are more inclined to take preventative or protective measures when they perceive that environmental risks directly threaten them. The proximity of tainted water supplies, which the people of Gengle depend on for both household and agricultural needs, makes them feel vulnerable.

According to table 3 results, residents have a reasonably solid understanding of the composition and possible risks of managing cholera outbreaks. This is consistent with earlier research that emphasized the significance of public education and awareness in controlling environmental risks. The findings is inconsistency with recent study (Olanrewaju & Adepoju, 2021). This result implies that public education campaigns about the risks of cholera outbreaks have been effective in increasing awareness among Gengle community members. In order to promote community involvement and support for risk-reduction strategies, public knowledge and comprehension of environmental issues are crucial.

According to table 2, which shows a high degree of knowledge of cholera signs and symptoms, the respondents indicate that attempts have been made to educate the public about the possible risks of cholera outbreaks and recurrences, which is consistent with earlier research that (Abdulrahim et al., 2022). These initiatives, which could have taken the form of community gatherings, public education campaigns, or the distribution of educational materials on topics such as the dangers of open defecation, the importance of washing your hands, the importance of participating in case surveillance, and the need to report cases promptly, have been instrumental in providing locals with the knowledge they need to identify the risks of contaminated food and water.

The diversity of concern towards current cholera outbreak management practices and the perceived threat to health quality aligns with findings from other studies that have documented varying community perspectives on environmental issues (Abubakar, et al., 2016; Elimian et al., 2020). This diversity highlights the need for a nuanced

and inclusive approach that considers the different viewpoints and prioritizes, community participation on their health decision making, open dialogue and participatory decision-making processes.

The known correlation between age, gender, and educational attainment is supported by the statistically significant relationship between cholera outbreak management issues and sociodemographic traits on human health (Olanrewaju & Adepoju, 2021). Furthermore, table 4 and table 6's findings that age and educational attainment have an impact on knowledge of cholera outbreaks and health consequences are consistent with earlier studies that examined how sociodemographic traits shape environmental risk of cholera (Gwenzi et al., 2019). This implies that in order to effectively address the problems of various age groups within the community, education, age-specific considerations, and focused communication tactics may be required.

Conclusion

The outcome of these findings offers important information that can guide initiatives to reduce the risks of the cholera outbreak, manage it, prevent it from happening again, and advance public health and environmental protection. The main findings of the study indicate that the locals possessed a reasonably thorough understanding of the symptoms and indicators of cholera as well as its possible risks. To stop the rapid spread of cholera and its accompanying hazards, the study also found that residents had varying levels of willingness and perceptions to participate in case surveillance and report any signs and symptoms for prompt action.

Additionally, the results of this study highlight the value of inclusive and community-based approaches in tackling issues associated to cholera outbreaks. Cholera necessitates a strong multi-sectoral response because it is both a health issue and a socioeconomic development concern. Economic growth and universal access to clean drinking water and basic sanitation are the long-term solutions to cholera control. Through acknowledging the various viewpoints in the community, encouraging candid communication, and supporting well-informed decision-making procedures, authorities and interested parties can create all-encompassing plans that put public health and clean water supplies first.

Notably, the study found that age and educational attainment were sociodemographic factors that influenced knowledge of the cholera outbreak and its health effects. This was statistically significant, as shown in table 6, whereas gender did not show any significant associations, as shown in table 5 above. Public education plays a significant influence in influencing attitudes, and it is suggested that ongoing initiatives to spread correct knowledge might support well-informed decision-making.

Recommendations

Preventing the recurrence of cholera in communities requires a multi-faceted approach involving government, community leaders, healthcare providers, educational institutions, and individuals. Here are tailored recommendations for each group:

Government should:

1. **Strengthen Water and Sanitation Infrastructure:** Invest in clean water supply systems and proper sanitation facilities. Ensure regular maintenance and monitoring of these systems.
2. **Implement Surveillance Systems:** Establish robust disease surveillance systems to quickly identify and respond to cholera outbreaks. This includes monitoring water quality and reporting cases promptly.
3. **Emergency Preparedness Plans:** Develop and regularly update emergency response plans for cholera outbreaks, including stockpiling necessary medical supplies and vaccines.

Community Leaders should:

1. Promote Hygiene Practices: Encourage the community to adopt good hygiene practices, such as handwashing with soap, especially before meals and after using the toilet.
2. Community Clean-Up Initiatives: Organize regular clean-up drives to eliminate potential breeding grounds for cholera, such as stagnant water and waste accumulation.
5. Support Vulnerable Populations: Identify and support vulnerable groups within the community, ensuring they have access to clean water and sanitation facilities.

Healthcare Providers should:

- 1 Rapid Response Teams: Establish rapid response teams to address cholera cases promptly and effectively, ensuring that treatment is accessible to all.
2. Promote Oral Rehydration Solutions (ORS) and Vaccination Campaigns: Educate patients and communities about the importance of ORS in treating dehydration caused by cholera.
5. Data Collection and Research: Collect and analyze data on cholera cases to identify trends and inform prevention strategies.

List of Abbreviations

WASH: Water Sanitary and hygiene

NCDC: Nigeria Centre for Disease Control

OCV: Oral cholera vaccine

LGA: Local Government Area

ORS: Oral Rehydration Solutions

Declaration

Ethics approval and consent to participate

Ethical approval was obtained from Ethical Review Committee of Adamawa State Ministry of Health. The king of the community and his council of chiefs were informed of the research. The head of Primary Health care in Mayo-Belwa Local Government Area was also put in the known. The objective and procedure of this study were explained to all participants. Participation is voluntary, and participants were allowed to discontinue at any stage of the study, privacy and confidentiality of every participant was ensured.

Availability of data and material

The data and material used during this study are generated from primary source and available with the corresponding author on reasonable request, included in this manuscript submitted.

Competing interests

The author declares that no competing interests

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EFFECT OF DIETARY SHEA NUT CAKE AND RICE HUSK FERMENTED WITH *RHIZOPUS OLIGOSPORUS* ON GROWTH PERFORMANCE AND SERUM ELECTROLYTES OF WEANER PIGS

BY

Apata, D.F.¹, Adesina, O.M.¹, Ishola, H.¹, Adedayo, M.R.² & Adebisi, O.A.³

¹ Department of Animal Production, Kwara State University, Malete, Nigeria

² Department of Microbiology, Kwara State University, Malete, Nigeria

³ Department of Animal Science, University of Ibadan, Ibadan, Nigeria

Email: david.apata@kwasu.edu.ng

Abstract

The high cost of conventional feed ingredients has led to the search for alternative feed sources for pig production. This study investigated the effect of dietary fermented shea nut cake (FSNC) and fermented rice husk (FRH) with *Rhizopus oligosporus* on the growth performance and serum electrolytes of weaner pigs. Solid-state fermentation using *R. oligosporus* CBS 534 was carried out on rice husk and shea nut cake for 10 days. 36 Duroc x Large White weaned pigs (18 males and 18 females), with an average age and weight of 8 weeks and 10 ± 2 kg were randomly assigned to dietary treatments in a 3 x 3 x 2 factorial arrangement. The factors included FSNC (0, 5, or 10%) x FRH (0, 5, or 10%) in diets x sex (male or female) in a completely randomised design with 18 treatments and 2 replicates over a period of 5 weeks. Results showed that the feed intake and weight gain were not significantly ($P > 0.05$) influenced by dietary FSNC and FRH. Feed conversion ratio was significantly ($P < 0.05$) affected by dietary FSNC, FRH and sex. The serum electrolyte concentrations showed that pigs fed FSNC had a significant ($P < 0.05$) effect on HCO_3^- , FRH significantly ($P < 0.05$) influenced Na and Cl, and sex had a significant ($P < 0.05$) effect on Na. Pigs fed FSNC showed reduced HCO_3^- concentration with increasing FSNC inclusion. The findings suggest that up to 10% FSNC and FRH could be incorporated into weaner pig diets without adverse effect on growth performance and electrolyte balance.

Keywords: shea nut cake, rice husk, *Rhizopus oligosporus*, weaned pigs, serum electrolytes

Introduction

A major problem for the expansion of the pig industry is the short supply of conventional feed ingredients, which are expensive, compelling the use of alternative feedstuffs (Atteh and Apata, 2024). Shea nut cake (SNC) and rice husk (RH) are major agro-industrial by-products that are readily available in large quantities at a low cost. RH consists of 39-42% crude fibre, 2.9-3.6% crude protein, 8-12% ether extract, and 15-22% ash and is limited in usage for monogastric animals due to its high fibre content (Aderolu et al., 2007). SNC is an agroforestry by-product obtained from the processing of nuts of the shea butter tree (*Vitellaria paradoxa*) that explored its fat with no economic value (Dei et al., 2008). Abdul-Mumeen et al. (2013) reported that its overall nutritional value contained 13.03, 23.38, 4.25, 8.71, 59.37% and 4485.86 kcal ME kg⁻¹ of crude protein, crude fat, ash, crude fibre, carbohydrates, and metabolisable energy, respectively. SNC has been used for dietary maize replacement in poultry rations (Aguihe et al., 2017). However, the presence of anti-nutritional factors like saponins, alkaloids, phytic acids and tannins resulted in its poor digestibility possibly (Annongu et al., 1996; Oddoye et al., 2012). RH included at 10-20% replacement of maize led to decreased growth performance and increased the rate of mortality among weaner pigs (Ejiofor et al., 2024); high fibre in RH resulted in poor digestibility in pigs (Omotoso and Arilekolasi, 2019).

Fermentation is a distinctive process with great potential for re-recycling some agro-industrial by-products into useful animal feeds. The process does not require the use of chemicals and is easy to manage in on-farm settings and/or on an industrial scale. Fermentation processes using *Rhizopus* species have been used to improve the nutritive value of some feeds, such as soybean pulp for pigs (Vong et al., 2018). Kehinde et al. (2020) observed that solid-

state fermentation improved the nutritive value of SNC. Mafimidiwo (2022) reported that solid-state fermented rice husk could replace up to 75% wheat offal in the diet of growing pigs.

The blood biochemical profile, including the electrolytes, is an index for the health of livestock. The normal blood biochemical indices have been found to be influenced by sex, diet, and feeding method (Adeyemo et al., 2018). Electrolytes are important components in livestock, such as Na, K, and Cl concentrations in blood, which reflect the changes of electrolyte balance, and their concentrations within the normal range are important in maintaining physiological function (Mushtaq et al., 2005; Gonzalez-Esquerria et al., 2006). Potassium plays a vital role in regulating the osmotic pressure of cells, as well as maintaining the acid–base and electrolyte balances of body fluids (Wei et al., 2023). RH is acknowledged for its high fibre and low protein content, along with antinutritional factors such as tannins, saponins, alkaloids, and phytates in SNC, which hinder its application as feed for pig production. The necessity of enhancing the nutritional value and minimising the harmful constituents in these materials has led to the cost-effective application of solid-state fermentation (SSF), a fungal biotechnology that transforms these wastes into beneficial feed for pigs. This study investigated the growth performance and blood electrolytes of weaned pigs fed shea nut cake and rice husk fermented with *Rhizopus oligosporus*

Materials and methods

Experimental site

The research was carried out at the piggery unit of the Teaching and Research Farm, Kwara State University, Malete, Nigeria, which is located in the Southern Guinea Savanna Vegetation Ecological zone on longitude 11° 71'N and latitude 40° 44'E 671m above sea level.

Preparation of fermented rice husk and shea nut cake

RH and SNC were obtained from Ilesha-Baruba, Baruteen Local Government Area, Kwara State. Samples (500 kg) each of the RH and SNC were milled and then subjected separately in batches to the SSF process. The fungus used for fermentation was *Rhizopus oligosporus* CBS 534, and the stock was obtained from the Microbiology Laboratory, Kwara State University, Malete.

In preparing suspension, *R. oligosporus* CBS 534 was cultivated on potato dextrose agar (PDA) at 28±1°C for 7 days, after which it was subcultured to obtain a pure suspension containing 5 x 10⁴ spores ml⁻¹ following the procedure outlined by Hesseltine (1983). A batch (1 kg) each of the RH and SNC were separately autoclaved at 121°C for 15 min. Autoclaved meals were cooled to room temperature for 1 h, hydrated with distilled water at a ratio of 1:1.5 (w/v), and inoculated with 20 ml of spore suspension of *R. oligosporus* CBS 534 per kg of wet meal. The meal was thoroughly mixed and fermented in an airtight plastic bucket for 10 days. The fresh fermented samples were then re-autoclaved at 121°C for 15 min to destroy *R. oligosporus* and sun-dried for 5 days. The dried products were ground in the mill, packed in a polythene sack, sealed and stored at ambient temperature until mixed into diets described below.

Pigs, diets, management and experimental design.

Thirty-six Duroc x Large White weaned pigs (18 males and 18 females) with an average age and weight of 8 weeks and 10 ± 2 kg were randomly assigned to dietary treatments in a 3 x 3 x 2 factorial arrangement. The factors included FSNC (0, 5, or 10%) x FRH (0, 5, or 10%) in diets x sex (male or female) in a completely randomised design with 18 treatments and 2 replicates over a period of 35 days. The dietary formulation is presented in Table 1.

The weaner pigs' initial weight was recorded at the beginning of the feeding trial and thereafter weekly using a weighing balance. The final weight was also recorded at the end of the feeding trial. The weight gain was computed as the difference between the final weight and the initial weight measured. The mean weight gain was then computed. The feed intake per pig per day was estimated by subtracting the feed offered from the feed left over.

Electrolyte Determination

At the end of the experimental period, one weaner pig was randomly selected from each replicate, and blood samples were collected into clean, dry tubes for serum electrolyte analysis. Serum samples were separated from whole blood by centrifugation at 3000 rpm for 10 min and stored at -4°C. All the parameters viz. sodium (Na), potassium (K), chloride (Cl), and bicarbonate (HCO₃) were analysed by using the Acculyte-3P electrolyte analyser (Shakkarpude et al., 2023).

Statistical analysis

Data were analysed using a three-way analysis of variance (ANOVA) and SPSS version 25. Duncan's multiple range test was used to determine significant differences at the 0.05

Table 1 Formulation (gkg⁻¹) of weaner pig diets

	Diets								
	1	2	3	4	5	6	7	8	9
Ingredients									
Maize	430.0	430.0	430.0	360.0	350.0	330.0	330.0	330.0	330.0
Fermented shea nut cake (FSNC)	0	50.0	100.0	0	50.0	100.0	0	50.0	100.0
Fermented rice husk (FRH)	0	0	0	50.0	50.0	50.0	100.0	100.0	100.0
Groundnut cake	354.0	255.0	95.0	330.0	250.0	50.0	285.0	200.0	50.0
Soybean meal	40.0	70.0	150.0	63.0	65.0	195.0	100.0	115.0	175.0
Cassava powder meal	30.0	20.0	50.0	30.0	30.0	30.0	40.0	30.0	50.0
Maize offal	97.0	100.0	50.0	100.0	100.0	100.0	50.0	50.0	20.0
Vegetable oil	3.0	10.0	30.0	20.0	30.0	50.0	40.0	50.0	60.0
Blood meal	1.0	20.0	50.0	2.0	30.0	50.0	10.0	30.0	70.0
Limestone	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Bone meal	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5

Vitamin/mineral premix ^a									
Lysine	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Methionine	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Salt	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Nutrient content ^b (gkg ⁻¹)									
Crude protein	209.7	208.1	206.9	206.7	203.7	206.7	207.2	206.5	207.4
Crude fibre	41.6	62.1	57.1	38.1	64.8	55.5	42.2	64.8	55.9
Ether extract	55.8	84.5	76.4	62.4	86.3	71.0	54.9	83.5	68.4
Calcium	13.9	14.1	13.7	14.1	13.8	13.8	13.6	14.1	13.9
Phosphorus	6.3	4.5	5.2	5.1	5.2	5.7	5.9	5.6	6.1
Methionine	5.4	5.0	5.0	5.1	5.0	5.1	5.2	5.2	5.3
Lysine	13.2	14.3	13.7	13.6	13.3	13.3	13.1	13.5	13.2
Metabolizable energy (MJ kg ⁻¹)	12.0	11.7	11.8	11.4	11.8	11.9	11.9	11.9	11.8

^a Provided 1.5 mg retinol, 25 mg cholecalciferol, 16 mg α -tocopherol, 1mg menadione, 0.8 mg thiamine, 2.4 mg riboflavin, 14 mg nicotinic acid, 4 mg calcium D-pantothenate, 1.4 mg pyridoxine, 10 mg cyanocobalamin, 0.4 mg folic acid, 0.02 mg biotin, 120 mg choline chloride, 0.62 mg zinc bacitracin, 36 mg avaten, 40 mg Mn, 18 mg Zn, 0.8 mg Cu, 0.09 mg Co, 20 mg Fe, and 0.04 mg Se kg⁻¹ diet.

^b Determined values except for metabolisable energy (ME), lysine, methionine, calcium and phosphorus which were calculated from the published (NRC, 2024) compositions of the ingredients used and the ME of FSNC and FRH was estimated from their analytical data (Pauzenga, 1985).

Results and Discussion

The effect of dietary *Rhizopus oligosporus* FSNC and FRH at varying inclusion rates on the weaner pigs' growth performance is shown in Table 2. The FSNC and FRH did not significantly affect the feed intake and weight gain ($P > 0.05$). However, there was a trend of increase in the feed intake and weight gain with increasing dietary FSNC. Feed conversion ratio (FCR) was significantly affected by dietary FSNC and FRH and sex. There was no interaction between FSNC x FRH and FSNC x Sex on feed intake and weight gain, but there was an interaction among FSNC x FRH x Sex on FCR. The slight increase in the observed feed intake and weight gain in the weaner pigs with increasing FSNC inclusion compared to those fed the control diet could be ascribed to the fermentation process which improved the nutritive value of SNC. This is in agreement with Dei et al. (2008), who reported improved nutritive value of SNC for poultry, consequent upon reduction in the adverse effect of anti-nutritive factors such as tannins and saponins in SNC (Annongu et al., 1996). FCR improved significantly in female weaner pigs fed both FSNC and FRH compared to their male counterparts. This could be potentially related to hormonal or metabolic

differences between males and females. Weaner pigs fed 10% FRH had an increase in FCR values, indicating inefficient conversion of the feed material at that level. This could be partly attributed to decreased nutrient digestibility and lower energy utilisation linked to high fibre in FRH. This corroborates earlier reports of Omotoso and Arilekolasi (2019) and Hamid et al. (2020).

Table 2: The effect of *Rhizopus oligosporus* fermented sheanut cake and rice husk at different inclusion rate on the growth performance of weaner pigs

Treatment	Initial body weight (kg)	Final body weight (kg)	Feed intake (kg per pig day ⁻¹)	Weight gain (kg per pig day ⁻¹)	FCR
FSNC (%)					
0	10.42 ± 0.41	23.20 ± 0.81	1.20	0.37	3.24 ^b
5	10.12 ± 0.41	23.88 ± 0.67	1.28	0.39	3.28 ^b
10	10.57 ± 0.47	24.63 ± 0.87	1.33	0.40	3.33 ^b
FRH (%)					
0	10.38 ± 0.32	24.13 ± 0.43	1.27	0.39	3.25 ^b
5	9.68 ± 0.31	23.03 ± 0.73	1.25	0.38	3.28 ^b
10	11.03 ± 0.53	24.55 ± 1.06	1.30	0.38	3.42 ^c
Sex					
Female	10.23 ± 0.33	23.46 ± 0.56	1.20	0.38	3.15 ^a
Male	10.50 ± 0.37	24.36 ± 0.71	1.38	0.39	3.54 ^d
Interaction					
FSNC x FRH	ns	Ns	ns	ns	ns
FSNC x Sex	ns	Ns	ns	ns	ns
FRH x Sex	ns	Ns	ns	ns	ns
FSNC x FRH x Sex	ns	Ns	ns	ns	*

Means values with superscript ^{abcd} within the same factor and within the same column are significantly different ($p < 0.05$), FCR= Feed Conversion Ratio, FSNC = fermented shea nut cake, FRH = fermented rice husk, ns = not significant. *= significant

Table 3: Effect of dietary shea nut cake and rice husk fermented with *Rhizopus oligosporus* on serum electrolytes of weaner pigs

Treatment	K ⁺ (mmol/L)	Na ⁺ (mmol/L)	Cl ⁻ (mmol/L)	HCO ₃ ⁻ (mmol/L)
FSNC (%)				
0	5.53	139.17	97.33	22.58 ^a
5	5.21	140.17	97.92	21.42 ^{ab}
10	5.84	139.33	98.42	19.08 ^b
FRH (%)				
0	5.31	139.58 ^{ab}	97.58 ^b	21.58
5	5.78	141.17 ^a	99.25 ^a	20.92
10	5.49	137.92 ^b	96.83 ^b	20.58
Sex				
Female	5.46	138.72 ^b	97.89	21.00
Male	5.60	140.39 ^a	97.89	21.06
Interactions				
FSNC x FRH	ns	ns	Ns	*
FSNC x Sex	ns	ns	Ns	*
FRH x Sex	ns	ns	ns	ns
FSNC x FRH x Sex	ns	ns	ns	ns

Means values with superscript ^{ab} within the same factor and within the same column are significantly different ($p < 0.05$), FRH= Fermented Rice Husk, FSNC = Fermented Shea nut cake, K⁺ = Potassium, Na⁺ = Sodium, Cl⁻ = Chloride, HCO₃⁻ = Bicarbonate

The serum electrolyte concentrations of weaner pigs fed FSNC and FRH are presented in Table 3. The results revealed that pigs fed FSNC had a significant ($P < 0.05$) effect on bicarbonate (HCO₃⁻), the FRH significantly ($P < 0.05$) influenced Na and Cl, and sex had a significant ($P < 0.05$) effect on Na. Pigs fed FSNC showed reduced HCO₃⁻ concentration with increasing FSNC inclusion. There was no main effect of the three factors or interaction on K concentration in weaner pigs. In the present study, the serum values obtained for most of the electrolytes are within the normal range for pigs (Yeom et al., 2012), which are important in maintaining physiological functions (Mushtaq et al., 2005; Gonzalez-Esquerria et al., 2006). The serum electrolyte concentrations of weaner pigs fed FSNC and FRH revealed significant effects on some electrolytes. However, the decrease in HCO₃⁻ in weaner pigs with increasing FSNC inclusion could affect the acid-base balance in the pigs. Similar findings have been reported by Lin et al. (2024), who found decreased pH and HCO₃⁻ in piglet blood fed low-protein diets. Generally, HCO₃⁻ are waste products of mitochondrial energy production that play a role in pH buffering throughout the body. As a result, they neutralise bases (urea from the catabolism of proteins) and acid produced in the blood through other metabolic processes (Kumari et al. 2014).

The Na and Cl balance is one part of the internal environment homeostasis that is necessary to maintain the health of the small intestine of pigs (Zhang et al., 2022). In the present investigation, the significant influence of FRH on Na and Cl concentrations observed suggests that FRH may have a specific effect on the regulation of these electrolytes. The sex-related difference in Na concentration warrants further investigation, potentially related to hormonal or metabolic differences between males and females. In conclusion, the findings demonstrate that up to 10% FSNC and FRH could be incorporated into weaner pig diets without adverse effects on growth performance and electrolyte balance.

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IMPACT OF ARTIFICIAL INTELLIGENCE (AI) ON JOURNALISM PRACTICE IN NIGERIA

BY

Gambari-Jejelola Latifat¹, Tope Joseph Olorunmola¹, Bashir Amoda Ajijola¹, Thanni Abdulhammed Maimasa² & Abdulhafeez Taiye Oyewole³

¹Department of Mass Communication, Faculty of Humanities and Social Sciences, Al-Hikmah University, Ilorin

²Department of Mass Communication, School of Information and Communication Technology, College of Arabic and Islamic Legal Studies, Kwara CAILS, Ilorin

³Albarka 89.9 FM, BOA Junction, Ganmo, Kwara State

Email: temitopeolorunmola@gmail.com / maimasa89@gmail.com / Abdulhafeezoyewole1@gmail.com

Abstract

This research examines the ways artificial intelligence (AI) is transforming journalism in Nigeria, exploring its capacity to fundamentally change how news is gathered, processed, and shared. This study reveals that Nigerian newsrooms are swiftly adopting AI tools to automate tasks like transcribing interviews, personalize content for individual readers, monitor social media for breaking news, and fact-check information. This adoption holds the promise of increased efficiency and productivity, greater audience engagement, and reduced operational costs. However, this study also emphasizes the need to address challenges such as the potential displacement of human journalists, the risk of algorithmic bias, ethical concerns surrounding AI-generated content, and the limitations posed by Nigeria's technological infrastructure. Through an analysis of real-world examples, this study highlights both the successes and setbacks of AI integration in Nigerian media. This includes examining the introduction of "Leo," Africa's first AI chatbot launched by the United Bank for Africa (UBA) to provide personalized financial advice, as well as a case study of an AI-powered tool designed to interpret medical images. Furthermore, this research explores emerging AI technologies with the potential to revolutionize investigative journalism by analyzing vast datasets, personalize news experiences for individual users, and create immersive storytelling formats. This study acknowledges the broader implications of AI for Nigeria's media, including its potential to reshape how news is consumed, influence media ownership and control, and redefine the role of journalists in society. It underscores the importance of media organizations proactively developing AI literacy programs, collaborating with AI developers to create tools tailored to their needs, establishing ethical guidelines for AI use, addressing infrastructure limitations, and fostering a culture of innovation. Journalists are encouraged to adapt by acquiring new skills, upholding journalistic ethics in the AI era, collaborating with AI developers, and critically evaluating AI-generated content. Finally, this study provides detailed recommendations for policymakers to promote AI literacy among the public, invest in crucial infrastructure, develop regulatory frameworks for AI in media, and support research and development in this field.

Keywords: Artificial Intelligence, Journalism, Newsrooms, AI Ethics

Introduction

Artificial intelligence (AI) is rapidly changing the world around us, and its impact is being felt in a variety of industries and Journalism is no exception (Thomas, 2022). AI is already being used in newsrooms around the world to automate tasks, personalize content, and even generate news stories. This is particularly true in Nigeria, where AI is being used to help journalists overcome the challenges of reporting in a complex and rapidly changing environment (Pavlik, 2023). The Nigerian media scene has undergone substantial transformations since the inception of the first printing press in 1846 (Makinde, 2024). The journey began with the publication of "Iwe

Irohin," a newspaper that primarily served as a missionary tool (Ogbondah & Anim, 2016). Over time, the media scene expanded to include radio broadcasting in 1933 and television broadcasting in 1959 (Nnayanwu & Nwanyanwu, 2021). Journalism in Nigeria has a long and rich history, dating back to the colonial era (Ogbiten, 2010). The first newspapers in Nigeria were founded in the 19th century, and they played an important role in the struggle for independence (Maringues cited in Pavlik, 2023). After independence, the Nigerian media continued to grow and develop. Today, there are hundreds of newspapers, magazines, radio stations, and television stations in Nigeria (Larraz, 2023).

The transition from traditional media to the modern era was marked by the rise of the internet. This digital revolution opened up new avenues for information dissemination and consumption. Traditional media outlets had to adapt to the changing times, embracing online platforms to remain relevant in the face of increasing competition from new media entities (Al-Zoubi, Ahmad & Hamid, 2024). In recent years, the prominence of artificial intelligence (AI) has grown significantly, impacting various sectors, including journalism. AI refers to the development of computer systems capable of performing tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation (Alzoubi *et al.*, 2024). There are a number of ways that AI is being used in Nigerian newsrooms. For example, AI is being used to automate the process of transcribing interviews, translating languages, and generating news summaries (Gondwe, 2024). AI is also being used to help journalists personalize content for their audiences. Additionally, AI is being used to create new forms of investigative reporting and to help verify and fact-check information (Alzoubi *et al.*, 2024). AI is also being used to personalize the user experience. For example, some news organizations are using AI to recommend articles to readers based on their interests. The integration of AI into journalism has been met with mixed reactions. Some hail it as a revolutionary tool that can enhance efficiency and productivity, while others express concerns about its potential to displace human journalists (Makinde, 2024).

The impact of AI on journalism practice in Nigeria is significant. AI is helping journalists to be more efficient and effective. It is also helping to create new forms of journalism and to reach new audiences. However, AI is also raising several ethical challenges for journalists (Sonni, Hafied, Irwanto & Latuheru, 2024). For example, there is the risk that AI could be used to create fake news or spread propaganda (Shukla & Tripathi, 2024). There is also the risk that AI could lead to job losses in the journalism industry. It is important to note that the adoption of AI in Nigerian newsrooms is still in its early stages. However, AI is already significantly impacting journalism practice in Nigeria (Nneji, 2024). This study aims to explore how AI is used in Nigerian newsrooms and the challenges and opportunities AI presents to journalists. Using a conceptual approach, it provides insights into the potential of AI in a developing country context. Nigeria is the most populous country in Africa and has a large and growing media industry. The findings of this study will be of interest to journalists, media scholars, and policymakers in Nigeria and other developing countries.

Objectives of the Study

This study aims to explore how AI is used in Nigerian newsrooms and the challenges and opportunities AI presents to journalists. The objectives include to:

- i. examine the current applications of AI in Nigerian newsrooms;
- ii. assess the perceived benefits and challenges of AI adoption in Nigerian journalism;
- iii. investigate the ethical implications of AI in Nigerian journalism;
- iv. analyze the potential of emerging AI technologies in reshaping Nigerian journalism;
- v. identify the implications of AI for the future of news consumption, media ownership, and the role of journalists in Nigeria;
- vi. provide recommendations for media organizations, journalists, and policymakers on how to effectively navigate the AI revolution in the Nigerian media.

Literature Review

Artificial intelligence (AI) is the development of computer systems capable of performing tasks that typically require human intelligence, such as visual perception, speech recognition, decision-making, and language translation (Mukasa, 2024). AI is already being used in newsrooms around the world in a variety of ways. For example, AI is being used to automate the process of transcribing interviews, translating languages, and generating news summaries. AI is also being used to help journalists personalize content for their audiences (Guanah, Agbanu & Obi, 2020). Additionally, AI is being used to create new forms of investigative reporting and to help verify and fact-check information. It is important to note that the impact of AI on journalism practice in Nigeria is not limited to the newsroom. AI is also impacting how news is consumed and shared. For example, AI is also being used to personalize the user experience. For instance, some news organizations are using AI to recommend articles to readers based on their interests (Nwanyanwu & Nwanyanwu, 2021). There are a number of studies that have examined the impact of AI on journalism globally. For example, a study by the Tow Center for Digital Journalism found that AI is being used in a variety of ways to support journalism, such as automating tasks, providing insights into data, and creating new forms of storytelling (Mukasa, 2024).

According to Atoi, (2024), in Nigeria, AI is being used to help journalists overcome the challenges of reporting in a complex and rapidly changing environment. Another study by the Reuters Institute for the Study of Journalism found that journalists are generally optimistic about the potential of AI to support journalism. However, the study also found that journalists are concerned about the potential for AI to be used to create fake news or to spread propaganda (Marconi, 2020). Udoh, Nsude & Oyeleke, (2022) found that journalists in Nigeria are generally aware of AI and its potential to impact journalism. However, the study also found that journalists in Nigeria are concerned about the potential for AI to lead to job losses in the journalism industry. Iyinolakan, (2023) found that AI is already being used in Nigerian newsrooms to automate tasks, personalize content, and even generate news stories. The study also found that AI is helping to create new forms of investigative reporting and to help verify and fact-check information. The impact of AI on journalism practice in Nigeria is still unfolding. However, AI is a transformative technology that can revolutionize how journalism is practiced in Nigeria (Mukasa, 2024).

AI Applications in Nigerian Journalism

AI tools are being employed in Nigerian newsrooms in a variety of ways, including:

1. **Automated content creation:** AI is being used to generate news summaries, data visualizations, and even entire news articles. This is helping journalists be more efficient and productive, and it is also helping to create new forms of journalism (Nwanyanwu & Nwanyanwu, 2021). For example, the Nigerian news agency, *The Punch*, is using AI to generate news summaries and translate languages (Bello, Salaudeen & Umeaku, 2023).
2. **Content personalization and recommendation systems:** AI is being used to personalize content for audiences and recommend articles to readers based on their interests. This is helping news organizations reach new audiences and increase engagement with their content (Bello *et al.*, 2023). For example, the Nigerian newspaper, *The Guardian*, is using AI to recommend articles to readers based on their interests (Hansen, Roca-Sales, Keegan & King, 2017).
3. **Social media monitoring and analysis:** AI is being used to monitor social media platforms for breaking news and analyze public sentiment. This is helping journalists stay ahead of the news cycle and better understand the public mood (Latar, 2018). For example, the Nigerian television station, *Channels TV*, is using AI to monitor social media platforms for breaking news.
4. **Fact-checking and combating misinformation:** AI is being used to help verify and fact-check information and combat the spread of misinformation. This is helping to ensure that the public has access to accurate and reliable information (Alzoubi *et al.*, 2024). For example, the Nigerian fact-checking organization, *Africa Check*, is using AI to help verify and fact-check information.

Potential Benefits of AI in Nigerian Journalism

1. **Increased efficiency and productivity:** A key driver for the adoption of AI in Nigerian journalism is the pursuit of increased efficiency and productivity. AI-powered tools can automate various tasks, such as transcribing interviews, translating languages, and generating news summaries. This automation frees up journalists' time, allowing them to focus on more complex and creative aspects of their work, such as investigative journalism and in-depth reporting (Bello *et al.*, 2023).
2. **Enhancing News Quality and Accuracy:** AI is instrumental in enhancing news quality and accuracy. AI-powered fact-checking tools can quickly verify information, combating the spread of misinformation and fake news (Hansen *et al.*, 2017). This not only improves the credibility of news organizations but also fosters trust among the audience. Additionally, AI algorithms can analyze vast amounts of data to identify patterns and trends, leading to more insightful and data-driven news stories (Alzoubi *et al.*, 2024).
3. **Expanding Reach and Audience Engagement:** AI is pivotal in expanding the reach of news organizations and enhancing audience engagement. AI-powered translation tools can break down language barriers, making news content accessible to a wider audience (Lawal, 2023). This is particularly relevant in Nigeria, where linguistic diversity is a hallmark of the media landscape. Additionally, AI algorithms can personalize news delivery, recommending content based on user preferences and behavior. This personalization not only increases audience satisfaction but also fosters loyalty and engagement (Ade-Ibijola & Okonkwo, 2023).
4. **Cost Reduction and Resource Optimization:** AI can contribute to cost reduction and resource optimization in Nigerian journalism. AI-powered tools can automate tasks that are traditionally labor-intensive, such as transcribing interviews and generating news summaries. This automation not only saves time but also reduces the need for additional human resources. Additionally, AI algorithms can optimize content distribution, ensuring that news reaches the right audience at the right time, minimizing wasted resources (Saad & Issa, 2020).

Challenges and Concerns of AI in Nigerian Journalism

While the integration of Artificial Intelligence (AI) into journalism practice in Nigeria presents a plethora of opportunities, it is essential to acknowledge and address potential drawbacks.

1. **Job Displacement and Skills Gap:** One of the most pressing concerns is the potential for job displacement. As AI-powered tools become more sophisticated, they may automate tasks previously performed by human journalists, leading to job losses (Schmelzer, 2018). This is particularly concerning in the Nigerian context, where the journalism industry is already facing challenges such as job insecurity. Additionally, the integration of AI may lead to a skills gap, as journalists need to adapt to new technologies and acquire new skills to remain relevant (Guanah & Ijeoma, 2020).
2. **Mitigating Algorithmic Bias and Ethical Considerations:** AI algorithms are trained on data, and if this data is biased, the AI system will also be biased. In the context of journalism, this can lead to the spread of misinformation and the amplification of harmful stereotypes. Therefore, it is crucial to ensure that AI systems are trained on diverse and unbiased data. Additionally, human oversight is essential to ensure that AI-generated content is accurate and fair (Christian, 2024).
3. **Addressing Dependence on Technology and Infrastructure Limitations:** The successful integration of AI into Nigerian journalism is contingent on the availability of robust technological infrastructure. This includes reliable internet connectivity, access to advanced AI tools, and the availability of skilled personnel to manage and maintain AI systems (Nneji, 2024). However, Nigeria's technological infrastructure is still developing, and there are concerns that this may hinder the widespread adoption of AI in journalism (Ibrahim, Liu, Asim, Battu, Benabderrahmane, Alhafni & Zaki, 2023).
4. **Maintaining Journalistic Integrity and Credibility:** The use of AI in journalism raises concerns about the potential threats to journalistic integrity and credibility. AI-powered tools can generate news content,

but they may not always adhere to the ethical standards and professional norms of journalism (Ibrahim *et al.*, 2023). This can lead to the spread of misinformation and the erosion of public trust in the media. Therefore, it is crucial to ensure that AI is used in a way that complements and enhances human journalism, rather than replacing it altogether (Ade-Ibijola & Okonkwo, 2023).

AI Integration in Nigerian Media - Case Studies

A comprehensive examination of the impact of AI on journalism practice in Nigeria necessitates a close look at specific case studies. These real-world examples provide insights into the successes and challenges of AI integration in the Nigerian media scene. One notable case study is the United Bank for Africa's (UBA) introduction of Leo, Africa's first AI chatbot. Leo serves as a financial assistant, providing customers with personalized financial advice and assistance. Leo's success underscores the potential of AI to enhance customer engagement and service delivery in the media industry (Afolabi, Oladesu, Siyanbola, Adeloye, & Odewole, 2024). Despite the successes, there have been challenges in integrating AI into the Nigerian media landscape. The case of the Akure-based Print designers, who had limited awareness of AI and its applications, underscores the need for increased AI literacy and training among media professionals. Another challenge is the potential for AI to perpetuate biases and spread misinformation. The case of the 2023 general elections, where AI-generated content was used to spread fake news and disinformation, highlights the need for ethical guidelines and human oversight in AI-driven journalism (Afolabi *et al.*, 2024).

Future Trends and Implications

Emerging AI Technologies in Nigerian Journalism

The future of journalism in Nigeria is poised for a significant transformation with the advent of emerging AI technologies. These advancements promise to redefine how news is gathered, processed, and delivered, opening up new possibilities for investigative journalism, personalized news experiences, and immersive storytelling formats.

1. **AI-Powered Investigative Journalism:** AI can be a game-changer for investigative journalism in Nigeria. AI algorithms can sift through vast troves of data, such as public records, financial reports, and social media feeds, to identify patterns, anomalies, and potential leads that may be missed by human journalists. This can help investigative journalists to uncover corruption, expose wrongdoing, and hold power to account. Additionally, AI-powered tools can assist in verifying information and authenticating sources, ensuring the accuracy and credibility of investigative reports.
2. **Personalized News Experiences:** AI can usher in a new era of personalized news experiences in Nigeria. AI algorithms can analyze user data, such as reading habits, interests, and location, to curate and deliver news content tailored to individual preferences. This can enhance audience engagement and satisfaction by ensuring that readers receive news that is relevant and meaningful. Furthermore, AI-powered news aggregators can filter through various news sources and provide readers with a balanced and comprehensive view of events, catering to their specific information needs.
3. **Immersive Storytelling Formats:** AI can revolutionize storytelling formats in Nigerian journalism. AI-powered tools can create interactive data visualizations, 360-degree videos, and augmented reality experiences that immerse readers in the news. This can make news more engaging and accessible, particularly for younger audiences who are accustomed to consuming information in a multimedia format. Additionally, AI can assist in automating the production of multimedia content, such as generating subtitles for videos and creating audio versions of news articles, making news more accessible to a wider audience.

Implications for the Future

The implications of AI for the Nigerian media are significant, with the potential to reshape news consumption habits, media ownership and control, and the role of journalists in society.

1. **News Consumption Habits:** AI is poised to revolutionize news consumption habits in Nigeria. As AI-powered personalized news experiences become more prevalent, audiences will likely gravitate towards curated content that aligns with their interests and preferences. This may lead to a decline in the consumption of general news sources and an increase in the use of niche news aggregators. Additionally, the rise of immersive storytelling formats, such as interactive data visualizations and AI-generated 360-degree videos, may transform how audiences engage with news content.
2. **Media Ownership and Control:** The increasing use of AI in journalism may also impact media ownership and control in Nigeria. AI technologies can be expensive to develop and implement, potentially giving larger, well-funded media organizations an advantage. This may lead to further concentration of media ownership and control in the hands of a few, potentially stifling independent journalism and diverse voices. However, the availability of open-source AI tools and the potential for collaborative AI development may also empower smaller media organizations and independent journalists, fostering a more diverse and competitive media landscape.
3. **The Role of Journalists in Society:** The role of journalists in society may also evolve with the integration of AI into journalism practice. As AI-powered tools take over routine tasks, such as data collection and basic reporting, journalists may have more time to focus on investigative journalism, in-depth analysis, and holding power to account. This may elevate the role of journalists as critical thinkers and storytellers, enhancing their ability to serve the public interest. However, it is essential for journalists to adapt to the changing media landscape and acquire new skills to remain relevant in the AI-driven era.

Summary

This paper has explored the impact of AI on journalism practice in Nigeria. The findings highlight the potential of AI to revolutionize newsgathering, processing, and dissemination, while also acknowledging the challenges and concerns that accompany this technological wave. AI is being used in Nigerian newsrooms to automate tasks, personalize content, and even generate news stories. This is helping journalists to be more efficient and effective, and it is also helping to create new forms of journalism and to reach new audiences. However, AI is also raising several ethical challenges for journalists. For example, there is the risk that AI could be used to create fake news or spread propaganda. There is also the risk that AI could lead to job losses in the journalism industry.

Conclusion

The future of journalism in Nigeria is intertwined with the development and integration of AI technologies. AI has the potential to reshape news consumption habits, media ownership and control, and the role of journalists in society. The Nigerian media can harness the power of AI to enhance its service to the public and contribute to a more informed and engaged citizenry by embracing these advancements responsibly and addressing the associated challenges.

Recommendations

For Media Organizations: Media organization should:

1. Invest in comprehensive training programs to educate journalists and editors about AI, its applications in journalism, and its ethical implications.

2. Partner with AI developers to create and customize AI tools that cater to the specific needs and challenges of Nigerian journalism.
3. Develop and implement clear ethical guidelines for the use of AI in journalism to ensure fairness, accuracy, and transparency.
4. Advocate for policies that improve internet connectivity and access to AI technologies, particularly for smaller and community-based media organizations.
5. Encourage a culture of innovation and experimentation with AI tools and technologies to stay ahead of the curve in the evolving media landscape.

For Journalists: Journalist should:

1. Invest in continuous learning to acquire new skills in data analysis, multimedia storytelling, and AI literacy to remain relevant in the changing media landscape.
2. Remain committed to the core principles of journalism, such as accuracy, fairness, and transparency, even when using AI-powered tools.
3. Collaborate with AI developers and data scientists to create and refine AI tools that enhance journalistic capabilities.
4. Critically evaluate AI-generated content and insights to ensure accuracy, fairness, and alignment with journalistic standards.

For Policymakers: The policymakers should

1. Develop and support AI literacy programs for the general public to foster a more informed and critical understanding of AI and its implications for society.
2. Invest in improving internet connectivity and access to AI technologies, particularly for underserved communities and smaller media organizations.
3. Develop clear regulatory frameworks for the ethical development and deployment of AI in journalism to ensure fairness, transparency, and accountability.
4. Support research and development of AI technologies that cater to the specific needs and challenges of the Nigerian media landscape.

Suggestions for Future Research

Future research could focus on conducting empirical studies to gather quantitative and qualitative data on the impact of AI on Nigerian journalism. This could include investigating the effects of AI on audience engagement, the ethical implications of AI-generated content, and the long-term effects of AI on the journalism profession. Additionally, future research could explore the potential of AI to support and promote indigenous language journalism in Nigeria, addressing the issue of linguistic diversity in the media landscape.

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DYNAMICS OF PLAY BASED LEARNING AS PREDICTOR OF PUPILS ACADEMIC PERFORMANCE IN PUBLIC PRIMARY SCHOOLS (A CASE OF ALIMOSHO L.G.A OF LAGOS STATE)

BY

Ola-Alani, Eniola Keji¹, Fowowe, S.S.² & Daniju Jegede, Suwebat Opemiopin³

¹Department of Adult and Primary Education, Faculty of Education, University of Ilorin, Nigeria

²Department of Earlychildhood Care & Primary Education, College of Specialized and Professional Education,
Lagos State University of Education, Ijanikin

³Department of Educational Foundations and Counseling Psychology, Faculty of Education, Lagos State
University, Ojo, Lagos State, Nigeria.

Email: ola-alani.ek@unilorin.edu.ng / simeonfowowe@gmail.com / opemiopindaniju@gmail.com

Abstract

The crux of this study is to investigate play based learning as predictor of Pupils Academic Performance in Public Primary Schools in Lagos State. Two objectives of the study were structured alongside two research hypotheses respectively. Population of 50,583 public primary school pupils in which sample of 250 pupils were selected for this study. Two instruments were used in this study. The first was a self structured Questionnaire titled, "Dynamics of Play Based Learning as Predictor of Pupils Academic Performance in Public Primary Schools (DPBLPPAPPPS)". The instruments were validated by test experts in the department of Primary Education Studies, University of Lagos, Akoka. Reliability was determined through the use of Cronbach-alpha a reliability type. An index value of 0.862 and 0.891 were obtained Data generated was analysed using Analysis of Variance, ANOVA statistics tested at 0.05 level of significance. The study revealed that Play Based (construction play, language play, play with Arts and Sensory motor play) Learning is a good predictor of Pupils Academic Performance especially in Public Primary Schools. The study concluded among others that children learn very fast when they are exposed to play activities because such exercise motivates them to achieve specific objectives. It then recommended that caregivers and teachers should be exposed to the positives associated with Play as it goes a long way to improve and develop Pupils' Cognitive, Affective and Psychomotor domains.

Keywords: Play Based Learning, Pupils, Academic Performance, Education, Dynamics

Introduction

Play is a time when children act on their interests, create explorations, and discover new ideas. In early childhood settings, play can be spontaneous, guided or teacher directed. These types of play occur along a continuum that moves from child initiated to teacher initiated. When children are engaged in play activity with their peers, observers notice a child's unwillingness to be distracted (Ray & Smith, 2010). Because of the impact of play in children's lives, it has become imperative and an effective way for teachers to address specific educational goals in line with children's play activity which serves as a vehicle through which children learn. Meanwhile the impact of play on children encapsulates the whole essence of play to children: Play as well as learning are natural components of children's everyday lives. When children are asked what they like to do best the answers are unanimous. On the other hand, education for children is on the whole organised to promote learning rather than play.

Gallagher (2017) emphasised that when the cognitive skills of children are still in their early phase of inception it is important to related value of play-based learning during this developmental period. This is learning through means of play which ranges from active play that requires physical, verbal or mental engagement to pleasurable play that emphasises on enjoyment as a key feature. The manner in which children interact with one another and perform independently is learned from their surroundings, experiences and by parents and teachers. If an education system is conceptualised which utilises and manipulates play-based learning teach children, the many subjects they are

required to learn. It will greatly impact the way things are done. No one child is alike, every child learns differently and that is true for adults. By introducing play-based learning, we can maximise the academic standards by having more than one way to teach the same concepts (Gallagher, 2017).

Play Based Learning, PBL, is an approach used to disseminate information to children through a variety of play way activities. Through play children find learning interesting as they are submerged in the play activity (Graue, 2011). Play based Learning is a form of exposure that provides for children to actively and imaginatively engage with people, objects and the environment. This learning process provides opportunities for children to develop a sense of the world around them through inquiry, exploration, interaction and problem solving. During this process of activity based their thoughts and emotions, explore their environment and connect what they already know with what they already know with new knowledge, skills and attitudes. Michael (2019) stated that Play-based learning allows pupils to engage in purposeful activities that will allow for the simulation of such experiences they are likely to encounter.

According to Michael (2019) Play Based Learning have the following four features:

- 1) It is usually voluntary
- 2) It is intrinsically motivating, that is it is pleasurable for its own sake and is not dependent on external rewards
- 3) It involves some level of activity, often physical, engagement and
- 4) It is distinct from other behaviours by having a make-believe quality.

From the above, each feature leaves room for fostering of strong meta-cognitive skills and the ability to build independence as well as co-dependency on their peers. Students benefit greatly from their play experiences through the innate learning method, educators can manipulate scenarios to teach children certain curriculum goals. Play-based learning can provide an appropriate environment for a child's growth, development, and learning. Play-based learning is based on the traditional kindergarten, which focused on the whole child and the dependence on play for teaching and guiding a child during development. Play-based learning activities allow children to explore, at the same time are intrinsically motivating, engaging and have an overall learning purpose (Chervenak, 2011). Phillips and Scrinzi (2013) stated, "when pupils engage in meaningful, play-based experiences such as investigations, dramatizations, constructions, and projects, they apply and practice new knowledge and skills in natural and relevant ways.

Play-based learning provides the integrated context essential to support the growth of the whole child. Children experience a variety of significant changes in all areas of development during their developmental phase (Phillips & Scrinzi, 2013). Phillips and Scrinzi (2013) further stated that pupils' brains are specially responsive to stimulation during this highly sensitive developmental period, making this time frame an opportune time for learning. Giving children the chance to play helps them internalize information, as well as build knowledge and make the new learning relatable to their lives. Play also helps them interact with their peers and learn how to solve problems and cope with things that occur in their environment. Hoorn et al. (2015) wrote, "*play is essential for optimal development and learning in young children. The match between the characteristics of play and the characteristics of the young child provides a synergy that drives development as no teacher-directed activity can*". The activity of play in the classroom is critical to the early learning needs of pupils and the teacher's role in this play-centered learning a key to the success of its implementation (Hoorn et al., 2015). Play-centered learning supports pupils in many areas of self-regulation and emotional development.

According to Miller and Almon (2009), the twelve key types of play-centered learning are:

- Large-motor play: Children love to climb, run, slide, swing, jump, and engage in every type of movement possible. Such play develops coordination, balance and a sense of one's body in the space around it.
- Small-motor play: Play with small toys and activities like stringing beads, playing with puzzles, and sorting objects into types develop dexterity.

- **Mastery play:** Children often repeat an action in play and persevere until they master it, such as making dozens of “birthday packages” to learn to tie bows, or playing on a balance beam to become a “circus performer.”
- **Rules-based play:** Kindergarteners and grade-school children enjoy the challenge of making up their own rules and the social negotiation involved in adapting the rules for each play situation.
- **Construction play:** Building houses, ships, forts and other structures in a basic form of play that requires skill and imagination.
- **Make-believe play:** This broad category incorporates many other play types and is rich with language, problem-solving, and imagination. It frequently begins with “Let us pretend” and goes on to include anything children might have experienced or imagined.
- **Symbolic play:** Children take an object at hand and convert it into the toy or prop they need through a fluid process of fantasy or imagination.
- **Language play:** Children develop mastery by playing with words, rhymes, verses, and songs they make up or change. They tell stories and dramatize them. They are fascinated by foreign languages, especially when they are presented playfully in story, verse or song.
- **Playing with the arts:** Children integrate all forms of art into their play, using whatever materials are at hand to draw, model, create music, perform puppet shows, and so on. They explore the arts and use them to express their feelings and ideas.
- **Sensory play:** Most children enjoy playing with dirt, sand, mud, water, and other materials with different textures, sounds, and smells. Such play develops the senses.
- **Rough-and-Tumble play:** This fundamental form of play is found in animals as well as human children. Animals know how to play roughly without injury by rounding their body gestures and not aiming for dominance. Children can be helped to do the same if their play becomes too aggressive.
- **Risk-taking play:** Children extend their abilities through risky play and learn to master challenging environments. They generally know how far they can go without actually hurting themselves.

Notwithstanding at the primary school level, academic performance cannot be disassociated from Play. Academic Performance of Pupils is one variable that centres on their level of achievement and progression in classroom tasks. Capacities such as problem-solving, communication, collaboration, innovation, and creative thinking are developed through child-initiated and child-directed play (Miller & Almon, 2009). Akins (2017) submitted that academic performance is an assessment type that is undertaken with the progression of learners over time. A sequence of movement over time be it positive or negative. Pupils’ academic performance is best determined with the trend of Pupils movement in classroom related tasks. Academic performance is the measurement of pupils’ achievement across various academic subjects. In determination of a child’s academic performance, cognitive, affective and psychomotor domains have been factored in because these are the core areas where assessment can be undertaken in learners. Caregivers and teachers typically measure achievement using classroom interaction, graduation rates and results from standardised tests. Academic performance of pupils is boosted when they find the tasks interesting, motivating and interactive. It is no news that pupils also perform better when teachers introduce play way as a medium of instruction. This play enables these young learners towards self-discovery and content internalisation. According to Miller and Almon (2009) & Phillips and Scrinzi (2013) they noted that when pupils are exposed to series of play activities before and sometimes during teaching, such play have the tendency of expanding the scope of learning and mastery level of learners. To them, play based learning enables a long-lasting content and ability to replicate such skills when the need arises. Play Based Learning discourages rote learning, memorization, short-term learning among others but rather instils a relatively permanent learning in learners especially through play. However sometimes performance scale is said to be determined by gender.

As certain studies have identified gender as a pivotal variable to consider when noting performance because of the various psychological factors that are inherent in individual learners. Although Lekan (2017) and Michael (2019) had a contrary view as they claimed that Pupils performance is not tied to external conditions like Play as

performance is determined by interest, motivation and teachers' mastery of the subject and content. To them they emphasised that Gender disparity as individuals does not have anything to do with performance, claiming that both male and female pupils both loves play as individuals but that would never be a criterion for improved performance on their gender. Advancing the course of performance, it is crucial to educate caregiver/teachers, not only about the importance of play-centered learning but also about the types of play that have the propensity to improve classroom tasks. This knowledge and understanding of play is very crucial to the implementation in classrooms. The development of a pupil's academic performance requires a merge of teaching styles from preschool to the primary school that move from highly structured and less structured instruction, experiences that are teacher and pupil-led and time for purposeful play. At the primary level, pupils are conditioned to think abstractly but need concrete experiences, follow directions and also explore on their own (Kostelnik, Soderman&Whiren, 2011).

Statement of Problem

As pressure to raise scores on both standardized and teacher made tests has trickled down to the lower grades, teachers in lower classes are even more over worked to bring about a sharp rise in learners outcome especially in their academic performance. The perception of most parents and other stakeholders towards public primary schools is that the Pupils are so dull, not attentive in classroom, lack coordination, rarely participate and assimilate in class tasks with obvious reason that they play too much. In our educational system, many stakeholders play down the significant role of play in child development especially as it concerns child's learning process. Negligence of this act most times leads to an increase in under achievement and poor academic performance of Pupils as teachers engage them with classroom tasks while their interest, motivation and abilities are downplayed. In a bid to improve performance, it is advisable to expose Pupils to play and direct learning activities to Play Based Method such that Pupils will associate the learning activity with Play way. It is believed that through Play Based Learning, Pupils cognitive, affective and psychomotor skills are better developed for efficiency and quality delivery. In the course of having an empirical over view of the import of Play Based Learning, the study seeks to investigate the dynamics of Play Based Learning a Predictor of Pupils' Academic Performance in Public Primary Schools.

Purpose of the study

The broad purpose of this study is to investigate the dynamics of Play Based Learning as predictor of Pupils Academic Performance in Public Primary Schools in Lagos State while the specific objectives include:

1. Justify how playbased learning can contribute to Pupils Academic Performance in Public Primary Schools.
2. Determine if there is any difference in gender's academic performance when exposed to Play Based Learning in Public Primary Schools.

Research Hypotheses

H0₁: Play based Learning is not a significant Predictor of Pupils Academic Performance in Public Primary Schools.

H0₂: Play Based Learning does not have any significant effect on Pupils Academic Performance in Public Primary Schools gender.

Gaps of this study

Although studies conducted by Miller and Almon (2009) carried out a study on "Crisis in the Kindergarten: Why Children need to Play in Schools" alongside Philips and Scrinzi (2013) on "Basics of Developmentally Appropriate Practice; An Introduction for Teachers of kindergarteners". They all claimed that pupils exposed to series of play

activities before and after play activities, would promote performance while the research executed this study to justify that play remains one of the most reliable activity that can be used to promote relatively permanent change in pupils behaviour and performance.

Moreso on gender disparity on play, while other literatures may have aligned that gender of pupils contribute play significant role in contributing to performance, this researcher successfully established that pupil's academic performance is never a function of gender at any level and stage noting that only external or environmental factors contribute towards influencing the performance of male and female pupils in schools.

Methodology

Survey type of research design was used for this study. This design seeks to under study a large population with the intention of generalising from a pool of sample selected for the study. The population of the study was 50,583 and comprise of all pupils in Public primary Schools in the state while the target population was Basic 5 Pupils in Public Primary School in Alimosho education area of the state. The reason for the choice of Alimosho LGA lies on the premise that aside being the largest education zone in the state. It also records the highest pupils enrolment rate in the state hence so many learners attributes were identified. Since Taro Yammane formula of $N/1+N(e)^2$ was used to select appropriate sample size since the official population of pupils enrolment was disclosed to the researchers, were 50,583 pupils. However, with the introduction of simple random sampling technique to select 5 Public Primary Schools in Alimosho LGA, a sample size of 250 pupils was involved in this study. Two instruments were used in this study. The first was a self-structured Questionnaire titled, "Dynamics of Play Based Learning as a Predictor of Pupils Academic Performance in Public Primary Schools (Pupils Academic Performance) containing 15 items on 4–Likert scale format. This Questionnaire was divided into two sections of A & B; where A focused on respondents' bio-data and Section B focused on statement items generated for the study and needed to be responded to. A total of twenty items on 4-point scale type of Strongly Agreed (SA), Agree (A), Disagree (D), and Strongly Disagree (SD) respectively; the second instrument was School Based Test specifically in subjects like Mathematics, English Language and Social Studies were used as Performance index. The instruments were validated by test experts in the department of Primary Education Studies, University of Lagos. The instruments were validated as Construct and Content validities was acclaimed to be met while reliability was determined through the use of Cronbach-alpha and split-half reliability forms. An index r-value of 0.862 and 0.891 were obtained respectively meaning that the instruments are very reliable and suitable for the study. In other to allow for equality and normality, the scores generated for pupils' academic performance were transformed using Z-score and T-score. With the aid of Statistical Package for Social Sciences, SPSS version 26, data generated was analysed using Analysis of Variance statistics. However, the hypotheses were tested at 0.05 significant level.

Data Presentation an Interpretation

H0₁: Play based Learning is not a significant predictor of Pupils Academic Performance in Public Primary Schools

Table 1: Estimate of the relative contribution of the Predictor variables to Pupils Academic Performance
Dependent Variable: Pupils Academic Performance

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	8.624 ^a	5	1.725	2.851	.017
Intercept	33.399	1	33.399	55.201	.000
Play Based Learning	3.123	1	3.123	5.162	.024
Sensory Motor	4.869	1	4.869	8.047	.005
Language Play	.433	1	.433	.716	.039
Construction Play	.278	1	.278	.459	.040
Play with Arts	.003	1	.003	.692	.009

Error	248.376	247	1.2341		
Total	1807.000	250			
Corrected Total	246.000	249			

R Squared= 0.472 (Adjusted R Squared = 0.289)

From the table 1 above it shows that Play Based Learning approach an independent variables have its intervening variables as Sensory motor, Language Play, Construction Play and Play with Arts as good predictors of Pupils Academic Performance the dependent variable in Public Primary Schools. Language Play: $F_{(1,250)} = 0.716$, $p=0.039$, partial eta=0.090; Construction Play $F_{(1,250)} = 0.459$, $p=0.040$, partial eta=0.122; Play with Arts $F_{(1,250)} = 0.692$, $p=0.09$, partial eta=0.160; Sensory Motor $F_{(1,250)} = 8.047$, $p=0.005$, partial eta=0.000. This implies that interaction between Language play, Construction play, Play with Arts and S Construction play, Play with Arts and Sensory motor play accounts for 9%, 12.2%, 16% and 0% which amounted to 37.2% for the variance in this work while 62.8% can be accounted for by variables outside the study.

H0₂: Play based Learning does not have any significant effect on Pupils Academic Performance in Public Primary Schools by gender

Table 2a: Analysis of Group statistics

	Gender	N	Mean	Std. Deviation
Performance	Male	100	2.150	0.316
	Female	150	3.921	0.804

From table 2 it reveals that 250 pupils were captured for this work, although male pupils recorded a lower mean and standard deviation values as 2.15 and standard deviation as 0.316 while female pupils recorded a higher mean and standard deviation value as 3.912 and 0.804 respectively.

Table 2b: ANOVA statistics showing effect in playbased learning on academic performance by gender

One-Way ANOVA Performance					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.241	1	.241		
Within Groups	305.923	248	1.234	.195	.659
Total	306.164	249			

From table 2b, the F-calculated value of 0.195 is obtained as sig. value of 0.659 is derived meaning not significant. Hence since the P-value of $0.05 < 0.659$, the null hypothesis which states that Play based Learning does not have any significant effect on Pupils Academic Performance in Public Primary Schools by gender is retained.

Conclusion

From the outcome of the study the researcher can then conclude that:

- Children learn very fast when they are exposed to play activities because such exercise motivates them to achieve specific objectives.

- ii. There is no difference in gender's Academic Performance when exposed to Play Based Learning especially in Public Primary Schools.
- iii. Play based Learning remains a significant predictor of Pupils Academic Performance in Schools

Recommendations

1. Complex exercises or classroom tasks should be presented to Pupils through the intervention of Play.
2. Pupils should not be discouraged from playing because it goes a long way to spur them to simplifying tasks.
3. There should not be gender discrimination to play as it has no impact on gender performance.
4. Teachers and Caregivers should be exposed to the positives associated with Play as goes a long way to improve and develop Pupils' Cognitive, Affective and Psychomotor domains.

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EVALUATING THE ROLE OF MARKET SEGMENTATION IN ENHANCING THE PERFORMANCE OF INDIGENOUS BEVERAGE COMPANIES

BY

Rahman O. Mustapha, Nurudeen Bello & Khadijat Ayo Ayedun

**Department of Business and Entrepreneurship, Faculty of Management and Social Sciences, Kwara State
University, Malete**

Email: Khadijatayedun@yahoo.com

Abstract

Local players in the beverage industry are also faced with specific challenges including; they lack adequate capital base, rivalry with global players in the market, and have to respond to consumers' pulling forces in the market. This study evaluates the role of market segmentation in enhancing the performance of indigenous beverage companies, focusing on the critical relationship between customer satisfaction, perception, and loyalty. The research problem centers on the insufficient understanding of how effectively these companies utilize market segmentation strategies to reach targeted consumer segments and enhance their overall performance. Employing a quantitative research strategy and a deductive approach, the study targeted consumers of indigenous soft drink products, utilizing random sampling techniques to select 381 respondents based on Krejcie and Morgan's methodology. Data was collected through online surveys administered via Google Forms, and analyzed using descriptive and inferential statistics with SPSS software. The results indicate a significant positive relationship between customer satisfaction and loyalty, with strong perceptions of indigenous products enhancing both loyalty and market performance. Furthermore, the findings suggest that current marketing strategies are effective in reaching targeted consumer segments, although there is a need for continuous adaptation to remain competitive. The study concludes that improving product quality, customer experience, and tailored marketing strategies are vital for enhancing the performance of indigenous beverage companies. Recommendations include investing in product innovation, leveraging digital marketing, and fostering community engagement to build stronger consumer relationships.

Keywords: Market Segmentation, Customer Satisfaction, Indigenous Beverage Companies, Consumer Loyalty, Marketing Strategies.

Introduction

Market segmentation is now perceived as critical when organizations seek to satisfy customer needs successfully. Competing in the beverage industry, and especially for indigenous beverage firms, this capacity to segment the market presents an avenue to better understand the market to efficiently and effectively meet consumer needs and desires to improve on overall performance. Local players in the beverage industry are also faced with specific challenges including; they lack adequate capital base, rivalry with global players in the market, and have to respond to consumers' pulling forces in the market. Therefore, market segment gains a strategic role as a way of identifying heterogeneous groups of customers and designing corresponding goods, prices, and promotional campaigns. In its development, the indigenous beverage companies in emerging markets including Nigeria have had to couple up with forces to survive competition from well established international brands. For these businesses to be effective, they need to implement processes that would ensure that those customers are locked in. Market segmentation is very helpful in this regard as it provides the indigenous firm an opportunity to capture little and gradually fill the value chain gap in local or regional markets based on culture and tastes (Parasecoli, 2017).

Using market segmentation these companies are able to discover unserved markets, bring niche products into the market, and create a promotional mix that will effectively communicate with numerous segments and therefore improve business performance and market opportunities for growth. Within the last decade especially, the concept

of market segmentation has increasingly been referred to as a tool to enhance the performance of organizations. A study shows that organisations that practice more advanced segmentation techniques achieve better sales, market coverage, and profit levels than organisations not using the concept (Okpara et al, 2019; Korpi, 2020). This is especially important for the indigenous beverage companies which function across different markets and for which the decision making of consumers is influenced by their culture, economic, and social status. Highly developed beverage industry requires knowledge of many segments in order to satisfy customer needs and deliver adequate products. Hence, the practice of market segmentation is not just needed but also advantageous for such firms to sustain and grow.

There is high competition in the beverage industry, short consumer lifespan on trends and preferences, and high brand multinationality dominating the Nigeria market. Most indigenous beverage firms are challenged in creating and sustaining competitive positioning due to a lack of capital and influence from the giant international firms with large marketing muscles. While generally dealing in products that target certain local markets and therefore may be seen to be more acceptable to these markets, these firms often grapple with enterprise marketing problems and regularly post low profits. The central research question concerns the manner in which indigenous beverage firms can improve their market standing and performance given such competition via market segmentation.

One of the critical issues arising from such companies is the harder it becomes to identify the segments in the market. Since indigenous firms may lack adequate knowledge about the market segmentation mechanisms, they end up applying the same strategy across the market segment, which may be unprofitable, in most cases. According to Raman (2019) despite understanding the importance of market segmentation in its organizational growth, many indigenous companies are not fully equipped with the skills and assets necessary to bring it to reality. This research problem is made worse by the ever-shifting tide in consumers' preferences, especially in the emergent markets where social economic factors and culture in particular have a profound influence on the consumption pattern. Thus, the research problem of interest is to identify ways through which indigenous beverage firms can integrate and apply the market segmentation concept in the pursuit of operations improvement and optimal and efficient identification of consumer segments for effective competition in a challenging market domain (Rahman, 2016).

Objectives of the Study

- i. To evaluate customer satisfaction and perception of indigenous beverage products
- ii. To assess the effectiveness of current marketing strategies employed by indigenous beverage companies in reaching targeted consumer segments

Literature Review

There is high competition in the beverage industry, short consumer lifespan on trends and preferences, and high brand multinationality dominating the Nigeria market. Most indigenous beverage firms are challenged in creating and sustaining competitive positioning due to a lack of capital and influence from the giant international firms with large marketing muscles. While generally dealing in products that target certain local markets and therefore may be seen to be more acceptable to these markets, these firms often grapple with enterprise marketing problems and regularly post low profits. There are four key criteria for segmenting markets: Demographic, Psychographic, Geographic and Behavioural segmentation. Demographic clustering separates the target market with regards to certain demographic characteristics such as age, sex, earnings, and education level. This criterion is one of the most standard is today because demographic factors have a big impact on consumers' needs and their buying behavior (Singh & Verma, 2017). The psychographic division takes it a notch higher than demographic division since it groups consumers based on their lifestyle, value systems, attitude and personality. For instance, while some of the consumers are health conscious and will be interested in organic or low-calorie material products such as beverages, other will be interested in convenience or pleasure. Geographic segmentation categorizes consumers by location, including geographic area, city or climate condition. This comes as informative especially to the beverage industry

because different areas may have different preferences; for instance, hot areas may be inclined towards cold beverages while cold areas may be inclined towards hot beverages. Lastly, behavioral approach divides consumers based on buying behaviour, usage rate, brand commitment or any other variable related to its purchase. In the alcoholic beverages industry, therefore, the company may target the high users or the brand users in a different way from the occasional buyers or users (Czinkota et al., 2021). Each of these criteria provides companies with a framework to better understand their customers and craft strategies that resonate with their target audience.

Market Segmentation in the Beverage Industry

Market segmentation is a critical success factor for the international beverage industry and helps firms in the industry to meet the needs of the consumers and improve its operational performance. From the literal base of products including soft drinks, mineral water, beer, wine and spirits segmentation makes it possible for the brands to determine markets with perceived needs and tailor products to suit specific markets. Therefore, strategic global beverage firms like the Coca-Cola and Pepsi-Cohave effectively segmented the market drawing consumers on demographic, psychographic, and behavioral segments. For instance, Coke divides its market neatly by customizing certain products and placing them within certain niches, for instance, Coca-Cola Zero Sugar and AHA sparkling water, which belongs to the health consciousness trend (Kovacs, 2022 para.11). The situation where special segments are predestined to such companies' products has made many firms successfully gain market share and customer satisfaction.

Other indigenous beverage firms are also affecting market segmentation strategies to enable them to effectively compete within the intensifying market environment. For example, Zobo and kunu producers in Nigeria have set their markets on culture background and health benefits from taking local raw organic products (Idowu-Adebayo, 2022). The most successful indigenous brand opportunities stem from the embrace of local consumers' palates, the ability to deliver the very brands and aspects that can effectively set the indigenous brand apart from multinationals. These companies commonly use bullocking advertising techniques that are annoying to the local population with appealing focuses, which are suitable for local users. However, both indigenous and multinational beverage companies face a common challenge: I agree with the author's description and analysis of the key dynamic within the current issue of international business, including the tension between managing the global image and managing the local context. Segmentation strategies can be very resource demanding, due to the need to acquire and analyze data about local markets, customer behaviour and culture.

However, there are significant opportunities and risks inherent with the use of market segmentation in the emerging market environment. The emerging markets involve a dynamic environment, consumer behavior and, changing economies and even cultures. Though segmentation proved useful in discovering new product development and marketing possibilities, it also creates a new dilemma for business organisations as the need to coordinate various and contrasting goals and objectives due to increased market uncertainty (Angmo et al., 2024). However, in some emerging markets, poor primary consumer research results in segmentation weaknesses and risk of poor match between products and consumers' need. But they also mean that there are growth points, that despite the problems there is potential to do things better. Businesses that take time to venture into the market to gauge consumers' purchase behaviour can create products to suit specific markets hence competitively edge the competitio Digital platforms and social media represented other opportunities for the companies as they allow direct communication with the target audience and the anlysis of the most effective marketing techniques in real time.

Indigenous Beverage Companies: Performance and Challenges

The indigenous manufacturers especially in the Nigeria market have thus shown greater importance in the beverage industry especially through production of locally accepted and preferred beverages. These firms from small scale producers of the native fermentation drinks like Zobo and Kunu to larger firms producing carbonated beverages are important in satisfying the expanding consumers whose preferences and demands are now directed at genuine and

local brands (Ogunlade & Adeleke, 2021). This has singled out beverage market in Nigeria for a rapid growth as a result of urbanization, increased disposable income in the society and new change in human face which has led to increase in demand for traditional as well as modern beverages. These changing conditions increase the potential for indigenous firms to seek specialization aiming at stakeing their claims on the identified market segments characterized by appeal to health or emphasizing cultural identity.

Nevertheless, indigenous beverage firms are characterised by strong market forces and competition from multinationals that constitute the greater part of the market. These corporations such as Coca-Cola and PepsiCo enjoy dominant brand image, well developed distribution channels and huge marketing expenses through which they can sustain their competitive strategy in the market (Dipty, 2023). On the other hand, indigenous companies can be faced with problems, such as lack of capital and ability to pay for very elaborate and comprehensive marketing platform or huge distribution networks. This forces local firms to engage in new product development by develop unique selling proposition such as using traditional method of production or use local material to prepare the food in different tastes. Additionally, the competition brings about paradox, since local players are usually under pressure to capture the market by offering products that match potential of big firms in the multinationals.

There are several areas that could be used in the analysis of the performance of indigenous beverage companies, these include market share, profitability and the level of customer loyalty. Despite some indigenous brands achieving improved market share especially in the niche segments, most indigenous brands continue to struggle in making improved profitability figures (Kumar et al., 2013; Kuranga & Salau, 2020). Loyalty is very important for indigenous brands since, through the relationship with consumers, customers, they ensure a repeat sale, through word of mouth since trust plays an important role in consumer decision making. However, the effectiveness of these companies can be lowered by some constrained with funding, ill-organized supply chains, or requirements to boost advertising to increase brand awareness (Silvestre, 2015). When facing these issues, these companies will have to pay particular attention to how they overcome these issues as they look to leverage their local knowledge and consumer base in order to continue to grow and to strengthen their position in the market.

Consumer Behavior in the Indigenous Beverage Market

For companies that may be interested in the indigenous beverage market it is important to advocate for consumer behavior knowledge in the market. Some of the most important determinants of consumers' preferences of indigenous beverages include flavour, quality and health consequences. Traditional alcoholic and non-alcoholic beverages create associations with people's identity and history and those consumers, who are willing to enjoy only thoroughly authentic cuisines (Chen & Lin, 2024). Furthermore, the discovery by consumers about the negative impacts of most artificial ingredients has led to a shift towards natural products and locally produced products being preferred due to the short supply chain that indigenous beverages have in the market. These factors put together provide a strong foundation when making sense of the consumer discontent, as brands that focus on quality and culture are likely to catch the eye of the users.

Current developments show a significant new form of customer allegiance and brand image perception in indigenous markets. There is a rising awareness of consciousness regarding sustainable buying and the chosen brands are taking into account that they must act better for the society (Schlaileetal., 2018). Therefore, organizations will have relatively higher brand loyalty levels when they develop a favorable relationship with customers, and when they engage in the support or funding of community programs. Discoveries about customer satisfaction show that they are highly correlated with company performance; customers who are satisfied are likely to repurchase the products and encourage others to do the same. Such a relationship emphasises the need to develop and supply the right quality of products that are acceptable by the consumers' standards and are culturally acceptable. Growing into new areas or enhancing the performance indigenous beverage companies will require appreciation of and focused effort on the factors that influence the consumers of the product in the consuming companies.

Theoretical Review

According to the Theory of Market Segmentation, the idea that a market can be segmented into groups of consumers and then targeted based on these segments can indeed increase customer satisfaction as well as product and service marketing. This theory was developed based on the concept that, consumers are basically different and unique in their preferences, behavior and characteristics thus need different ways to be marketing to (Smith, 1956). Market segmentation is the process of dividing the market into groups or segments based on specific characteristics such as demographic, psychological, behavioral and geographic information to create marketing communication messages, products, services and prices that address the specific needs and wants of the target audience. It does more than improving the chances of consumers engaging with various ads; it builds consumer loyalty and encourages them to purchase products from a particular business hence improving business performance (Lestari, 2023).

Regarding indigenous beverage firms, the Theory of Market Segmentation assumes significance more so due to large competitive forces within which many of these firms' function, require segmentation to support differentiation strategies. The application of this theory allows indigenous firms to appropriately recognize and understand consumer actions and choices according to cultural and geographical tendencies to appropriately set up and influence product related and marketing related systems favored by the local consumers (Choudhury et al., 2020). Moreover, this theory helps in discovering sources of under-served markets which indigenous companies can take advantage of to snatch a competitive edge over multinational companies' brands. Therefore, the Theory of Market Segmentation offers a solid foundation for analyzing and demonstrating how market-focused strategies can help defy or compensate for the decline of many indigenous beverage firms in more competitive global markets.

Empirical Review

A study by Kumaret al. (2018) explored the relationship between market segmentation and consumer behavior within the beverage industry. The researchers utilized a survey method to gather data from consumers across various demographics. They found that companies that effectively employed market segmentation strategies achieved higher customer satisfaction and loyalty compared to those that did not. This study highlights the importance of tailoring marketing messages and product offerings to specific consumer segments, affirming the relevance of market segmentation in enhancing performance in the beverage industry. The findings support the idea that understanding consumer behavior through segmentation can lead to improved engagement and market success. In a quantitative analysis conducted by Barakat and Rahman (2021), the authors examined how market segmentation impacts the sales performance of beverage companies. Using data from various indigenous and multinational firms, the study employed regression analysis to determine the relationship between segmentation strategies and sales growth. The results revealed a positive correlation, indicating that firms that utilized targeted marketing strategies based on market segmentation experienced significant increases in sales. This study provides empirical evidence supporting the notion that effective market segmentation can directly enhance business performance, particularly in competitive industries such as beverages.

Research by Mazzon and Beni (2022) investigated the cultural influences on consumer preferences for indigenous beverages. The study utilized focus groups and surveys to gather qualitative and quantitative data from consumers in different regions. The findings revealed that cultural identity significantly influenced consumers' choices, demonstrating that effective market segmentation must consider cultural factors. This research underscores the necessity for indigenous beverage companies to adopt culturally relevant segmentation strategies to enhance their market performance. It also highlights the importance of aligning product offerings with the cultural values and preferences of target consumer segments. A study by Khanna and Raghunathan (2023) explored the challenges faced by indigenous beverage companies in implementing market segmentation strategies in emerging markets. The researchers conducted in-depth interviews with industry experts and company executives to gather insights. The findings indicated that many companies struggle with data collection and analysis, which hindered their ability to identify and effectively target market segments. The study suggests that overcoming these challenges requires

investment in technology and training, enabling indigenous firms to better leverage segmentation strategies for improved business performance. This research is pertinent to the current study, as it highlights the barriers that indigenous companies face in realizing the benefits of market segmentation.

A study by Osei and Ameyaw (2024) examined the effectiveness of market segmentation in enhancing brand loyalty within the beverage sector. The authors employed a mixed-methods approach, combining quantitative surveys with qualitative interviews. Their findings demonstrated that companies that utilized effective segmentation strategies not only improved customer satisfaction but also fostered strong brand loyalty among consumers. The study emphasizes the need for continuous evaluation of segmentation strategies to ensure alignment with changing consumer preferences, which is critical for sustaining business performance. This empirical evidence reinforces the idea that targeted marketing efforts, grounded in thorough market segmentation, are essential for driving brand loyalty and overall company success.

Methodology

The research employs a quantitative research approach to examine the relationship between market segmentation and the performance of indigenous beverage firms. This choice is made because the objective of the research is to identify and analyze numerical data that will give nodal descriptions of consumers (Creswell & Creswell, 2017). Abstracted from the quantitative approach, the study is purposed to identify the correlation between consumer segments variables and the company's performance. The research employs a deductive research approach since it test the applicability of existing theories that exist on market segmentation on indigenous beverage companies by comparing them with real life data (Bryman, 2016). It also offers an orderly approach to the research process from one level of theory to another down to observations and from the specifics derived, confirm or infirm the hypothesis formulated in the study. The target population for this research is the consumers of indigenous soft drink products, a decision that was made following the rationale that to understand the pattern of consumption of soft drink brands it is important to consider persons who patronize these local brands. To include participants in this population, this study employs the random sampling technique because it ensures that all have equal probability of being selected thus minimizing selection bias. According to a formula by Krejcie and Morgan (1970) on sample size, a total sample of 381 personnel were used. This means that, data will be collected online through Google Forms for the benefit of the Researchers since it will take a shorter time and encounter a large number of participants. In the analysis, both ordinal and interval data will be analyzed using descriptive and inferential statistic with the aid of SPSS. The exploratory section of statistics, the descriptive statistics was useful in presenting results in relation to research questions whereas inferential statistics helped test the hypotheses and determine a connection between the market segmentation and the company performance. Such a mixed statistical analysis guarantees a clear examination of the findings.

Data Analysis

The demographic information of the respondents offers useful information on the various indigenous beverage companies target market. The age factors show that the highest percentage of the respondents are within the age range of 25-34 years, accounting for 38.5% of the participants hence, young consumers are leading towards demand towards indigenous beers. Also, the great number of young people 18-24 years old (26.2%) refers to the fact that the young generation is more likely to try new kinds of beverages. From the gender distribution there is an equal proportion between male (50.7%) and female (49.3%); this is an important aspect especially in a process of marketing the indigenous beverages where both sexes are interested. Education level and income creates additional understanding of the consumer picture, however, self-education level highlights it even more concerning that as much as 59.4% of respondents have a Bachelor's degree. That is why it can be stated that the target market may focus on the quality and recognition of certain brands, as a result of being educated consumers. Considering the ability to pay, the majority of respondents earns between ₦ 50 000 – ₦ 100 000 per month, which represent 34.9 % of the customers, a group that needs good quality, relatively cheap beverages services. Also, a very high number of

respondents from the urban areas (66.1%) makes it even more appropriate to consider market segmentation techniques to reflect the urbanity or the urbanite taste. The final consumption frequency shows that 45.5% of the respondents drink beverages in a week confirming the opportunity brands have in developing brand loyalty based on the regular use of such products. In totality, these demographic aspects will enable indigenous beverage companies to devise suitable strategies for market competition in order to improve their performance.

Test of Hypothesis

Customer satisfaction and perception of indigenous beverage products do not have a significant influence on their loyalty and overall market performance.

Table 1: Regression Results

	Unstandardized Coefficients		Standardized Coefficients		P-Value
	B	Std. Error	Beta	T	
(Constant)	5.832	0.715			
Customer Satisfaction	.589	.045	.742	13.133	.000
Perception of Products	.478	.038	.603	12.579	.000
R=.834^a R²=.694, Adjusted R²=.416					
Anova F=487.130 P=.000					

Source: Researcher's Survey, 2024

The regression analysis results indicate a significant influence of customer satisfaction and perception of indigenous beverage products on their loyalty and overall market performance, thus leading us to reject the null hypothesis. The unstandardized coefficients reveal that both customer satisfaction (B = 0.589) and product perception (B = 0.478) are positively associated with customer loyalty, with standard errors of 0.045 and 0.038, respectively. The T-values of 13.133 and 12.579 further underscore their significance, as both have p-values of 0.000, suggesting that the likelihood of observing these results due to chance is virtually zero. Additionally, the model demonstrates a strong fit with an R² value of 0.694, indicating that approximately 69.4% of the variability in customer loyalty and market performance can be explained by customer satisfaction and perception. The high F-value of 487.130, coupled with a p-value of 0.000, confirms the overall significance of the regression model. These findings imply that enhancing customer satisfaction and improving perceptions of indigenous beverage products could lead to increased loyalty and better market performance, emphasizing the need for beverage companies to focus on quality improvement and effective communication strategies to build positive consumer experiences.

H02: The current marketing strategies employed by indigenous beverage companies are not effective in reaching targeted consumer segments.

Table 2: Regression Results

	Unstandardized Coefficients		Standardized Coefficients		P-Value
	B	Std. Error	Beta	T	
(Constant)	4.561	0.834			
Marketing Strategy Effectiveness	.652	.056	.778	13.364	.000
Target Consumer Reach	.534	.049	.615	10.898	.000
R=.820^a R²=.672, Adjusted R²=.670					
Anova F=376.184 P=.000					

Source: Researcher's Survey, 2025

The regression analysis results provide compelling evidence to reject the null hypothesis stating that the current marketing strategies employed by indigenous beverage companies are not effective in reaching targeted consumer segments. The unstandardized coefficients indicate that both marketing strategy effectiveness ($B = 0.652$) and target consumer reach ($B = 0.534$) significantly contribute to the model, with standard errors of 0.056 and 0.049, respectively. The T-values of 13.364 and 10.898 are notably high, reflecting the substantial influence of these factors on marketing outcomes, and both have p-values of 0.000, affirming that these results are statistically significant. The model demonstrates a strong explanatory power, as evidenced by an R^2 value of 0.672, which indicates that 67.2% of the variance in effectively reaching targeted consumer segments is accounted for by the marketing strategies assessed. Additionally, the ANOVA results show an F-value of 376.184 with a p-value of 0.000, confirming the overall significance of the regression model. These findings imply that indigenous beverage companies should prioritize refining their marketing strategies to enhance their reach and effectiveness, as doing so could lead to better alignment with consumer preferences and ultimately improve market performance in a competitive landscape.

Discussion of Findings

The findings from the regression analysis reveal a significant relationship between customer satisfaction and perception of indigenous beverage products, demonstrating that these factors play a crucial role in enhancing customer loyalty and overall market performance. With both customer satisfaction ($B = 0.589$) and product perception ($B = 0.478$) yielding statistically significant results (p-value = 0.000), the evidence clearly supports the notion that positive consumer experiences directly contribute to increased loyalty and business success. This aligns with the findings of Oghojafor et al. (2021), who assert that customer satisfaction is pivotal in influencing consumer loyalty within the Nigerian beverage market. Their study emphasizes the importance of understanding consumer preferences and delivering high-quality products to foster loyalty. Conversely, a study by Adetunji et al. (2022) challenges this perspective by suggesting that while customer satisfaction is essential, it is not the sole driver of loyalty in the beverage sector. Their research highlights that brand reputation and effective marketing strategies also significantly influence consumer retention, indicating that beverage companies must adopt a multifaceted approach to ensure long-term loyalty. However, the current findings reinforce the assertions of Adeleke et al. (2023), who found a direct correlation between customer satisfaction and loyalty in emerging markets, suggesting that improving product quality and consumer perceptions can substantially enhance market performance. Furthermore, the results resonate with the work of Ibrahim and Abiodun (2020), which illustrated that customer perceptions of product quality and satisfaction levels are crucial determinants of repeat purchases in the beverage industry. Their findings indicate that enhancing customer satisfaction leads to increased loyalty, supporting the conclusions drawn from the current study. Collectively, these studies underscore the importance of prioritizing customer satisfaction and positive product perception as integral components of effective marketing strategies in the indigenous beverage sector.

The regression analysis findings for the second hypothesis, which examines the effectiveness of current marketing strategies employed by indigenous beverage companies in reaching targeted consumer segments, reveal significant insights. The analysis shows that marketing strategy effectiveness ($B = 0.652$) and target consumer reach ($B = 0.534$) have strong and statistically significant coefficients (p-value = 0.000), indicating that these factors are crucial for achieving successful market penetration and engagement. This finding aligns with the study by Ogunyemi and Okoro (2022), which emphasized the importance of targeted marketing strategies in enhancing consumer engagement within the beverage industry. Their research highlights that understanding consumer demographics and preferences is vital for crafting effective marketing campaigns. Contrastingly, a study by Chukwuma et al. (2021) suggests that while marketing strategies are important, their effectiveness can be limited by external factors such as market competition and economic conditions. Their findings imply that indigenous beverage companies must not only focus on their marketing strategies but also adapt to changing market dynamics to effectively reach consumers. Nonetheless, the current results support the conclusions of Adebayo and Alabi (2023), who found that well-designed marketing strategies significantly improved customer engagement and loyalty among consumers in the beverage sector. Their research indicates that targeted marketing efforts enhance brand visibility and strengthen consumer

relationships. Moreover, these findings are consistent with Sulaimon et al. (2020), who demonstrated that effective segmentation strategies lead to improved market performance in the Nigerian beverage industry. Their study reinforces the notion that tailoring marketing strategies to specific consumer segments can enhance overall business performance and competitiveness. Together, these studies affirm the importance of developing and implementing effective marketing strategies that resonate with targeted consumer segments, thus contributing to the success of indigenous beverage companies in a competitive marketplace.

Conclusion

Conclusions from the study findings on the first hypothesis which postulates that customer satisfaction and a perception of indigenous beverage products play insignificant roles in their loyalty and overall market performance are as follows. First of all, the investigated hypothesis postulating that there is a positive correlation between the level of customer satisfaction and their loyalty to indigenous beverage products is confirmed. Besides, increased consumers' attitude towards these products leads to high brand loyalty and market performances indicating that quality of products and their image are important factors for the success of businesses. Likewise, the second hypothesis regarding the current marketing strategies that the indigenous beverage firms is able to target the considered consumer segments prove useful. The above analysis reveals that these marketing strategies are useful in increasing interaction and, hence, the market share of consumer segments of interest. That underscores the importance at which beverage companies must target the marketing strategies they use according to the population subgroup and their tendencies, which in turn enhances the brand recognition and customer loyalty. Nevertheless, it is pointed out that the effectiveness of the proposed strategies largely depends on factors outside the organization and its marketing activities, which again raises the issue of the dynamics of marketing activity. Based on the above findings, the study recommends that Indigenous beverage companies should prioritize product quality by investing in research and development to innovate and improve existing product lines. This could involve exploring new flavors, healthier options, or sustainable packaging to meet evolving consumer preferences. Regular quality assessments and consumer feedback loops can help ensure that products consistently meet high standards.

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A STUDY OF SOCIAL MEDIA RAPPORT MANAGEMENT ON AL-JAZEERA FACEBOOK PAGE

BY

Zaynab Raji-Ellams

Department of English and Literary Studies, Bayero University Kano

Email: zbaji-ellams.eng@buk.edu.ng

Abstract

This study investigates the dynamics of rapport management within user interactions on the official Facebook page of Al-Jazeera. Drawing on Spencer-Oatey's Rapport Management Theory, it examines the linguistic strategies employed by users to maintain, enhance, challenge, or neglect rapport in discussions spanning sensitive discourse categories, including religion, politics, gender, terrorism, and race. A corpus of 250 utterance tokens, collected between 2019 and 2021, was analysed using a combination of qualitative discourse analysis and quantitative statistical tools such as cross-tabulation and the Chi-square test. The findings reveal that rapport challenge is the most prevalent strategy, particularly within religious and conflict-related discussions, followed by maintenance, neglect, and enhancement. The prevalence of impoliteness and confrontational language is attributed to factors such as anonymity, perceived social distance, and the contentious nature of the topics discussed. The study establishes a statistically significant relationship between discourse categories and rapport strategies, thereby affirming that the nature of the discourse influences patterns of interaction. This research contributes to the growing field of pragmatics and computer-mediated communication by demonstrating the applicability of rapport theory in interpreting digital politeness, aggression, and interpersonal dynamics.

Introduction

Social media platforms have become pivotal spaces for contemporary public discourse, characterised by their immediacy, accessibility, and capacity to transcend geographical and cultural boundaries. Within these digital environments, users engage in real-time dialogue, often navigating contentious or sensitive topics under conditions of anonymity and minimal social accountability. Facebook, in particular, fosters a unique communicative climate in which social cues are absent, yet emotional and ideological intensity is amplified. The official Facebook page of Al-Jazeera, renowned for its global reach and provocative reporting, serves as an apt context for examining the pragmatics of online interaction. This study extends prior theoretical engagement with politeness and rapport management by applying Spencer-Oatey's (2008) framework to digital discourse. It specifically focuses on how users construct, manage, or undermine interpersonal rapport in response to Al-Jazeera's news posts. The analysis encompasses 138 selected utterances from a total of 250, gathered across diverse discourse categories including religion, politics, terrorism, race, and gender, over a two-year period (2019–2021). Adopting a mixed-methods approach, the study integrates qualitative discourse analysis with inferential statistical testing, particularly the Chi-square test of independence, to identify patterns of rapport strategy deployment. The results illuminate how user interactions are shaped not solely by the content of news posts, but by sociocultural positioning, identity politics, and the structural features of computer-mediated communication. This research makes an original contribution to the field of intercultural pragmatics and digital discourse studies, offering insights into the mechanisms of online affinity and antagonism in pluralistic communicative contexts.

Methodology

Content Category for the Study

The content categories for the research are shown in Table 1.0.

Table 1.0: Content Category for Study

CATEGORY	CONTENTS
Content Category	a. News post b. Comments c. Reply
Direction of posts/comments/replies	a. Bald-on b. Negative c. Positive d. Off Record
Story Characteristics	a. Al-Jazeera news post b. Public comments c. Replies
Story Theme	a. Politics b. Religion c. Terrorism d. Current Affairs e. Diplomacy f. Violence/Conflict g. Gender h. Racism

Data Gathering Procedure

Over two hundred and fifty (250) utterance tokens were randomly selected, covering different human endeavours ranging from politics, education to the economy. The tokens were gleaned between 2019 and 2021 to cover a long period of communication behaviour. All the selected messages were read in their entirety and one hundred and thirty-eight (138) tokens were coded for instances of rapport management/mismanagement. This information was recorded to quantify whether instances of rapport challenge/neglect were more likely to occur within certain types of activities. Also, these categories were used to estimate the nature of online discussions.

Rapport was measured using an index, such that:

- If a message included at least one instance of rudeness/impoliteness, it was labelled impolite.
- If name-calling, aspersions, hyperbole, words that indicated non-cooperation, or vulgarity occurred, then the message was considered a rapport-challenging act.
- If other instances of impoliteness occurred that had to do with sarcasm, using all-caps (frequently used online to reflect shouting), and other types of more covert impolite behaviour, those were coded as others (neglect/maintenance/enhancing).

These categories were derived from the research of Spencer-Oatey (2008, p.32). The direction of impoliteness was also recorded and categorized as interpersonal, group, Al-Jazeera, story source, or other-oriented.

Total Population of Study and Sample Size

Table 2.0 provides a concise summary of the population characteristics for the study. The data for this study are primarily selected from Al-Jazeera Facebook page. The researcher selects from the different posts of Al-Jazeera within the period of 2019 and 2021. Then, the researcher allows comments and replies to trickle in so that they are treated alongside the theme of the posts.

Table 2.0: Population Characteristics

Aspect	Population Characteristics
Study Population ¹	Entire posts/news on Al-Jazeera Facebook page/timeline
Classification	Gender, Age, Race/Ethnicity, Religion
Age Range	16-65 years (eligible and able to use Facebook)
Gender ²	Men, Women, LGBTQ oriented individuals covered
Race/Ethnicity	People from all continents, representing every race and ethnicity
Religion	Various religions and beliefs (Christianity, Islam, Hinduism, Buddhism, Atheism)

From the wide range of the population study as shown in Table 2.0, over two hundred and fifty (250) utterance tokens were randomly selected as samples to analyse rapport management and politeness. Each sample falls under one of these theme categories (religious, political, gender, racism, diplomatic and terrorism related discourses). The reason for this categorisation is that every news post stirs different reaction due to sentiments and legitimacy of the post, all of which were further analysed under Spencer-Oatey's rapport orientation strategies which include Maintenance, Challenge, Neglect and Enhancement.

Method of Data Analysis

Spencer-Oatey & Franklin (2009) described rapport as a subjective perception of harmony or disharmony, smoothness-turbulence, and warmth-antagonism during interpersonal communication. This study analyzed interpersonal communication in computer-mediated interaction, further narrowing its focus to computer-mediated discourse on social network platforms. In the study of politeness strategies, users' comments were read in addition to the reading of the news post. Rejoinders were also read where available, and detailed notes were taken to aid the interpretation of qualitative analysis. The analysis was done on a subject basis. Hence, rapport strategies in each of the politics-related, religion-related, current affairs, and so on were examined independently. In this research, Facebook was the case study. Social network applications are ubiquitous as they are enabled on almost all types of smartphones; statistics showed that more than half of the world's population owned smartphones. According to Laricchia (2023), the global smartphone penetration rate was estimated at 67 percent in 2021, the same value since 2018.

Al-Jazeera, right from its inception, had such a great impact and effect on global society, especially the way they presented headlines, presents, and caption news. On one level, the Al Jazeera Effect changed perspectives, disrupted censorship and propaganda, and sent information from the global East and South to the West. Author Philip Seib expanded the idea of the Al Jazeera Effect even further, counting it as part of the entire system of new media, from satellite broadcasting to digital technology (Zingarelli, 2010).

¹ Difficulty in ascertaining the total number of posts, comments, and replies by Al-Jazeera on Facebook within the study period (2019-2021)

² Some countries (Middle Eastern) may have internet restrictions, especially for women and LGBTQ

Anonymity in computer-mediated communication (CMC) played a major factor in determining whether interaction between strangers who did not know each other, nor each other's social role went a long way in determining the ebb and flow of their conversation. Anonymity in CMC made participants leverage their freedom of speech. Al-Jazeera Facebook participants also had these high tendencies. Essentially, Al-Jazeera Facebook participants were more inclined to be impolite in their interactions. They tended to be easily triggered by certain topics, perhaps due to the way the Al-Jazeera team presented their reports. To properly analyze the politeness/impoliteness of Al-Jazeera Facebook page audience, Spencer-Oatey's four rapport management orientation strategies were applied. Table 3.0 summarises the key aspects of the data analysis.

Table 3.0: Key aspects data analysis

	Aspect	Description						
1	Rapport Definition	• Subjective perception of harmony or disharmony • Smoothness-turbulence, warmth-antagonism in communication						
2	Analysis Scope	• Interpersonal communication in computer-mediated interaction • Further narrowed to computer-mediated discourse on social network platforms						
3	Politeness Study	• Users' comments and rejoinders analyzed alongside news posts. • Detailed notes taken to aid qualitative analysis. • Subject-based analysis for politics, religion, current affairs, etc.						
4	Anonymity in CMC	• Anonymity in computer-mediated communication analysed. • Participants leverage anonymity for freedom of speech. • Al-Jazeera Facebook participants show tendencies towards impoliteness						
5	Analysis Strategies	Spencer-Oatey’s four rapport management orientation strategies applied. <table><tr><td>i. Rapport Maintenance</td><td>Routine politeness behavior. Efforts to restore relations is also exhibited</td></tr><tr><td>ii. Rapport Enhancement.</td><td>Corresponds with Leech's politeness model. Acts enhancing politeness or face, e.g., saying "please," "thank you</td></tr><tr><td>iii. Rapport Neglect</td><td>Neglect of face support or redress where face threat</td></tr></table>	i. Rapport Maintenance	Routine politeness behavior. Efforts to restore relations is also exhibited	ii. Rapport Enhancement.	Corresponds with Leech's politeness model. Acts enhancing politeness or face, e.g., saying "please," "thank you	iii. Rapport Neglect	Neglect of face support or redress where face threat
i. Rapport Maintenance	Routine politeness behavior. Efforts to restore relations is also exhibited							
ii. Rapport Enhancement.	Corresponds with Leech's politeness model. Acts enhancing politeness or face, e.g., saying "please," "thank you							
iii. Rapport Neglect	Neglect of face support or redress where face threat							

			occurred. - Lack of concern or interest in social relations
		iv. Rapport Challenge	Accommodation of impoliteness; A desire to impair harmonious relations between participants

Rapport enhancement corresponded with Leech's (1983) politeness model that accommodates acts that simply enhance politeness or face like saying "please," "thank you," or giving compliments to build social interactions/relations. One might reasonably expect that the audience on Al-Jazeera Facebook page deployed 'face-enhancing actions' like making use of subtle and kind words in the comment section as a means of creating a face-supportive atmosphere. Rapport maintenance could be simply a matter of performing routine politeness behavior where it was expected, or, in tune with Brown and Levinson (1987), a matter of restoring relations. The difference between rapport maintenance and enhancement was that without the effort to maintain rapport, rapport would be threatened; enhancement, in contrast, was a relatively free gift. Moreover, pointing out errors and suggesting corrections could be highly face threatening. Rapport neglect, as the term 'neglect' implies, had negative connotations: it was the neglect of face support or redress where face threat or loss had occurred. It was a lack of concern or interest in the quality of social relations. Spencer-Oatey's suggestion that a 'focus on self' may lead to the neglect of another's face was plausible in many situations. Rapport challenge accommodated impoliteness; it was a desire to impair harmonious relations between participants.

Presentation of Analysis

The presentation of the analysis was done in a systematic manner. This section highlights the specific aspects of the studies, findings, challenges, and the final focus on politeness strategies. This is to make the sequential progression of the presentation of data more concise. The data was obtained from overall objective of the study which is to:

- i. Analyse how Al-Jazeera observes affinity (rapport) in her general social media settings.
- ii. Describe how rapport management is deployed in the general posting on Al-Jazeera Facebook page.
- iii. Identify how Al-Jazeera followers engage in rapport in the comments and reactions.
- iv. Analyse the measure of politeness followers observes in the comments.
- v. Discuss how the perceived social distance affects rapport management.

The analysis is done under the following themes:

- a. Religious Discourse
- b. Current Affairs Discourse
- c. Politics-Related Discourse
- d. Violence/Conflict- Related Discourse
- e. Terror-Related Discourse
- f. Racism-Related Discourse
- g. Gender- Related Discourse
- h. Diplomacy-Related Discourse

Each of the above sections of analysis is examined from the perspectives of the four rapport orientation strategies identified by Spencer-Oatey.

For brevity, only two themes are presented in this seminar vis a vis religious and racism related discourses. A summary of other themes is provided from the perspective of identified strategies as per Spencer-Oatey.

Rapport Challenge in Religious Discourse

Religious issues are highly controversial, given Al-Jazeera's diverse audience spanning different religions and beliefs. These topics can easily trigger face-threatening acts among users, but positive rapport management is not entirely impossible. A lot of the interactions underscores the challenges in managing rapport when dealing with religious issues on Al-Jazeera's Facebook page. It highlights the diverse opinions and responses, ranging from rejection to positive strategies, and suggests the importance of effective policies to foster a respectful online discourse.

a) Sri-Lanka Anti-Muslim Riots:

Al-Jazeera posts about the Sri-Lankan government imposing a state of emergency and blocking Facebook access due to anti-Muslim riots in 2018. Comments reflect diverse opinions, with some rejecting Facebook's apologies and others suggesting apologies from all parties involved. Positive rapport strategies include some users extending an olive branch for peace, while some comments exhibit negative rapport management through sarcasm.

b) Discussion on Policy Reform:

Yasir Khan's direct and polite response highlights the possibility of disagreement while maintaining positive rapport. A user also raises a crucial question regarding Facebook's measures to reform policies on hate speech. The discussion emphasises the importance of implementing measures to curb extreme comments and promote a more respectful online environment.

Rapport Maintenance in Religious Discourse:

This section explores the intricacies of rapport maintenance and challenge in discussions related to religious discourse on Al-Jazeera's Facebook page. Here are the key points:

a) Significance of Religious Discourse:

- Ethno-religious issues are prominently discussed on Al-Jazeera's Facebook page, attracting attention due to their sensitivity and potential for generating diverse opinions.
- These discussions often lead to both instances of rapport management and challenges.

b) Example: Saudi Women Joining Military

- A post discussing Saudi women joining the military prompts various reactions.
- Rosario Marques expresses concern about women being turned into military forces, leading to diverse participant reactions.
- Merlin Emiliano adopts a neutral stance, emphasizing the semantic nature of the world to avoid taking sides and sparking further arguments.
- Ahmed Hassan's defensive comment attempts to correct a perceived face threat, showcasing the sensitivity of religious discussions.

c) Religious Diversity and Controversy:

- Religious-related discourse is the most talked-about and controversial topic on Al-Jazeera's Facebook page.

- The token presents a news post related to religious matters, with comments and rejoinders examined for rapport-building or challenging elements.

d) Rapport Maintenance/Challenge in Religious Discussions:

- James Dedes offers a friendly statement preaching peace and harmony, but Muhammed Noor disagrees, initiating a potential face-threatening situation.
- Participants who aim to start arguments often wait for initial comments, then reply with disagreements to spark debates and engage others.
- The perceived victim of face threats may choose cautious words to avoid further arguments and face threats, maintaining a neutral stance with statements like "thank God we have a god who decides such things."

Discussions on religious discourse on Al-Jazeera's Facebook page are marked by a mix of efforts to maintain rapport, diverse opinions, and occasional face-threatening challenges, highlighting the complexity and sensitivity of such topics.

Rapport Neglect in Religious Discourse

Spiteful comments are one of the major pointers to rapport threatening acts, in the posts shown in Figure 1 (a&b), three users replied to the comment of Khadr Imam Ali about Mother's Day in relation to Islam, his comment "*every day is Momy's day in Islam.... "Paradise is under feets(sic) of your mother!"*" Muhammed peace be upon him" this comment could have easily been supported and attracted a lot of 'friendliness' which supports rapport management. Rather there is an array of several insulting, debasing and face threatening statements/words such as 'cult' (Ibrahim Mwiti) '*that's why women are slaves in Islam?*' (Kobi Litman) '*what about the 72 virgins?*' (Jeevi Sunthar). These are classified under sociality rights which have been broken by these participants and are therefore a threat to rapport building and rapport management strategies.

a)



b)



Figure 1: Mother's Day Celebration

Rapport Challenge Orientation in Religious Discourse:

Rapport challenges are a common occurrence in Al-Jazeera Facebook users' responses to religious posts, often involving face and identity-threatening acts. Participants tend to make blunt and bald statements without softening the threat, given the sensitivity of religious topics.

a) Example: Muslims Pray in Hagia Sophia in Turkey:

Rapport-challenging statements, like the one suggesting the conversion of *Al-Aqsa* to the temple of Solomon, trigger tongue-lashing responses from other users.

A comment advocating that religion should be a source of peace receives zero replies and angry reactions due to the initial rapport-threatening statement.

b) Another Instance: New Zealand Faith-Based Care Abuse:

Al-Jazeera's headlines on religious issues are crafted to cause controversy in the comment section, leading to sensitive discussions. A seemingly neutral comment like "peaceful Christians" is interpreted as insinuating and capable of turning violent, leading to a clap back from another user defending their identity and saving face.

Euphemism and Interpretation:

The use of euphemism, expressing a negative statement in a neutral manner, can contribute to negative rapport strategies.

The interpretation of statements by users who do not know each other becomes crucial in determining the potential for face-threatening situations.

Identity Defense and Sociality Management:

Users engage in direct responses and clap backs to defend their identity rights and save face when they feel their sociality/identity is being threatened.

The dynamics of sociality and identity management come into play as participants navigate religious discussions on the platform.

In summary, the breakdown of rapport in religious discourse on Al-Jazeera's Facebook page often involves the careful interpretation of statements, the use of euphemism, and users' defense of their identity rights to manage sociality in an online context.

Racism Rapport Discourse

The extract delves into various instances of racism-related discussions on Al-Jazeera's Facebook page, particularly focusing on Miss Universe, New Mexico electing women of color, Canada's indigenous people, and dark-skinned dolls. It shows how racism-related topics evoke diverse reactions, ranging from efforts to maintain rapport through positive engagement to challenges and disagreements that may lead to rapport breakdown. The analysis provides insights into the dynamics of online discussions around sensitive racial issues on Al-Jazeera's Facebook page.

Rapport Maintenance in Racism Discourse

i. Miss Universe Racism Rapport:

- Users engaged in discourse about Miss Universe, showcasing different views and perspectives.
- Examples of rapport maintenance orientation, emphasizing compliments and appreciation to promote harmony.

- Certain users express disagreement, with varying tones from aggressive to face-saving.
- ii. **New Mexico Elects “Women of Color”:**
 - Al-Jazeera's headline generates controversy, leading to differing opinions in the comments.
 - Disagreement on the term "women of color" with some seeing it as racist and others supporting it.
 - Users engaged in a mix of rapport maintenance, challenge, and neglect, expressing their viewpoints.
- iii. **Canada’s Indigenous People:**
 - News about racial social media posts about Canada's indigenous people prompts a heated discussion.
 - Negative insinuations and comparisons heightened tensions, resulting in condescending remarks and further discord.
 - Users employ face-saving strategies to address the conflict and attempt to maintain a civil tone.
- iv. **Dark-Skinned Dolls:**
 - Discussion on dark-skinned dolls involves cautious comments and face management to handle potential disagreements.
 - Users express preferences for locally handmade toys, emphasizing cultural and emotional significance.
- v. **Floyd Trial Testimony:**
 - Issues relating to racism as shown in Figure 2.0 often generate various opinions among Al-Jazeera users, when a group of interlocutors think alike and have the same views they usually get involved in a conversation where they demonstrate support and agreement. This act of unison minimizes the social distance among the interlocutors as well as mitigates the possibilities face threat.

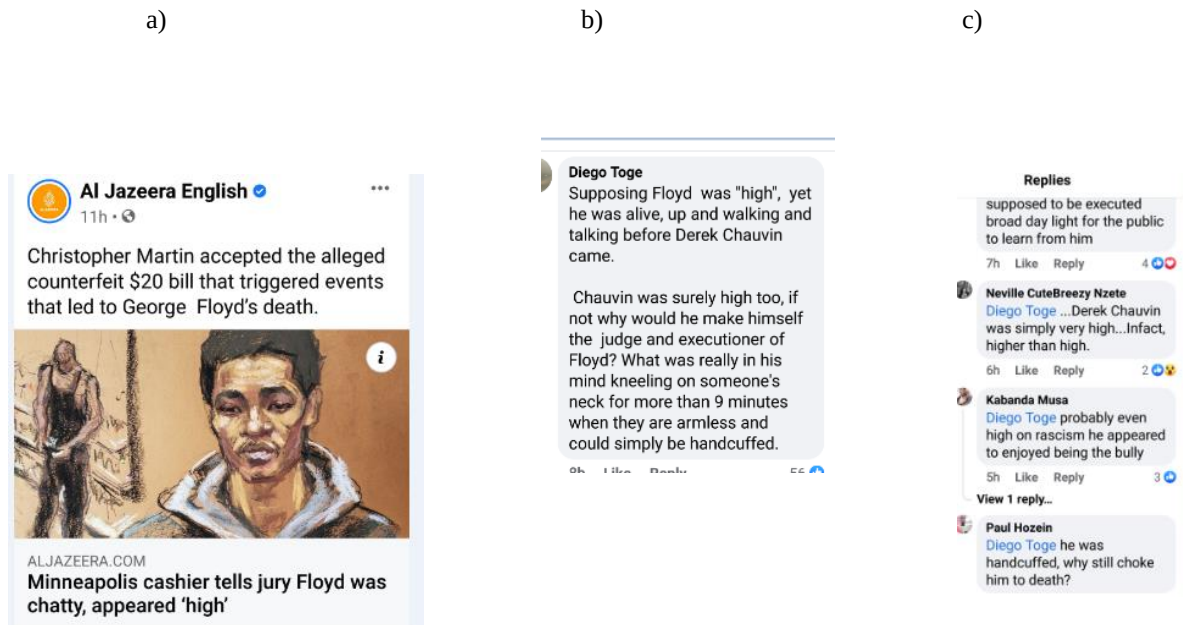


Figure 2: Cashier testifies that Floyd appeared to be on Drugs.

As shown in Figure 2 (b), although Diego Toge (DT)'s comment is not directed at anyone in particular, he employs the use of rhetorical question when he/she says: '*Chauvin was surely high too if not why would he make himself the judge and executioner?*'. This question in particular and DT's comment in general paved the way for similar responses from other interlocutors. All the responses directed at DT's comment are proof that the interlocutors have similar opinions like DT especially that of Neville: '*Derek Chauvin was simply very high....*' Which answers the rhetorical question in DT's comments.

Rapport Enhancement in Racism-Based Discourse

On racial related discourse (like the news report in the above extract) some Al-Jazeera audience are usually careful about the things they say and their choice of words in order not to sound discriminatory and offensive. Failure to employ the careful use of words in racial related discourse, often results in participants using insulting words at each other thereby mitigating the chances of building rapport. The comment in Figure 3.0 will examine the rapport enhancing strategy used by some participants.

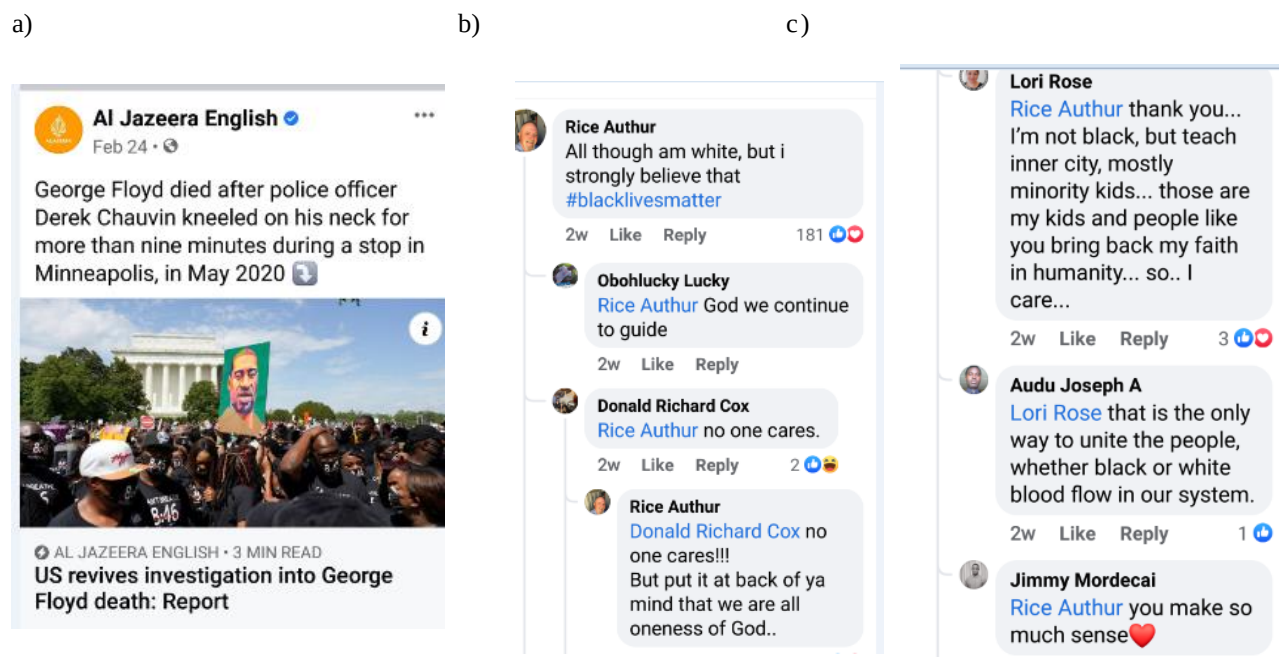
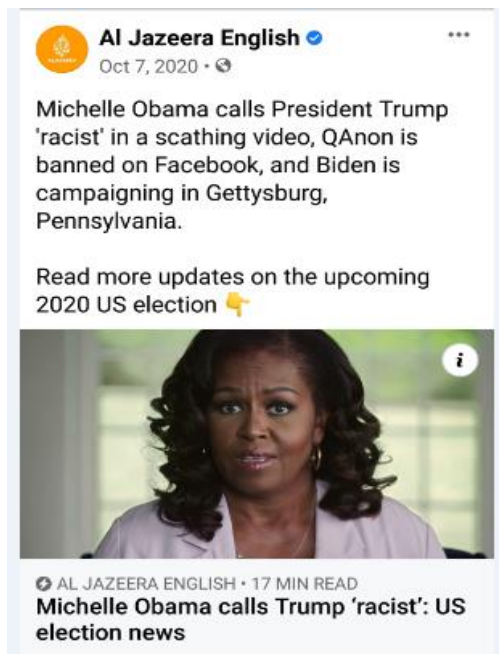


Figure 3: George Floyd Death by US Police

One of the ways Al-Jazeera users enhance rapport with other participants is by identifying with them, as shown in the comment of Rice Arthur especially in the hash tag #blacklivesmatter used in his comment which is a commonly used tag on social media by black individuals when speaking about racial discrimination, he further buttresses his point in his reply to Donald which gave his comment a more rapport enhancing tone. The comments that follow are shown in the excerpt in Figure 3.0 (b&c). Drawing on the last comment by jimmy Mordecai, '*you make so much sense*' the use of the heart emoji in the comment emphasizes on the positive impact of Rice's comment in the interaction. Also, the comment of Lori Rose shows similarity with that of Rice especially when she says "*...I care*", this shows kindness and like mindedness which altogether enhances rapport among participants.

Rapport Neglect in Racism Discourse

a)



b)



Figure 4: Michelle Obama Labels Trump a Racist

Rapport neglect strategy is sometimes identified among Al-Jazeera Facebook when there is a unison in the comment of more than two participants in response to another user's comment especially when the comment is perceived by the majority to have a negative meaning or impact and there is a collective attempt to clam up such comments. An instance of such comment is seen in excerpt shown in Figure 4.0(b). The comments in excerpt c above are the replies that followed the comment of Joshua Efebor (JE). Although these comments were not planned, they are in alignment and are all aimed at one thing, which is to point out the inappropriate use of words in JE statement. This is done without regard for mutual relations among each other.

Rapport Challenge in Racism Related Discourse

a)



b)



Figure 5: UK Report Denies Systematic Racism (2)

Whether or not a speaker makes a negative statement, the responses and reactions from other participants cannot be predicted hence, rapport challenge strategy recurs when an interlocutor deliberately makes a negative comment under to another participant, when this happens, the speaker in turn attacks back in the same vein, hence impeding the possibilities of having quality relations among participants. As shown in Figure 5.0 (b), Mark Peter (MP)'s comment is the first instance of rapport challenge in the above extract when he/she says '...eternal blamers....' The Abdi Jama's reply is a response to MP's attack: 'troller train detected...' Instead of improving the mutual interaction between these interlocutors, this dialogue increases further the social distance between them.

General Discussions

Through discourse analysis and classification, we may better understand, and model social media interactions around various subjects. Critical exploration is done to discover behavioural patterns, such the inclination to challenge or maintain rapport in certain discussions. Thus, this kind of structured data analysis offers thorough insights into the extracted interactions, while validating any qualitative assertions made through quantitative and statistical analysis. This section will elaborate and discuss data obtained, in relation to the specific objectives of the study.

The Degree of Politeness on Al-Jazeera Facebook Page

The outlook and manner of presentation of information on Al-Jazeera's Facebook page cannot be said to be entirely courteous, as it frequently discusses contentious themes that elicit harsh responses. Occasionally, their posts are incisive and frequently spark conflict. Sometimes, racial messages with political overtones are updated; other times, headlines trigger the followers thereby sparking debates and opinions in the comment section. Furthermore, it is important to note that the most frequently discussed topics on Al-Jazeera's Facebook page are usually ethno-religious related as they tend to strike a chord within the followers as well as contentious thereby provoking unpleasant outbursts. There is usually a sense of judgement in the overall Al-Jazeera Facebook media environment.

Rapport Management Deployment on Al-Jazeera Facebook Page

After careful observation of the data gathered in this study, it indicates that all four rapport strategies are commonly employed by the participants across all eight discourse categories. The challenge in rapport appears to be more prominent in religious-based discourse, violence/conflict/terrorism and social discourse as shown in Table 4.0. Participants use this avenue to initiate confrontations; when participants disagree on an issue, they typically attack one another which usually results in name calling, thereby impairing cordial relations among participants. From the data gotten from Al Jazeera Facebook feed, the frequency of each strategy has been organised within each discourse category as shown in Table 4.0.

Table 4.0: Cross Tabulation of Rapport Management Strategies by Discourse Categories

Discourse Category	Enhancement	Maintenance	Neglect	Challenge	Total
Religious	4	6	1	10	21
Political	3	6	2	8	19
Current Affairs	2	5	1	6	14
Violence/Conflict	1	2	5	10	18
Terrorism	1	2	3	9	15
Racism	5	4	3	8	20
Gender	2	3	1	4	10
Diplomacy	2	7	5	7	21
Total	20	35	21	62	138

From Table 4.0, it is obvious that religious discourse often faces a great number of challenges, indicating a high level of contention and conflict in this category. Occasionally, these confrontations directed at Al-Jazeera or Facebook as a means for some users to express their displeasure. Aspersion and name calling are two methods frequently used by participants in the categories. Other forms of rudeness and impoliteness that fall under the category of rapport challenge are mockery and ridicule of people, places and beliefs. Again, it is most prevalent in religious discourse, due to the sensitive nature of religious issues and the automatically defensive nature (almost reflex) displayed by participants when such issues are discussed. Maintenance efforts are moderate, but there is minimal neglect, suggesting that the topic is actively engaged in the Al Jazeera Facebook. Political discussions are heavily maintained and challenged, reflecting their dynamic and often contentious nature. The moderate enhancement indicates efforts to positively engage in political discourse, though challenges remain significant.

Noticeably, Current affairs tend to have a slight tendency noticed towards challenge and maintenance. Enhancement and neglect are low, indicating less effort is made to positively influence these discussions. Violence and Terrorism discourse are contentious and often avoided topics as seen in the frequency of challenge and neglect respectively. Gender discussions show a balanced approach with relatively heightened challenge discourse comparatively, suggesting constructive engagement and efforts to maintain positive discourse, while being moderately controversial. Diplomatic discourse is highly maintained and challenged, reflecting its importance and the effort to handle it constructively. The distribution is shown in Figure 6.0.

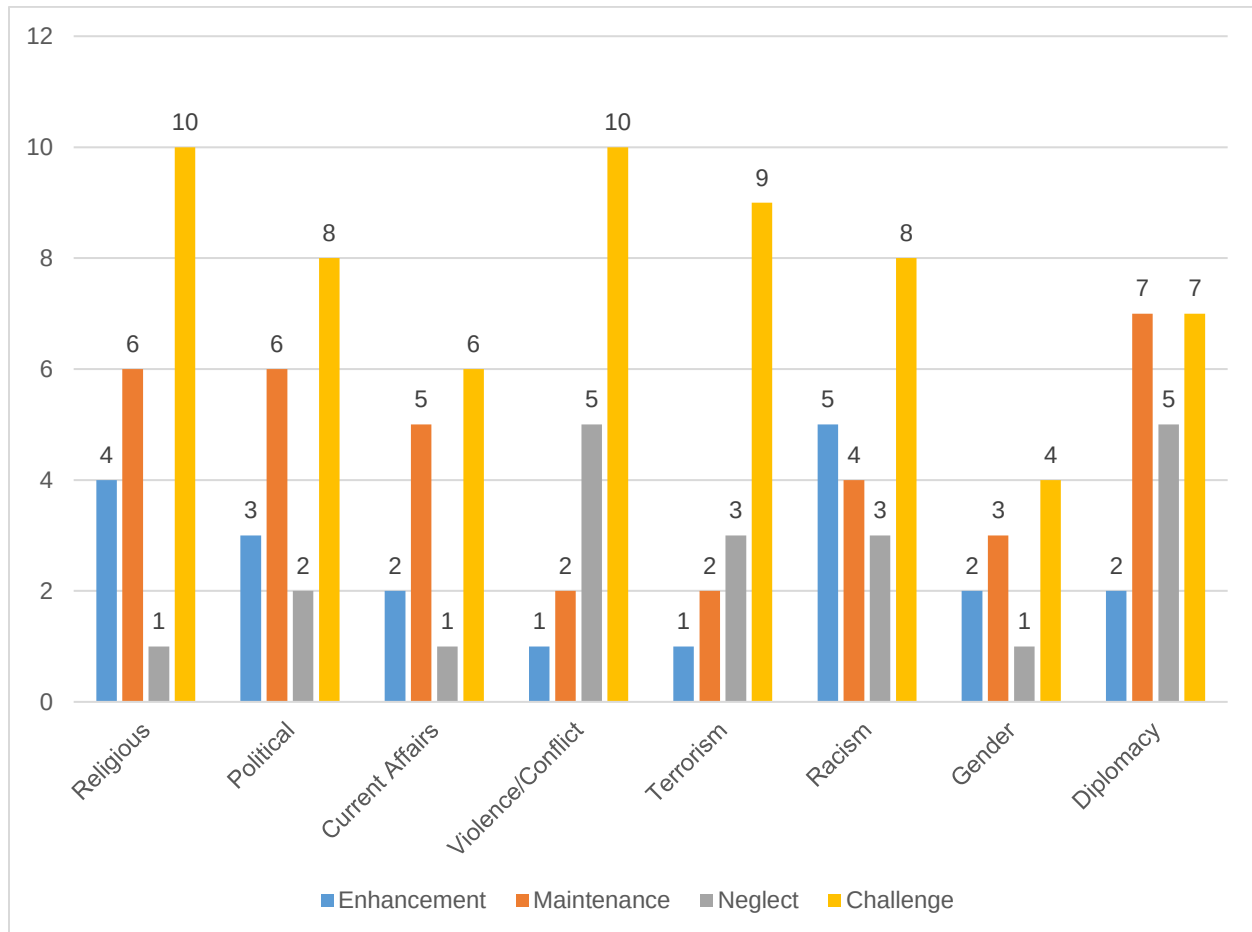


Figure 6.0: Distribution of Various Rapport Management Strategies

The percentage analysis in Table 5.0, Rapport Challenge is the most frequently used strategy, particularly in religious, violence/conflict, and terrorism discourse accounting for half of the strategies.

Table 5.0: Percentage Distribution of Rapport Management Strategies

Discourse Category	Enhancement (%)	Maintenance (%)	Neglect (%)	Challenge (%)
Religious	2.90	4.35	0.72	7.25
Political	2.17	4.35	1.45	5.80
Current Affairs	1.45	3.62	0.72	4.35
Violence/Conflict	0.72	1.45	3.62	7.25
Terrorism	0.72	1.45	2.17	6.52
Racism	3.62	2.90	2.17	5.80
Gender	1.45	2.17	0.72	2.90
Diplomacy	1.45	5.07	3.62	5.07

Discourse Category	Enhancement (%)	Maintenance (%)	Neglect (%)	Challenge (%)
Total Percentage	14.48%	25.36%	15.19%	44.94%

From Table 5.0, Rapport Maintenance comes second with 25.36 percent usage, indicating attempts to maintain politeness and social harmony. This characterised by support, agreement, and the use of positive statements between users. This method is frequently used in gender, politics, current affairs, and racial related discussions. Participants' use of this strategy mitigates the possibility of all kinds of traits which arises during interaction between participants. Essentially, the method ensures that the interaction/dialogue between participants flows smoothly and coherently, regardless of the presence of an agreement or disagreement. Rapport Neglect accounts for just over 15.19 percent, which is the second least used strategy across all categories, despite its dominance in violence/conflict and social discourse. Rapport neglect is a deliberate lack of concern and interest in the quality of relationships between participants, as demonstrated by participants' off-the-record/off-topic comments and a lack of enthusiasm for the news/post. Participants who employ the rapport neglect strategy are simply unconcerned about the effect of their comments on the other participants. Occasionally, participants express their opinions using asperse language, which may irritate other participants who perceive it as an attack on them.

The least used strategy is Rapport Enhancement across all categories, which is slightly lower than neglect accounting for over 14.48 percent. This is possibly because Al-Jazeera participants are unwilling to invest the time and effort necessary to foster harmonious relationships among users. The most plausible explanation for this lack of effort is the anonymous nature if Facebook users. There are only few instances of this strategy being used on Al-Jazeera Facebook page and among participants. The strategy of enhancing rapport entails the use of endearing words and compliments to convey familiarity between participants. Sympathy/empathy is another common trait demonstrated by participants and it has been shown to facilitate rapport-building strategies. Thus, this method has been shown to significantly reduce the social distance between participants. It is shown in the data that religious discourse, and issues involving violence/conflict are the most contentious, both accounting for 7.25 percent challenge rapport of the total data, while being closely followed by Terrorism related discourse, with significant engagement despite varying levels of maintenance and neglect. Summarily, challenge accounts for close to half of the strategy employed. In contrast, topics like gender and diplomacy exhibit more balanced discourse with moderate challenges and efforts to enhance and maintain positive interactions.

Generally, maintenance is a consistently employed strategy, showing a consistent effort to engage across categories, whereas neglect is less frequent but notably high in violence/conflict and terrorism, pointing to areas where discourse might be avoided or insufficiently addressed. This analysis highlights the differing nature of discourse across various themes and the varying strategies employed to manage rapport within these interactions.

The Manner of Followers' Rapport Management in Comments and Reactions

Most users appear to be non-conservative while expressing their message(s), most comments contain coarse language. However, few users employ rapport maintenance strategies when trying to quench a heated debated or when a user agrees with a line of argument but does not wish to become too involved in the debate. When users identify with one another and demonstrate familiarity in the comment section, rapport is enhanced.

The Nature of Followers Politeness

The presence of negative politeness in all the eight categories of discourse indicates that followers usually impolite and do not employ rapport enhancing strategies during interactions. Due to the lack of familiarity and social relations between followers and participants negative politeness is the most prominent strategy used. Politeness on Al-Jazeera's Facebook page is usually taken for granted probably because it is believed that its primary

responsibility is to inform, it could be argued that Al-Jazeera Facebook page employs a bald on record strategy that is quite effective when the speaker is powerful or when little face is at stake. This directness may still be construed as a manifestation of politeness.

Social Distance and Rapport Management

Social distance and anonymity are the major factors that affect rapport management this is because, participants in computer-mediated discourse and in this case social media share no familiarity or sameness, also, there is a seemingly obvious distance between participants as their level of closeness does not go beyond seeing each other's comments. On one hand, this makes it easy for participants to get away with negative comments and impoliteness and other face threatening acts. On the other hand, social distance increased the lack of effort required to maintain and enhance rapport; most users simply do not care enough about people they do not know to make polite comments, use endearing words or give compliments in order to maintain and enhance rapport.

The data analysis reveals that the frequency with which language is used indicates a lack of or insufficient effort to build rapport among participants, which could be explained by the user's religious and social backgrounds. This corroborates Morand and Ocker's (2003) assertion that face-threatening behaviours are an unavoidable part of Computer-mediated communication.

Chi-Square Test of Independence

We also performed Chi-Square test to determine if there is a significant association between two categorical variables. This test was to see if the distribution of rapport management strategies is independent of the discourse categories. Essentially, the analysis tested the association between discourse categories and rapport management strategies (enhancement, maintenance, neglect, challenge). The following hypothesis formulation was adopted:

Null Hypothesis (H_0): There is no association between discourse categories and rapport management strategies.

Alternative Hypothesis (H_1): There is an association between discourse categories and rapport management strategies.

To perform the Chi- Square analysis, we created an expected frequency table as shown in Table 6.0. To do that we calculated the expected frequency using Table 4.0, extracting the row total and the column total.

To Calculate Expected Frequency (E_{ij}):

$$E_{ij} = \frac{R_i \times C_j}{n}$$

Where E_{ij} = expected frequency

R_i = Row total

C_j = Column total

n = Number of observations

Applying this formula for each cell:

Table 6.0: Expected Frequencies Table

Discourse Category	Enhancement	Maintenance	Neglect	Challenge
Religious	3.04	5.35	3.20	9.43
Political	2.75	5.52	3.00	8.73
Current Affairs	2.03	5.26	2.15	6.35
Violence/Conflict	2.61	4.61	2.75	7.89
Terrorism	2.17	3.79	2.31	6.72
Racism	2.90	5.13	3.08	8.89
Gender	1.45	2.56	1.53	4.47
Diplomacy	3.04	5.35	3.20	9.43

Thereafter, the **Chi-Square Statistics** was computed using the formula:

$$\chi^2 = \sum \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

where O_{ij} is the observed frequency from Table 4.1 and E_{ij} is the expected frequency from Table 6.0. The Chi-Square statistics table is shown in Table 7.0.

Table 7.0: Chi-Square Table Statistics

Discourse Category	Enhancement	Maintenance	Neglect	Challenge
Religious	0.29	0.26	2.13	0.26
Political	0.04	0.25	0.23	0.07
Current Affairs	0.00	0.12	0.49	0.13
Violence/Conflict	1.06	2.82	2.77	3.00
Terrorism	0.66	0.86	0.43	1.85
Racism	2.76	0.09	0.00	0.72
Gender	0.29	0.33	0.02	0.11
Diplomacy	0.34	0.77	1.94	2.82

From Table 7.0, the total sum of χ^2 was found to be 32.87.

The next stage was identifying the **Degrees of Freedom**.

The degrees of freedom (d_f) in the context of the chi-square test denote the quantity of independent data points that are available for estimating a statistical parameter.

$$d_f = (r - 1) \times (c - 1)$$

Where:

r = number of rows in the contingency table.

c = number of columns in the contingency table.

$$d_f = (8 - 1) \times (4 - 1) = 7 \times 3 = 21$$

Referring to the Chi-Square Distribution Table:

At the significance level of $\alpha = 0.05$ and $d_f = 21$, the critical value of χ^2 is around **32.67**. As $\chi^2 = 32.87$ is significantly greater than 32.67, the null hypothesis is rejected. This implies that significant association between discourse categories and the distribution of counts across Enhancement, Maintenance, Neglect, and Challenge categories.

Findings

After careful analysis of data, this research finds that:

1. Al-Jazeera Facebook page itself is strategic in its postings and employs contentious and highly debatable and sentimental topics/news.
2. Judging by the tone and outlook of Al-Jazeera Facebook page it is safe to say that a percentage/fragment of Al-Jazeera's page represents a certain degree of biasness.
3. Al-Jazeera followers frequently employ rapport challenging, neglecting and threatening acts than maintenance and enhancing strategies.
4. Al-Jazeera Facebook followers are often impolite in their comments and usually do not make use of rapport enhancing strategies during interaction with other users
5. Perceived social distance affects rapport in a negative manner as it breeds a "nonchalant" behaviour among participants which often lead to rapport neglect.
6. Statistically, enough evidence is found to draw the conclusion that there is a relationship between discourse categories and the distribution of frequencies in the given data, based on the Chi-Square Test of Independence, with the null hypothesis rejected.
7. This implies that it is improbable for the observed discourse category frequencies in any of four operational categories—Enhancement, Maintenance, Neglect, and Challenge—to result from pure chance.

Summary

This study is an assessment of rapport management in Al-Jazeera Facebook communication using the politeness approach. Five research questions were developed in accordance with the study objectives to guide the research's progression. The study is situated within the discipline of pragmatics. Although not all pragmatic issues were examined in this study, politeness/rapport management issues, as proposed by Spencer-Oatey, are examined in Al-Jazeera computer-mediated communication with emphasis on Oatey's four rapport strategies. Rapport management is a politeness theory which examines how people maintain, enhance or threaten harmonious relationship with others by managing three elements: face, sociality rights and obligations, and interactional goals. This study examined

rapport management in computer mediated communication using Facebook as case study; 200 token utterances were randomly selected from Al-Jazeera Facebook page, taking into consideration the subject/topic of discourse. These utterances were analysed under Oatey's four rapport management orientations. According to the study, social media facilitates conversation and interaction among followers by allowing them to create, comment, and share content. It enables anyone to communicate and become a source of information, allowing followers to share their perspectives, insights and experiences. It is from these that analysis based on the four rapport orientations are drawn.

As expected, and as revealed by collected data, primary posts on the majority of issues would likely divide followers into three groups:

1. Those who support the post.
2. Those that oppose it and
3. Those that are indifferent.

Occasionally, because of the polarity in their philosophical, political, religious, racial and social orientations, followers became personal and resorted to abuse or relationship neglect.

Conclusions

The purpose of this study from the general discussion and analysis conducted reveals that politics, social-related and violence/conflict discourses employ all the four-rapport orientation identified by Spencer-Oatey (2008). Rapport challenge and maintenance strategies are found to be the most frequently used strategies by Al-Jazeera Facebook users due to the nature of CMC which does not promote face value since users may not be personally confronted. It is then followed by rapport neglect and lastly rapport enhancement. Information from the data analysis also shows that several strategies such as rapport neglect, challenge and enhancement used by Al-Jazeera Facebook participants in their conversation on a religious post such as a particular comment from a user under a religious based news which states "where are the apologies from Muslims? All those killings the days before!!!!" shows less or low effort towards rapport building among participants, perhaps, due to the religious and social background of users. This indicates that most Al-Jazeera Facebook participants in a religious discourse are less concerned about the importance of building good rapport.

Majority of the users do not seem to be conservative in expressing their message as coarse language is replete in most of their comments. However, few users employ rapport maintenance strategy when the purpose of communication is to quell a harsh discourse; or when a user concurs with a line of argument, and probably does not want to be too involved in the discourse. Rapport enhancement occurs when users identify with each other and exhibit public display of closeness/familiarity. In the case of Al-Jazeera Facebook communication, the strategy is used without recourse to the social distance among the interlocutors. The inability to meet users in person appears to be the factor that encourages bald-on record. In summary, the Chi-Square Test of Independence offers strong evidence that the distribution of frequencies in the Enhancement, Maintenance, Neglect, and Challenge categories in the given data are related to discourse categories. This discovery advances our knowledge of how various discourse kinds may correspond with various attentional or engagement patterns within these operational categories.

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AN ANALYTICAL ASSESSMENT OF THE CHALLENGES ENCOUNTERED IN NIGERIA'S POLICY-MAKING PROCESS

BY

Okoh Itebite Daniel

Department of Political Science and Public Administration, Benson Idahosa University, Benin City, Edo State

Email: itebiteokoh@gmail.com

Abstract

In Nigeria, policy-making process faces numerous challenges that significantly affect its policy outcome, leading to issues such as insecurity, deteriorating infrastructure, multi-dimensional poverty, high unemployment rates, and elevated inflation. Thus, this study aimed to provide a comprehensive evaluation of the policy-making process and critically interrogated those challenges encountered in the policy making process of Nigeria. The theory of political systems served as a foundational framework for comprehending the intricacies of the policy-making process. This study adopted a qualitative methodology, employing content analysis to interpret non-numerical data from literature pertinent to the discussed theme. The analysis posited that the obstacles confronting policy making in Nigeria stem from institutional deficiencies, ineffective governance, self-serving decisions by executives, and inadequate legal frameworks that fail to regulate the misconduct of political actors. To address these challenges in Nigeria's policy-making landscape, the study advocated for the establishment of a comprehensive database, which is essential for effective national planning and development. Furthermore, it emphasised the importance of participatory governance in the policy-making process, ensuring that the beneficiaries of policies are not only consulted but also actively engaged. Additionally, it urged political actors, particularly those in executive positions, to demonstrate the requisite political will necessary to effectively navigate the policy-making process and realise the intended goals and objectives. Finally, there is an urgent need for a robust legal framework to regulate the actions of policy actors.

Keywords: Public policy, policy making, policy actors, input-output analysis

Introduction

Governments worldwide are actively involved in the formulation of policies aimed at addressing societal issues, regulating the behaviors of individuals, groups, and organisations, as well as redistributing wealth from the affluent to those in need. Consequently, public policy is the result of a dynamic interplay among various stakeholders, including businesses, interest groups, and individuals, who both compete and collaborate to influence policymakers' decisions across a range of issues. To pursue their objectives, these entities engage in lobbying, advocate for their positions publicly, and mobilise supporters, among other strategies (Prakash, 2022). Overall, the formulation of public policy is influenced by a combination of internal and external factors. Internal influences encompass public opinion, economic conditions, technological advancements, and the activities of interest groups, while external factors include the roles of donor agencies, neighboring countries, socio-cultural contexts, and political dynamics ("Factors that influence public policy," n.d.).

The policy-making process is characterised by its complexity, multifaceted nature and cyclical attributes, distinguishing it from a straightforward, linear sequence of steps. This process encompasses various phases, including identifying the policy problem, establishing the policy agenda, formulating and adopting policies, as well as implementation and evaluation. According to Egonmwan (1991/2014), there are two primary categories of actors involved in this process: primary and secondary actors. Primary actors possess direct constitutional authority to participate in policy formulation; this group typically includes the President as well as members of both the National Assembly and State Assemblies. In contrast, secondary actors do not possess the same level of authority, and their functions are frequently carried out by administrators, judges, special panels, and commissioners. These individuals play a significant role in the policy-making process, even though they do not wield direct constitutional power.

Further, in Nigeria, the policy-making process faces numerous challenges that significantly affect its outcome, leading to issues such as insecurity, deteriorating infrastructure, multi-dimensional poverty, high unemployment rates, and elevated inflation. Therefore, this study aimed to provide a comprehensive evaluation of the policy-making process and critically interrogate those challenges encountered in the policy making process of Nigeria. To accomplish these objectives, the paper was organised into several sections: an exploration of the conceptual foundations of public policy; an examination of the theoretical framework informed by political systems theory; a description of the methodology employed; an analysis of the policy-making process; few illustrations of Nigerian policies utilising input-output analysis in contemporary contexts; an investigation into the challenges encountered in policy making process within the Nigerian landscape; followed by a conclusion and recommendations.

Conceptualisation of Public Policy

Public policy represents both a domain of study and a foundational concept within the realm of public administration. It encompasses those areas designated as "public," in contrast to the private sector. The notion of public administration implies the existence of a shared domain of life that is not solely private or individualistic, but rather collectively held (Eneanya, 2016). Public policy is the action or proposed action of a government aimed towards achieving goals (Ikelegbe, 2006, as cited in Obona 2016; Ugwuanyi & Chukwuemeka, 2013). Y. Dror defines public policy as a major guideline for action. That is, a general directive for action. (Y. Dror, as cited in Egonmwan 2014). Contrary to Ikelegbe and Dror's definition of public policy is that of Dye, Dye (1972:18), sees "*public policy as whatever government chooses to do or not to do*". The definition is deficient because what government does not do is a mere statement of intent and policy goals or objectives are not achieved at the end of the exercise. Chandler and Plano (1988: 40), define public policy "*as the strategic use of resources to alleviate national problems or governmental concerns*". This definition focuses on the policy implementation. A more acceptable definition is given by Jenkins; he defines "*public policy as a set of interrelated decisions by a policy actor or group of actors concerning the selection of goals and the means of achieving them within a specified situation, where those decisions should in principle be within the power of those actors to achieve*". (Jenkins, as cited in Egonmwan, 1991/2014:3).

Based on the aforementioned definitions, it is clear that public policy is fundamentally focused on addressing specific issues. Consequently, public policy serves as a mechanism for problem-solving. Furthermore, it is inherently forward-looking, anticipating future outcomes. Public policy is also characterised by its action-oriented nature, involving a collaborative effort among various stakeholders to accomplish defined policy objectives. The policy process is a methodical sequence that includes various phases, beginning with problem identification and culminating in policy evaluation. Furthermore, public policy is inherently strategic, especially in terms of resource allocation and the efficient planning of human capital.

Theoretical Framework

Political Systems Theory

Public policy is viewed as the response of a political system to demands from its environment (Eneanya, 2016; Aibieye, 2009). According to David Easton, "*the political system is a system of interactions in any society through which binding or authoritative allocations or decisions are made*" (David Easton, as cited in Onah, 2010: 55-56). The political system can be conceptualised as comprising several interconnected components: inputs, a conversion process (often referred to as a black box), outputs, feedback, and the environment. Consequently, the framework facilitates an analysis of policymaking through the lens of input-output dynamics. Within this system, inputs are characterised by demands and support. Demands represent the appeals for action made by individuals or groups to fulfill their interests and values, while support manifests when citizens or groups adhere to electoral outcomes, pay taxes, comply with laws, and generally accept the decisions and actions taken by the political system in response to these demands (Aibieyi, 2009). Additionally, demands may arise from data analyses that provide insights into issues, thereby facilitating evidence-based approaches to problem-solving (Indeed, 2025). Furthermore, demands

can also stem from policy revisions suggested by analysts both within (regulatory agencies and think tanks) and outside (research institutions, academia and civil society organisations) governmental frameworks. Outputs from the political system may include the passage of new legislation, the establishment of government programmes, the maintenance of law and order and the provision of public goods and services. The framework facilitates an analysis of the input-output dynamics within the policymaking process by defining the conversion mechanism, often referred to as the "black box," through which inputs are transformed into outputs. The environment encompasses all external conditions and events that impact the political system (Eneanya, 2016). The actions and results of the output are relayed back into the system and the inputs through a feedback mechanism (Hanumanthappa, 2023).

The theory of the political system can be closely aligned with the policy-making process. Within this framework, the components of the system—namely inputs, the conversion process, outputs, feedback mechanisms, and the surrounding environment—mirror the stages of policy development. For example, issues identified as policy problems and those included in the policy agenda are categorised as inputs. The stages of policy formulation and implementation correspond to the conversion process, often referred to as the "black box." The outputs represent the results of policy implementation, which can manifest as the provision of public goods and services, the issuance of regulations, or the introduction of new government programmes. Throughout these stages, evaluation occurs continuously, generating feedback in the form of suggestions, recommendations, and prescriptions that re-enter the system as inputs. Therefore, this process constitutes a perpetual and iterative cycle.

Methodology

The study employed a qualitative methodology, utilising content analysis to assess the policy-making process in Nigeria. It aimed to critically examine the challenges experienced during this process, drawing on relevant literature from journals, books, and online resources.

The Policy Making Process

There are principally five (5) steps or stages in the policy making process. These steps are policy problem; policy agenda; policy formulation; policy Implementation; and policy evaluation.

Policy Problem

This is the first step in the development of public policy entails recognising a policy-related issue. A policy problem is characterised as a social circumstance that many individuals perceive as detrimental or unacceptable due to its impact on a substantial number of people over an extended period. Consequently, these individuals advocate for a constructive transformation of the situation (Egonmwan, 1991/2014). In essence, a collective expression of discontent regarding the situation is essential. It is crucial to distinguish between problems and issues; a problem transitions into an issue when a group calls for governmental intervention, when there is contention surrounding potential solutions, and when the selection among alternatives involves conflicting interests among various groups (Harris, 1980, as cited in Aibieyi, 2009). According to Egonmwan, (1991/2014), for a social situation to become a policy problem, all or some of the following conditions need occur: a large number of people are in unfortunate conditions, suffering deprivation, are dissatisfied with an undesirable situation; these adverse conditions are recognised by many people; those who suffer unsatisfactory situation, the decision makers are aware of the situation as they have responsibilities for coping with it; people outside the immediate social problem (third parties) must show concern; large number of people think something should be done about the situation apart from merely recognising the undesirable situation and conflicting interests and cognitive agreement on what remote cause of the problem is and how it should be solved.

Policy Agenda

The process through which policymakers either proactively address or feel compelled to tackle specific issues at any given moment is referred to as agenda setting. This concept is fundamentally different from the broader spectrum of political demands. Furthermore, it contrasts with the idea of political or policy priorities, which outlines a hierarchical arrangement of agenda items (Anderson, 2003, as cited in Eneanya, 2016). Certain matters may be classified as crises—such as a "health care crisis"—to enhance their prominence on the agenda and to expedite action. The designation of an issue as a "crisis" carries an inherent implication of urgency and importance (Aibieyi, 2009). For a public concern to attain agenda status, it must represent a problem that necessitates government intervention. Agenda items can be categorised into two types. Cobb and Elder (1983, as cited in Eneanya, 2016) describe the first type as the systematic agenda, which encompasses all issues that are broadly acknowledged by members of the political community as deserving of public attention and as falling within the legitimate scope of existing governmental authority. In contrast, the institutional or governmental agenda consists of problems that legislators or public officials feel compelled to address with serious attention and action (Eneanya, 2016). The policy agenda-setting process is characterised by three largely independent streams of activities: problems, proposals, and politics. Occasionally, these streams converge, creating what is referred to as a "policy window" that allows specific issues to ascend to the governmental agenda (Kingdon, 1995, as cited in Aibieyi, 2009). The problems stream features issue that stakeholders within or outside the government seek to move toward action. The proposals stream includes potential solutions to these identified problems, while the politics stream encompasses elements such as electoral outcomes, shifts in presidential administrations, public sentiment, and campaigns initiated by interest groups (Aibieyi, 2009).

Policy Formulation and Adoption Stage

"Policy formulation stage involves the development of pertinent and acceptable proposed courses of action for dealing with public problems" (Eneanya, 2016: 249). However, the actors involved in policy formulation can be classified into two groups: primary policymakers and secondary policymakers. Primary actors possess direct constitutional authority to participate in policy formulation; this group typically includes the President as well as members of both the National Assembly and State Assemblies while secondary actors lack such authority, and their roles are often fulfilled by administrators, judges, special panels, and commissioners who contribute to the policy-making process without holding direct constitutional power (Egonmwan, 1999/2014). Eneanya (2016) outlines the process of policy formulation as comprising several key stages: the identification of the policy issue or problem, the specification of objectives and targets, the development of various options and strategies, the selection of a preferred option or strategy, policymaking decisions, the design of implementation strategies, and finally, the evaluation and reform of the policy. This formulation phase culminates in policy adoption, whereby the chosen policy alternative is enacted into law or adopted through executive orders by the legislative branch of government. In democratic contexts, policies enacted by legislators are generally regarded as legitimate and binding (Eneanya, 2016).

Policy Implementation

This is the next stage after policy formulation and adoption; it is that stage where policy actors grapple with reality. This involves the translation of goals and objectives of policy into concrete achievements through various programmes. Hence, it is often said that policy implementation is programme implementation. (Egonmwan 1991/2014). *"Policy implementation is the process of translating policy mandates into action, prescriptions and goals in reality"* (Ikelegbe, 2005, as cited in Wilson & Epelle, 2018: 178).

"Policy implementation is the process of assembling resources (including people), allocating resources and utilising resources (operations) in the order to achieve policy objectives" (Eneanya, 2016: 250).

The primary entities responsible for the execution of established policies are governmental bureaucracies, specifically administrative agencies. Additionally, the judiciary and the legislature play significant roles in this

process. Notably, the legislature possesses the authority to override executive decisions with a two-thirds majority. Meanwhile, the courts are tasked with interpreting statutes and administrative rules and regulations (Eneanya, 2016). It is crucial to highlight that the implementation stage of the policy-making process is often the most challenging. Unlike the formulation phase, which involves a variety of stakeholders working behind the scenes to develop the policy, the implementation stage directly engages those tasked with enforcing the legislation or programme, as well as individuals who are affected by the policy's outcomes. Key questions arise during this phase, such as whether the implementing agency will adhere to the policy as outlined and whether the policy itself is practical, given that it is frequently articulated in ambiguous terms (Egonmwan, 1991, as cited in Wilson & Epelle, 2018). Furthermore, the complexity of the issues being addressed, the scale of the anticipated changes, the demographic groups targeted by the policy, and the allocation of human and financial resources for implementation all contribute to the challenges encountered. Additionally, the administrative structures and regulations established to facilitate policy implementation are critical factors in this intricate process (Sabatier and Mazmanian, 1995, as cited in Government & Nonprofit, 2016).

Policy Evaluation

This should not be confused as the last stage of the policy making process and also evaluation should be carried out at the policy formulation and policy implementation stages to ensure that the set objectives at each stage are been met and if there is any deficiency, a policy reformation could occur. Evaluation leads to feedback from the environment could enter the problem identification, policy adoption and policy formulation stages. Thus, public policy is a cyclical process. There are two predominant types of evaluation in policy analysis: a) political evaluation, which examines the political feasibility of a given policy; and b) systematic evaluation, which aims to objectively assess the impact of policies and evaluate the extent to which objectives are achieved. This form of evaluation focuses specifically on the effects that a policy has on the issue it aims to address (Anderson, Brady & Bullock, 1978, as cited in Eneanya, 2016). As noted by Eneanya (2016: 251),

“Policy evaluation is concerned with results of a policy or programme. It tries to determine the relevance, effectiveness and impact of policy and programme activities in the light of their objectives. It is also concerned with the efficiency with which programmes are implemented”

The preceding discussion illustrates the complex nature of public policy formulation, characterised by lobbying, deliberations, consultations, and disagreements among various stakeholders, including the public. This process is not strictly linear; rather, it can feature overlapping stages, occurrences that may unfold out of sequence, or retrospective engagements, thereby rendering it more dynamic than a mere straight-forward pathway.

Few Illustrations of Nigerian Policies Utilising Input-Output Analysis in Contemporary Contexts

The government of Edo State has recently reintroduced a monthly environmental sanitation initiative, scheduled to take place on the final Saturday of each month. This policy is designed to promote a clean and disease-free environment (Iyemefokhia, 2025). This reflects the government's commitment to addressing environmental degradation in Edo State. The initiative represents a collaborative effort by the Edo State government to enhance the cleanliness of the region. The execution of this programme falls under the purview of Oredo Local Government officials, with the ultimate goal being the achievement of a healthy and pristine environment. This initiative operates primarily within the confines of Benin City. The exchange rate unification policy of 2023 aimed to consolidate all exchange rates into a singular market framework. This initiative sought to diminish government intervention in the foreign exchange market, enhance price discovery, increase the supply of foreign exchange and bolster investor confidence, among other advantages (Ozili, 2024). The policy was largely influenced by issues of exchange rate arbitrage and existing market distortions. Public input played a crucial role in its formulation, with contributions from various stakeholders, including business leaders, parents, economists, politicians, and certain government officials, all advocating for a unified exchange rate window to facilitate improved access to foreign exchange and mitigate corruption and exploitation within the public sphere. The Central Bank of Nigeria (CBN) serves as the

regulatory authority overseeing this process, functioning according to the directives issued by the Federal Government of Nigeria. The CBN's output is the establishment of the exchange rate unification policy, while the operational environment encompasses banks, online trading platforms, Bureau de Change (BDCs), and CBN-operated systems such as the Electronic Foreign Matching System (EFEMS) and the Nigerian Autonomous Foreign Exchange Market (NAFEM).

The Petroleum Industry Act (PIA) of 2021 represents a significant legislative initiative in Nigeria, designed to overhaul the oil and gas sector. This Act aims to foster transparency, enhance information disclosure, and promote accountability within an industry historically characterised by opacity and corruption (Usman, 2011; Donwa, Mgbame & Ogbeide, 2015). The impetus for reform originated from various stakeholders, including the Nigerian Government, a hesitant National Assembly, the oil and gas industry itself, and the public, all of whom advocated for a restructuring that would introduce integrity, transparency, and accountability to the sector's operations. The legislative process involved the Senate and House of Representatives, which ultimately facilitated the passage of the landmark legislation after years of delays. The culmination of this process was the transformation of the Public Industry Bill (PIB) into the Public Industry Act (PIA) of 2021. The geographical focus of this initiative primarily encompasses the Niger Delta region, including both onshore and offshore areas, as well as other oil-producing states such as Ondo and Lagos.

The Federal Government's social safety net initiatives, notably the National Cash Transfer Programme—also known as the Household Upliftment Programme (HUP)—aim to alleviate pressing social challenges faced by Nigerians, such as poverty and unemployment. This programme provides financial assistance to eligible households, among other objectives. Contributions to its development have come from legislators, the general populace, and governmental agencies. The operational framework is managed by the National Cash Transfer Office (NCTO), which operates under the supervision of the Ministry of Humanitarian Affairs, Disaster Management, and Social Development. The primary output of this programme is the disbursement of cash transfers to qualifying beneficiaries, all functioning within the context of Nigeria's 36 states plus the Federal Capital Territory (FCT) and 774 local government areas. The aforementioned policies exemplify the input-output analysis within David Easton's systems theory, emphasising the components of input, conversion processes, output, and the environmental context in which these policies function.

Challenges Encountered in the Policy Making Process in Nigeria

Policies often reflect the preferences and values of elites rather than the general populace. Elite theorists argue that a relatively small, organised, and powerful group within society has a significant impact on the decision-making process and the outcomes of policies (Aibieye, 2009). This influence is exerted through various means, such as media, campaign events, press releases, and political financing. For instance, in Nigeria's oil sector, prominent individuals and corporations have historically played a crucial role in shaping energy policies and regulations. Notable entities include International Oil Companies (IOCs), the Nigerian Upstream Petroleum Regulatory Commission (NUPRC), and the Nigerian Mid-and Downstream Petroleum Regulatory Authority (NMDPRA), all of which hold considerable sway in the industry. Additionally, elite-driven businesses and contractors often gain from government infrastructure initiatives, examples being Dantata & Sawoe, Julius Berger, and Setraco. Ambitious policies, although well-intentioned, may prove impractical for implementation. Ifediba (2024) noted that the national policy aimed at regulating healthcare workforce migration is designed to mitigate the emigration of health professionals and enhance the healthcare sector—a commendable initiative by the government. However, funding remains a significant challenge. Ifediba (2024) emphasised that Nigeria has yet to fulfill its commitment to allocate 15% of its annual budget to healthcare, as promised in the Abuja Declaration of 2001. In 2024, healthcare funding constituted merely 4.6% of the national budget, which is substantially below the necessary threshold. This discrepancy indicates that the realisation of such a thoughtfully crafted policy may be nearly unattainable.

Certain policies are primarily designed to serve the political interests and self-esteem of politicians rather than effectively addressing societal issues. Initiatives aimed at poverty alleviation, such as Operation Feed the Nation and

the Green Revolution, exemplify this phenomenon; despite their intentions, none have successfully mitigated the poverty and suffering experienced by the Nigerian population. Additionally, national development frameworks such as Nigeria's National Development Plan and the National Economic Empowerment and Development Strategy (NEEDS) further illustrate the prevalence of politically motivated policies that fail to deliver tangible benefits to the citizenry. The individuals who are ostensibly intended to benefit from a specific policy often lack participation in the policy-making process (see, Ajaikeye, 2003 & Onokerhoraye, 2007, as cited in Obona, 2016). Ostrom & Ostrom (1977) contended that bureaucratic professionals tend to operate under the assumption that they are more qualified to ascertain the preferences of citizens regarding services, rather, than actively engaging them in the formulation of policies that impact their lives. In essence, this perspective diminishes the view of citizens as co-producers of various public goods and services. This is what Ostrom referred to as "service paradox" which means "where the better that services are, as defined by professional criteria, the less satisfied that citizens are with those services" (Ostrom, as cited in Sapru, 2013: 419).

The lack of adequately trained professionals significantly impacts informed decision-making, policy implementation, and ultimately results in poor policy outcomes. Ayiuche (2000) highlighted this concern, noting that the scarcity of trained specialists has resulted in ineffective implementation of development strategies in Nigeria. This problem is exacerbated by issues related to coordination and communication. As Olaniyi (2001) pointed out, insufficient or ineffective communication can impede the proper conveyance of intentions. Poor communication channels between policymakers and implementers may contribute to the failure to execute policies effectively (Olaniyi, 2001, as cited in Dahida & Maidoki, 2013). Many developing countries like Nigeria rely on various forms of assistance, whether financial or material, often provided by international organisations such as the World Bank and the International Monetary Fund (IMF), sometimes with conditionalities attached. The World Bank, due to its political influence, has the capacity to enforce policy preferences that may not effectively address the specific issues at hand (Government & Nonprofit, 2016). A pertinent example of this is the unsuccessful Structural Adjustment Programme (SAP) implemented in 1986, which serves as an important case study in this context.

Corruption is a prevalent issue in Nigerian government institutions, manifesting through various forms including embezzlement, bribery and fraud within the public sector. This pervasive problem significantly hampers effective policy implementation, as evidenced by inadequate public services reflected in deteriorating and insufficient infrastructure, such as crumbling roads, inadequate security, and unstable power supply (see Gafar, 2017; Bukar, 2021). A notable example is the Dasuki Gate scandal, which involved the misappropriation of \$2 billion earmarked for the procurement of military equipment (arms and ammunition). The severe repercussions of this scandal included compromised security, which jeopardized the lives and properties of Nigerian citizens, inadequate resources for military personnel and a profound erosion of public trust in government institutions. The public policy making is highly politicised. That is characterised by a multiplicity of government and government agencies involved in potentially over-lapping and conflicting policy making process (Agbazure, 2020). Also, lack of professionalism and indiscipline could affect the effective implementation of policies in public bureaucracies. Examples of lack professionalism include excessive red tapes, absence of limited discretion and lack of motivation due to slow adaptation of new ideas, practice, administrative techniques and technologies. Indiscipline, on the other hand, involves widespread corruption, laziness, rudeness to the public and lack of responsibility (Osezua, Abek & Gberville, 2009).

Furthermore, inadequate statistical data for planning could pose a major challenge to the effective formulation and implementation of public policies. However, data are unavailable or scarce or are even inadequate, thereby leading to the inability of the policy actors to identify and tackle specific causes of the public problem. Such data include census, national income among others (Obona 2016; Wilson & Epelle, 2018). An examination of the challenges confronting policymaking in Nigeria reveals that many of these issues can be attributed to institutional weaknesses, poor governance practices, self-interested decisions made by executives, and insufficient legal frameworks that do not effectively address the misconduct of political actors.

Conclusion and Recommendations

The policy making is a complex, multifaceted and iterative process that entails policy problem; policy agenda; policy formulation; policy implementation; and policy evaluation. The analysis posited that the obstacles confronting policy making in Nigeria stem from institutional deficiencies, ineffective governance, self-serving decisions by executives, and inadequate legal frameworks that fail to regulate the misconduct of political actors. To address these challenges in Nigeria's policy-making landscape, the study advocated for the establishment of a comprehensive database, which is essential for effective national planning and development. Furthermore, it emphasised the importance of participatory governance in the policy-making process, ensuring that the beneficiaries of policies are not only consulted but also actively engaged. Additionally, it urged political actors, particularly those in executive positions, to demonstrate the requisite political will necessary to effectively navigate the policy-making process and realise the intended goals and objectives. Finally, there is an urgent need for a robust legal framework to regulate the actions of policy actors.

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TOWARDS DIGITALIZATION OF SECONDARY EDUCATION IN NIGERIA: CHALLENGES AND PROSPECTS

BY

Eche, Patrick Inalegwu¹, Isaiah Agama Egiri² & Emmanuel Ajaka John¹

¹Department of Biology Education, Federal College of Education, Odugbo, Benue State- Nigeria

²Department of Computer Science Education, Federal College of Education, Odugbo-Benue State, Nigeria

Email: patrichinalegwueche@mail.com | emmyprosper85@gmail.com | isaiahegiri@fcedugbo.edu.ng

Abstract

Secondary education as a second tier of Education in Nigeria occupies a unique position. Apart from laying a solid foundation for subsequent higher education, it also provides a platform for making vocational choices. With current development in Information and Communication Technology and its associated benefits, the shift towards digitalization in Education sector and particularly secondary school education in Nigeria is non-negotiable. It therefore follows, that the conventional knowledge and skill transmission strategies currently employed in our secondary schools are fast becoming obsolete. The paper focuses on the challenges and prospects of digitalization of secondary education in Nigeria. The concept of digitalization was explained, which entails the innovative use of digital tools in teaching and learning processes. The objectives of secondary education and the need for secondary education digitalization were x-rayed. Some challenges hindering implementation of digitalization and its prospects were discussed. It was suggested that Government should show more commitment to digital education by investing in infrastructure, actionable policy development, e.t.c. if the goals and objectives of secondary education must be achieved in this 21st century.

Keywords: Digitalization, Challenges, Prospects, Secondary, Education

Introduction

Education is seen as the fulcrum around which meaningful developments revolve. The technological, economic and political levels of development of any country is a function of its educational system. Education is described as the transformative power in an era defined by expeditious technological advancement and unprecedented global challenges (Adejo,2023). The knowledge, skills and values that are necessary ingredients for development are acquired through education. It is therefore, a veritable sector for development that should be periodically evaluated for the purpose of its relevance in addressing country's multifaceted challenges. The worth of any educational system as an investment, lies in its capacity to serve its beneficiaries particularly the students, parents, employers of labour, and the society in general (Ijaiya, 2014). Education is fundamental in human existence as it empowers individuals to make informed decisions and improve their quality of life. It plays a crucial role in economic and social development by providing requisite knowledge, skills and values. The success stories of countries such as Japan, Russia and China that achieved remarkable progress through focused investment in education underscores the transformative power of a well-articulated educational system (Litvilova, 2015).

In the 21st century, digital transformation has become a pivotal force reshaping educational systems globally. The world is witnessing Fourth Industrial Revolution (4IR) characterized by utilization of technology as a learning platform where all previously automated instructional materials are manipulated to achieve learning objectives (Isa & Ojetunde,2019). The integration of digital technologies into education is revolutionizing the way students learn and educators teach, thereby offering improved accessibility, enhanced learning outcomes, and cost efficiency (Edugist, 2024). The role of education in the development of any nation cannot be over emphasized. The knowledge and skills gained through education are indispensable for national growth.

In Nigeria, popular amongst 4IR education technologies are the online learning platforms (Ojetunde & Ramnarain, 2023) and the push towards digitalizing secondary education is driven by the need to bridge educational disparities and align with global educational standards. The Nigerian government has recognized the importance of digital education in its National Digital Economy Policy and Strategy, aimed at enhancing digital literacy and infrastructure across the country. However, the journey towards fully digitalized secondary education in Nigeria is fraught with challenges such as inadequate infrastructure, limited access to digital devices, insufficient teacher training, and socio-economic disparities that hinder equitable access to digital resources. Moreover, resistance to change and lack of awareness about the benefits of digital education further impede progress.

Despite these challenges, there are significant prospects for digitalizing secondary education in Nigeria. The potential benefits include personalized learning experiences, improved student engagement, and the development of critical digital skills necessary for the modern workforce. Embracing digital education can also facilitate inclusive learning, reaching students in remote areas. (Suleiman & Umejiaku, 2023). This study therefore, explores the challenges and prospects of digitalizing secondary education in Nigeria, providing insights and suggestions that will advance the nation's educational landscape.

Concept of Digitalization

Digitalization in a broader term refers to the process of using digital technologies to transform and improve business processes, operations, and services by leveraging digital tools and platforms. Digitalization in education refers to the integration of digital technologies to enhance teaching, learning and administrative processes. Digitalization involves the innovative integration of modern technologies and digital tools to enhance teaching and learning while creating opportunities for remote access to educational content (Akinyemi, Amaechi, & Etoh, 2022). It encompasses the conversion of analog information such as printed educational items into digital forms, thereby producing digital surrogates that replicate the original physical materials. It is a systematic process of transforming traditional, paper-based instructional materials into electronic formats that can be stored, accessed, and manipulated using digital technologies. Ibezin (2013), further described digitalization as the application or integration of internet-based systems to deliver educational content, skills, and knowledge using a flexible, structured approach. This form of learning accommodates both synchronous and asynchronous modes, supporting instruction and training across time and geographical boundaries. The digitalization of education in Nigeria encompasses a continuum of practices from digitizing content to restructuring pedagogy for online and blended learning environments. Although the nation has made strides, substantial gaps remain in infrastructure, policy, and practice that must be addressed to ensure widespread and sustainable digital education, especially at the secondary level

Digitalization extends beyond the mere conversion of materials but also involves rethinking pedagogy to leverage the advantages of ICT for improved learning outcomes. Although the use of digital technology in Nigerian education is often considered a recent development, digital learning has historical roots. The integration of information and communication technologies (ICT) in education began shortly after Nigeria's independence (Ajadi, Salawu, & Adeoye, 2008). Notable initiatives included the Nigeria Broadcasting Corporation's educational radio programmes in the 1960s targeted at primary and secondary schools, and the University of the Air programme introduced by Ahmadu Bello University in 1972 (Mac-Ikemenyina, 2005). Despite these early efforts, traditional methods of teaching still dominate across Nigeria's secondary and tertiary institutions. Kazeen (2020), observed that chalk-and-talk pedagogy remains the standard in many schools, even as technology-based alternatives are becoming popular. Nevertheless, initiatives such as the National Open University of Nigeria (NOUN) have introduced digitalized course delivery formats using web-based modules, printed materials, audio-visual resources, and CD-ROMs (Mac-Ikemenyina, 2005), signifying a gradual shift towards digital learning in Nigeria's educational landscape. Digital learning is made possible by technology using different methods such as online classes, social learning, virtual meetings, -reality ads, online exams and blended learning (FRN, 2023). However, the level of digitalization in Nigerian education remains relatively low when compared with global standards. Multiple factors, including

resistance to change, lack of infrastructure, and inadequate digital literacy, are considered common factors hindering the transition to technology-enhanced learning models (Kazeen, 2020).

The COVID-19 pandemic significantly accelerated the urgency of digital adoption in education. Social distancing mandates and prolonged school closures exposed the vulnerabilities of conventional learning models and highlighted the necessity of digital solutions. The pandemic underscored the importance of enabling students to access lessons remotely, allowing teachers to assess and interact with learners digitally, and ensuring continuous access to educational materials and information. The impact of COVID-19 on the education sector was far-reaching as it disrupted formal educational services and emphasized the need to search and embrace alternative to traditional learning system. As reported in global literature, over 290 million students worldwide were directly affected by school closures at the height of the pandemic (FRN,2023). The COVID-19 pandemic therefore, has not only disrupted the steady operation of the traditional teaching mode but rather brought the urgent demand for leveraging digital learning as alternative mode of delivering quality education (Adamu,2023) In this context, digital learning has not become the last option but a critical necessity for continuity in education delivery. Though digital education had existed in Nigeria before the pandemic, it was not in popular use as government did not show sincere commitment by adopting it as alternative means of instruction delivery.

Secondary School Education in Nigeria

Secondary education in Nigeria refers to the stage of formal education that occurs after primary education and before tertiary education. It serves as a bridge between these two levels, laying a critical foundation for both higher academic pursuits and vocational development. Historically, secondary education in Nigeria was modeled after the British system, especially before the 20th century. This system was primarily aimed at preparing individuals for leadership roles within the society. However, over time, it became evident that this model was insufficient in meeting the broader national development goals of Nigeria. Consequently, the structure, duration, type, and curriculum content of secondary education have undergone several reforms (James & Obinne, 2013).

In Nigeria, secondary education is broadly categorized into two types: General Secondary Schools which prepare students for tertiary education and; Technical and Vocational Secondary Schools which equip students with practical skills, enabling them to engage in gainful employment upon graduation. This dual structure allows students to either continue into higher education or enter the workforce, depending on their interests and aptitudes. Secondary education occupies a unique and strategic position in the Nigerian educational system. It is not only a preparatory stage for tertiary education but also a platform for vocational decision-making and skill acquisition. This makes it essential for producing well-rounded individuals who can contribute meaningfully to national development. Secondary education in Nigeria is a vital component of the educational system, providing the necessary link between basic and higher education. Its significance extends beyond academics to national development through human capital formation, skill development, and economic empowerment.

Objectives of Secondary Education in Nigeria

The National Policy on Education (NPE) outlines the official objectives of secondary education in Nigeria. According to the Federal Republic of Nigeria (FRN, 2014), the broad goals of secondary education are to prepare individuals for:

1. Useful living within the society, and
2. Higher education.

To achieve these goals, the policy specifies that secondary education shall:

1. Provide all primary school leavers with the opportunity for education of a higher level, irrespective of sex, social status, religious or ethnic background.

2. Offer diversified curriculum to cater for the differences in talents, opportunities and future roles.
3. Provide trained manpower in the applied sciences, technology, and commerce at sub-professional grades.
4. Develop and promote Nigerian languages, art and culture in the context of the world's cultural heritage.
5. Inspire students with a desire for self-improvement and achievement of excellence.
6. Foster national unity with an emphasis on the common ties that unite us in our diversity.
7. Raise a generation of people who can think for themselves, respect the views and feelings of others, respect the dignity of labour, and appreciate those values specified under the broad national goals.
8. Provide technical knowledge and vocational skills necessary for agricultural, industrial, commercial, and economic development.
9. Promote the physical, emotional, and psychological development of all children.

As lofty as these objectives are, many are yet to be achieved probably because of the educational system.

The Need for Digitalization of Secondary Education in Nigeria

In the context of educational reform, the demand for digital transformation has become increasingly critical, especially in light of contemporary global trends and local systemic deficiencies. Prior to the COVID-19 pandemic, Nigeria's educational system was widely perceived as outdated and ill-equipped to drive the country toward the technological advancement needed for national development. As James et al. (2013) rightly observed, the system lacked the structural and instructional dynamism to match 21st-century global educational standards.

The outbreak of the COVID-19 pandemic, which disrupted academic activities globally, served as a catalyst for educational reform. In Nigeria, traditional learning mode which was suspended for several months, further exacerbated the inadequacies of the conventional educational system and this underscores the urgent need for digital alternatives. This period revealed a glaring gap in digital access and readiness, emphasizing the importance of equipping both teachers and learners with digital tools and resources for effective remote learning.

Digital education offers numerous advantages over traditional methods. It has revolutionized teaching and learning by making educational experiences more mobile, interactive, and engaging. Learners' attention spans can be increased, and their appetite for continuous learning sustained through multimedia content and adaptive instructional strategies. Furthermore, digital education promotes inclusivity and flexible learning pathways, enabling individuals to work and learn simultaneously a trend increasingly relevant in modern economies. It is noted that if digitalization is not achieved, the existing inequalities in education in the new normal will likely increase and new ones may arise (FGN, 2023). Government's commitment is therefore underpinned by the understanding that 21st century learning demands innovative pedagogical approach and integration of ICT (Adejo, 2023).

Globally, digitalization has become an integral component of educational reform, and Nigeria must align with this trajectory to ensure its relevance in the global knowledge economy. Integrating Information and Communication Technology (ICT) into education enhances learners' cognitive development and fosters innovation (Akiyemi, et al (2022). They emphasized, that curriculum delivery in a digital environment supports the development of critical thinking, creativity, and problem-solving skills essential for national competitiveness. Moreover, the pandemic laid bare the global digital divide, with over two-thirds of children worldwide lacking access to digital learning tools. In Nigeria, this divide further marginalizes disadvantaged groups, making the case for digital equity even more compelling. Bridging this gap through the digitalization of secondary education is essential for fostering digital literacy and ensuring that students acquire the skills needed to thrive in the 21st-century digital economy.

The 21st century has witnessed rapid technological advancement, fundamentally altering information processing and societal modernization. These shifts impose new demands on education, requiring the integration of modern technological innovations into teaching and learning processes. As Ibenzin (2013) noted, digital education leverages the internet and a flexible delivery model whether synchronous or asynchronous to support the acquisition of knowledge and skills in a way that transcends traditional limitations of infrastructure or course type.

Digitalization, therefore, is not only about educational strategy but a national imperative. It provides an innovative approach to teaching, impacting the quality of didactic and methodological practices. Hristovska and Jovanova-Milkova (2009), highlighted that digital learning redefines content delivery, where instructional tasks are executed through digital platforms, enhancing both teaching efficacy and learner autonomy.

To meet the demands of a globally competitive economy, Nigeria must prioritize the quality of its teachers and the methods they employ. A digitally competent teaching force is indispensable for the effective implementation of digital secondary education.

Digital Tools

Consequent of the positive impact of technology on educational process, overtime, various educational tools are designed which serve to achieve digital learning in an optimal way. Today there are various digital tools that can be used to influence the way of planning, implementation and evaluation of teaching and learning. Digital learning is oriented towards the student as the central person of teaching. Students become more active, they determine the time, place, pace of learning and gain experiences through digital resources. Self-directed processes of acquiring knowledge are considered to be the main feature because the student with the help of the internet and Tech- devices creates a view of the world and acquires the necessary skills for life. On the other hand, the role of the teacher has changed as his control during learning decreases as everything is left to the student and his independent work (Pandel, 2021). The teacher therefore, becomes an advisor, organizer of the teaching process, an expert in the field of using technology in order to achieve optimal educational results and continuous professional development. Considering the characteristics of digital learning, it can be concluded that it is currently the best learning paradigm and strategy for modern education (Elcullada Encarnacion et al, 2021) that is considered as one of the greatest achievements of the century.

Digital learning tools are type of tools whose primary purpose is the development and application of digital teaching content in teaching practice. They enable the planning, implementation and evaluation of teaching, the establishment of communication as well as the design of creative and stimulating teaching materials for most students. Web tools are only new teaching aids that promote and motivate effective learning in a web environment (Juric et al, 2014.). Technically, these are programming languages that allow the user to create and share certain contents via Internet (Maric & Aleksic Minic, 2016). In the pedagogical sense the tools meet all didactic requirements (Novalic & Novalic, 2018), and can be used at all levels of education and during all stages of the teaching process (Teofilovic & Isailovic, 2020). Digital tools do not fulfill purpose in themselves, but they are aids to teacher in the class room and the teaching environment. Their essence is reflected in the development of potentials and digital competencies of students, and more importantly in providing full mental engagement. In that way, skills for lifelong learning are created, which is considered the basic aspiration of modern education.

Key Digital Tools for Secondary Education and Their Characteristics

1. Google Classroom

Google Classroom is a free web-based educational platform developed by Google, designed to streamline the process of sharing files between teachers and students. It allows educators to create, distribute, and grade assignments digitally. The platform supports communication, feedback, and organization of course content in a centralized space, accessible via smartphones or computers. It is particularly useful in monitoring learning activities in distance education, supporting structured lesson delivery and collaboration (Dimitrijevic, 2021).

2. Google Meet

Google Meet is a secure, video conferencing application that enables virtual classroom sessions. It requires a Google account and internet access and supports real-time interaction through audio, video, and screen-sharing features. It is widely used in synchronous teaching sessions for delivering lectures, conducting discussions, and organizing parent-teacher meetings.

3. Zoom

Zoom is a widely adopted video conferencing tool that facilitates interactive remote learning. With a free tier supporting up to 100 participants, it offers features such as breakout rooms, screen sharing, virtual whiteboards, and real-time chat. According to Minhas et al. (2021), Zoom is effective in reducing feelings of isolation in online learning environments, enhancing student engagement, and enabling collaborative tasks, key components for successful digital education.

4. Microsoft PowerPoint

PowerPoint is a widely used presentation tool that allows the creation of multimedia-enhanced instructional content. It supports the integration of text, audio, video, charts, animations, and transitions to facilitate visually engaging learning materials. It is one of the most accessible and commonly used tools in Nigerian schools. Similar platforms like Google Slides provide equivalent functionality for cloud-based collaboration (Novali & Novali, 2018).

5. Google Forms

Google Forms is an easy-to-use tool for administering assessments, surveys, and feedback forms. Teachers can create quizzes and automatically grade student responses. It facilitates real-time data collection, making it useful for tracking student understanding, engagement, and learning progress (Dimitrijevic, 2021).

6. Kahoot! Kahoot! is an interactive learning platform used to create game-based quizzes. It fosters active participation and is effective for formative assessments. It allows teachers to assess knowledge retention in a fun and engaging way, especially useful for younger secondary school learners (Wang, 2015).

7. Edmodo. Edmodo is a learning management system (LMS) designed specifically for K-12 education. It allows teachers to share content, assign quizzes, track progress, and communicate with students and parents in a secure environment. It promotes social learning and collaboration within a controlled classroom space (Trust, 2017).

8. WhatsApp. While not originally designed for education, WhatsApp has become a practical tool for communication and learning in resource-constrained settings like Nigeria. It is used to share notes, voice messages, and videos, particularly when access to formal LMS platforms is limited (Okoye & Nwajiuba, 2021).

9. YouTube. YouTube serves as a repository for instructional videos. Teachers can curate or create video lessons and share links with students for self-paced learning. The platform supports visual learning and is especially helpful in delivering tutorials, experiments, and how-to lessons across subjects.

10. Padlet. Padlet is a digital canvas where teachers and students can collaborate by posting texts, images, links, and videos. It encourages creativity, brainstorming, and collective participation in classroom discussions.

Challenges of Digitalized Education in Nigeria

1. Erratic Power Supply

The irregular power supply in Nigeria continues to hamper the effective deployment and sustainability of ICT infrastructure in schools (Oyeniran et al., 2020).

2. Poor Internet Connectivity and High Cost of Access

Many schools, especially in rural areas, are excluded from digital opportunities due to poor broadband infrastructure and the high cost of internet services

3. Inadequate ICT Infrastructure in Schools

The lack of ICT facilities and digital tools in most secondary schools remains a major challenge to the implementation of digital education in Nigeria (Aduwa-Ogiegbaen & Iyamu, 2005).

4. Limited Digital Literacy Among Teachers and Students

Teachers often lack adequate training in digital pedagogy, making it difficult to integrate technology into teaching and learning

5. **Unpreparedness of Educational Institutions**
The sudden shift to online learning exposed the unpreparedness of many Nigerian institutions in terms of infrastructure, capacity, and planning
6. **Lack of Curriculum Reform for Digital Integration**
There is a clear mismatch between Nigeria's traditional curriculum and the digital competencies required in a technology-driven world
7. **Shortage of Skilled Technical Support Staff**
The effective operation of digital learning systems requires skilled technical staff, which many schools in Nigeria do not have. The present efforts of allowing teachers to attend a one- week- computer training is far from being adequate in the modern classrooms (Moemeke, 2019)
8. **Socioeconomic Barriers and Digital Inequality**
Poverty continues to hinder access to digital devices and internet among students, widening the digital divide (Adeoye et al., 2020).
9. **Urban-Rural Disparity in Digital Access**
Digital education in Nigeria is unevenly distributed, with rural areas suffering limited access to ICT tools and internet connectivity (Ifinedo, 2017).
10. **Policy Gaps and Weak Implementation Frameworks**
Although ICT policies exist, lack of funding and political will have hindered effective implementation in the education sector (Nwachukwu et al., 2020).

Lack of advocacy for inclusiveness in the existing learning method which equally exclude support for the blind with inability to communicate through mail or electronic media that require sight and paucity of research sincerely dedicated to design the program that will mitigate the challenges.

Prospects of Digitalization of Secondary Education

The digitalization of secondary education in Nigeria presents numerous opportunities to enhance learning outcomes, bridge educational disparities, and prepare students for the demands of the 21st-century knowledge economy. Some prospects include:

1. **Enhanced Access to Quality Education**
Digital platforms enable students, especially those in remote and underserved areas, to access a wealth of educational resources beyond traditional textbooks. This democratization of information can significantly reduce educational inequalities.
2. **Personalized and Adaptive Learning**
Technology facilitates personalized learning experiences by allowing students to learn at their own pace and according to their individual learning styles. Adaptive learning systems can identify students' strengths and weaknesses, providing tailored content to address specific needs.
3. **Improved Student Engagement and Motivation**
Interactive digital tools, such as educational games, simulations, and multimedia content, can make learning more engaging and enjoyable. This increased engagement can lead to better retention of information and higher academic achievement.
4. **Development of Digital Literacy and 21st-Century Skills**
Integrating digital technologies into education equips students with essential digital literacy skills, critical thinking, problem-solving abilities, and collaboration skills. These competencies are vital for success in the modern workforce.
5. **Teacher Empowerment and Professional Development**
Digital tools can support teachers by providing access to a vast array of teaching resources, facilitating collaboration with peers, and offering opportunities for continuous professional development through online courses and workshops

6. **Efficient Assessment and Feedback Mechanisms**
Technology enables the use of online assessments and real-time feedback, allowing educators to monitor student progress effectively and adjust instruction accordingly. This timely feedback can help identify learning gaps and improve student outcomes
7. **Promotion of Inclusive Education**
Digitalization can support inclusive education by providing assistive technologies for students with disabilities, ensuring that all learners have equal opportunities to succeed.
8. **Facilitation of Lifelong Learning**
Digital platforms offer opportunities for lifelong learning, enabling students to continue their education beyond the classroom and adapt to the evolving demands of the global economy.
9. **Strengthening of Public-Private Partnerships**
The digitalization of education opens avenues for collaboration between the government, private sector, and non-governmental organizations to invest in infrastructure, develop innovative educational solutions, and expand access to quality education.
10. **Acceleration of National Development Goals**
By fostering a digitally literate and educated populace, the digitalization of secondary education can contribute to Nigeria's broader national development objectives, including economic growth, poverty reduction, and social inclusion.

Conclusion

Digitalization has changed our educational system with moderation on the conventional method of teaching. Digital education has many benefits which is seen in time saving and without paper wastage as witness in the conventional method. The comfort of location for both the instructor and the learning are quit profiting especial in this time of insecurity in the country. The Government should therefore live to its responsibility by implementing the guide line on ICT policy for the purpose of national development.

Suggestions

Policy suggestions below offer a roadmap to building a digitally inclusive and future -ready secondary education system in Nigeria

1. Strengthen Digital Infrastructure in Schools.

Governments at all levels should prioritize investments in ICT infrastructure, especially in public and rural schools, to ensure reliable access to digital tools and internet services (Akinyemi et al., 2022). The lack of power supply remains a serious obstacle; hence, solar-powered and alternative energy solutions should be adopted to mitigate electricity problems

2. Improve Internet Access and Affordability

The Ministry of Communication and Digital Economy, in collaboration with internet service providers, should expand broadband access and subsidize internet costs for educational purposes. Poor connectivity has worsened digital inequality in many Nigerian schools. Programs like Nigeria's National Broadband Plan aim to increase internet penetration and bridge the digital divide. Policy interventions should prioritize digital equity as a foundational component of educational reform (Lawson, 2024). Also, free or subsidized data bundles for teachers and students should be implemented to improve online learning engagement.

3. Build Digital Literacy Capacity among Teachers and Students

There is a need to integrate structured digital literacy training into teacher education and professional development programs (NITDA, 2023). Teachers require skills not only in using technology but also in applying digital pedagogy, the effective integration of digital tools into instruction (Moemeke, 2019).

4. Curriculum Reform for Digital Integration

The Nigerian Educational Research and Development Council (NERDC) should revise the secondary school curriculum to incorporate digital literacy, coding, and digital citizenship (NERDC, 2023). Additionally, learning content should be digitized to be interactive, accessible offline and online, and compatible with devices commonly used in Nigerian schools (EdTech Hub, 2021). The world is moving at a fast rate. The present curriculum for educational technology for teachers requires not only a review but complete overhaul to include practical use of technologies for now and for the future (Moemeke, 2019)

5. Provide and Promote the Use of Educational Digital Tools

Schools should be encouraged to adopt free or low-cost platforms such as Google Classroom, Edmodo, and WhatsApp for teaching and communication (EdTech Hub, 2021). Teachers can also leverage platforms like YouTube, PowerPoint, and Kahoot! to create engaging and contextualized content

6. Establish Technical Support Units in Schools

Each school should have at least one trained ICT support personnel to provide basic maintenance and user support for digital learning tools. This can be achieved through partnerships with NYSC ICT graduates or outsourcing to private ICT providers

7. Address Socioeconomic Barriers to Digital Access

Device loan schemes and government-subsidized programs are necessary to ensure that students from low-income households have access to digital tools (BusinessDay, 2022). NGOs and international partners should also be encouraged to support device donation and digital inclusion programs, especially in underserved areas (Wired, 2007).

8. Foster Public-Private Partnerships

Government collaboration with telecommunications firms, tech companies, and educational NGOs can provide infrastructure, devices, and training support. These partnerships should be incentivized through corporate social responsibility (CSR) initiatives targeted at schools.

9. Develop a National Digital Education Policy Framework

A robust and inclusive national policy framework should be developed to guide digital education implementation. This should include standards for access, teacher training, content development, and monitoring (NITDA, 2023). Equity and inclusiveness must remain central to all policy strategies.

10. Promote Research and Innovation in Digital Education

Government and tertiary institutions should support contextual research on best practices, adoption models, and local digital learning challenges (Akinyemi et al., 2022). Pilot projects in schools can help test and scale innovative digital learning strategies.

By addressing these key areas, Nigeria can make significant strides in digitalization of secondary education thereby harnessing the potential of digital education to improve learning outcomes and prepare citizens for the complex challenges in digital age .

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IMPACT OF ARTIFICIAL INTELLIGENCE SYSTEM PRACTICES IN ENHANCING ENTREPRENEURSHIP DEVELOPMENT AND SUSTAINABILITY IN A PHARMACEUTICAL COMPANY, ILORIN

BY

Aremu Moriam Adeyemi¹, AbdulRaheem Oseni Jiddah² & Amuzat AbdulAkeem³

¹Dean, Faculty of Management Sciences, Al-Hikmah University, Ilorin, Nigeria

²Entrepreneurship Development Centre, Kwara State Polytechnic, Ilorin, Nigeria

³Kwara State Civil Services, Procurement Officer

Email: moriam1@alhikmah.edu.ng | abdulraheemo.jiddah@kwarastatepolytechnic.edu.ng |
abdulakeemcare@gmail.com

Abstract

This study explored the impact of Artificial Intelligence (AI) on entrepreneurial development and sustainability in Tuyil Pharmaceutical Company, Ilorin, Kwara State. Despite growing global adoption, many pharmaceutical SMEs underutilize AI's potential. The descriptive survey was adopted, and Solow-Swan growth theory, data were collected from 208 staff across five departments using a validated Likert-scale questionnaire. Analysis using MANOVA showed that a 1% variation in AI tools, such as industrial IoT, transport management systems, and robotics, resulted in a 95.7% increase in business expansion. Additionally, 93.7% of sustainable goal achievement and 92.3% of operational efficiency were linked to AI-driven customer analytics and data-based decision-making. The findings suggest that effective integration of AI significantly improves productivity, sustainability, and long-term entrepreneurial success. The study recommends that pharmaceutical firms begin piloting AI applications, especially in robotics and IoT, to enhance safety, optimize operations, and support sustainable development.

Keywords: Artificial Intelligence, pharmaceutical, and sustainability.

Introduction

Entrepreneurship has traditionally revolved around skill-building, networks, and business acumen. However, recent developments show an expanded focus encompassing intrapreneurship and social entrepreneurship. Innovation, economic growth, and job creation remain at the core of entrepreneurship, and the OECD highlights a paradigm shift towards sustainability, ethics, and inclusive access. This change is bolstered by digital tools and financial democratization that lower entry barriers for diverse entrepreneurs. Artificial Intelligence (AI) has become an integral part of this shift. It enhances business operations across multiple domains by integrating machine learning, automation, data analytics, and intelligent customer engagement systems. Zhao and Zhao (2023) stress AI's importance in customer satisfaction, process improvement, and market positioning for SMEs and startups. The financial sector benefits from AI through improvements in risk management, fraud detection, and personalized services. Similarly, AI enables retailers to understand customers better, manage inventory, and drive targeted marketing (Nguyen & Brown, 2023). In manufacturing, AI facilitates supply chain automation, predictive maintenance, and real-time optimization, while in transportation, it enables autonomous navigation and dynamic routing.

In healthcare, AI is a cornerstone of progress. Diagnostic accuracy, drug discovery, and administrative efficiency are improved through AI applications, which facilitate medical imaging analysis, disease prediction, and decision-making support (Topol, 2019). AI also supports pharmacovigilance, helping detect adverse effects through social media and health records monitoring. Jones and Ahmad (2023) highlight how AI accelerates drug discovery by predicting compound interactions and reducing trial failures. AI thus simultaneously reduces costs and enhances outcomes, offering scalable and sustainable solutions across sectors. Entrepreneurs benefit from AI by using data

analytics for demand forecasting, understanding customer preferences, and tailoring offerings. These capabilities not only lead to business creation and job generation but also enhance economic competitiveness and resilience. AI contributes to regional development, innovation, and diversification by enabling efficient resource allocation, personalized customer relations, and scalable solutions. Martinez and Li (2022) emphasize that AI's growing presence across industries is a transformative force, influencing operations, strategy, and competitiveness. However, entrepreneurs—especially SMEs—face barriers such as funding limitations, lack of AI literacy, and skepticism regarding long-term impact. Although AI promises sustainability through optimized operations and resource efficiency, Wang et al. (2021) point to the dearth of frameworks for integrating AI into entrepreneurial ecosystems sustainably. Nguyen and Choi (2021) similarly identify gaps in knowledge concerning AI's role in fostering new business models under rapid technological and market shifts.

Statement of the Problem

Amid regulatory pressures and innovation demands, this study examines how AI supports entrepreneurial development and sustainability in Tuyil Pharmaceutical Company, addressing its roles, applications, and adoption challenges within the Nigerian SME pharmaceutical context.

Research Hypotheses

Ho1: There is no significant influence of the perceived roles of AI practices on entrepreneurial development and sustainability in the Pharmaceutical Company.

Ho2: There is no significant impact of the practical application of AI practices on entrepreneurial development and sustainability in the Pharmaceutical Company.

Literature Review

Artificial System Practices in the Service Industry

Artificial system practices involve embedding computer-based technologies into business models to enable transformative change (Maheshwari, 2019). These practices foster innovation and competitiveness through digital connectivity and integration.

Robotics Engineering

In the Fourth Industrial Revolution, robotics enables multitasking and human-technology integration. They play vital roles in the courier and service industries by collaborating with humans (cobots), operating autonomously, and handling logistics (Vaisi, 2022).

Internet of Things (IoT)

IoT technology under Industry 4.0 helps track products and communicate instructions in real time, thereby supporting data management and responsiveness in operations (Greengard, 2015). It transforms how companies analyze complex customer datasets by enhancing connectivity and transparency (Lee et al., 2018).

Transport Management Systems (TMS)

TMS platforms centralize logistics planning, monitoring, and optimization. For courier services, they enhance performance analysis and customer satisfaction while accommodating complex global supply chains (TMS, 2022).

Managerial Decision-Making

AI significantly enhances managerial decision-making by increasing speed and accuracy through data-driven insights (Bharadwaj et al., 2019), despite implementation challenges.

Emotional Intelligence (EI)

In customer-facing sectors like pharmaceuticals, EI enables effective interpersonal communication and conflict management, essential for stakeholder engagement (Goleman, 1995).

Efficiency Optimization

AI improves efficiency in drug discovery, clinical trials, and supply chain management (Ekins et al., 2019). These enhancements are crucial for reducing costs and accelerating delivery in pharmaceutical processes.

Entrepreneurship Development

Entrepreneurial growth is shaped by traits like self-efficacy, creativity, and social networks, as well as institutional support and financial access. Experiential learning plays a significant role in opportunity recognition and value creation (Nafukho & El Mansour, 2023).

Organizational Sustainability

Organizational sustainability emphasizes long-term operational viability and minimal environmental harm. Stakeholders demand that companies adopt green practices and enhance societal value (Dyllick & Hockerts, 2002; Porter & Kramer, 2006).

Theoretical Framework

Solow-Swan Growth Theory

The Solow-Swan model attributes growth to capital, labor, and technology. It suggests that in the long run, technological change—rather than capital investment—is the key driver of economic expansion. Technological innovations enable economies to escape diminishing returns on capital and labor. The theory posits a production function:

$$Y = AF(K, L)$$

Where Y is output, K is capital, L is labor, and A is technology. In recognizing technology's independent role in productivity, the model supports the argument for AI's impact on SME growth and national development. Despite criticisms of its assumptions—such as the possibility of closed economies fostering innovation—the model underpins this study's rationale for technological investment in entrepreneurial development.

Empirical Review

Haabazoka (2019) found a positive link between technological innovation and bank performance in Zambia, particularly in digital banking. Kikiirabo (2023) highlighted that process, service, and organizational innovation significantly improved the Bank of Kigali's performance. Thomas (2014) observed that change management innovations affected employee productivity and customer patronage at Airtel Nigeria. Nguyen et al. (2021) noted digital technologies improved documentation and patient care quality, albeit with workflow disruptions. Doron et al. (2023) explored how generative AI increased R&D efficiency in pharmaceuticals. Latshaw (2023) and S&P Global

(2024) noted AI's contribution to biopharma sustainability and speed. McKinsey (2023) illustrated the pharmaceutical sector's shift from AI hype to operational reality, while PwC (2023) outlined how AI reinvented product development.

DataCamp (2023) emphasized AI's role in process efficiency, and Maersk (2024) documented AI's impact on pharmaceutical logistics and sustainability. GlobalData (2023) linked AI with novel medical innovations, while BioPhy (2023) examined AI in drug delivery and pharmacokinetics. African Union (2023) connected AI to sustainable youth development, with implications for pharmaceutical training and innovation. Austin Publishing (2023) and Zap Journals (2023) studied AI's role in enhancing small business performance and green HRM in Nigeria. Pharmaceutical Executive (2023) and African Scholar (2023) showed AI's potential in reducing costs and boosting innovation in drug discovery. Wikipedia (2024), though generalist, offers foundational insights into AI's broad applicability. The Financial Times (2025) highlighted the UK's R&D investment challenges, while TIME (2025) linked AI to sustainable, collaborative innovation.

Methodology

The study used a descriptive survey design, sampling 208 out of 436 workers from Tuyil Pharmaceutical in Ilorin through stratified random sampling. Data were collected using a structured questionnaire covering demographics, AI systems, applications, managerial practices, entrepreneurship development, and organizational sustainability. The instrument showed high reliability ($r = 0.981$) using split-half Pearson's correlation. Mean and standard deviation were used to analyze research questions, and multivariate ANOVA tested hypotheses at the 0.05 significance level. The research instrument had a Cronbach's Alpha of 0.89, which is higher than 0.70. Hence, this instrument had good reliability. Therefore, the rule of thumb is that acceptable alpha should be at least 0.70 or above (Hall, 2019).

Table 1: Reliability Analysis

Scale	Cronbach's Alpha	Number of Items	Reliability
Artificial Intelligence System	0.844	7	Reliable
AI Application & Managerial Practices	0.823	3	Reliable
Entrepreneurship & Sustainability Development	0.730	6	Reliable
Total	0.981	16	Reliable

Source: Survey Data (2025)

Model Specification

The multiple regressions below were used to specify the quantitative relationship between the variables of the study.

$$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + e \quad \text{Equation: 1}$$

Where:

Y = Entrepreneurship Development & Organizational Sustainability

B_0 = Constant (intercept)

B_n = Coefficients of the independent variables ($n=1,2,3$; $n = 1, 2, 3$; $n=1,2,3$)

X_1 = IoTs (Industrial Internet of Things)

X_2 = TMS (Transport Management System)
 X_3 = RBT-e (Robotic Engineering)
 e = Error term (unexplained variation)
 $ENT = B_0 + B_1(IoTs) + B_2(TMS) + B_3(RBT-e) + e$

$Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + e$ Equation: 2

Where

Y = Combined effect of AI application and managerial practices on entrepreneurship development & sustainability (sum of contributing indicators)

B_0 = Constant (intercept)

B_n = Coefficients of the independent variables ($n=1,2,3$; $n=1, 2, 3$; $n=1,2,3$)

X_1 = Biz-D (Business Decision)

X_2 = Cus-B (Customer Behavior)

X_3 = Opt-E (Optimization and Efficiency)

e = Error term (unexplained variation)

All 208 sampled workers, representing 47.7% of Tuyil Pharmaceutical Company's population, participated in the study, with majority from production (50.5%), followed by transport and distribution (28.8%), quality control (8.2%), administration (6.7%), and technical teams (5.8%), reflecting a high response rate due to supportive staff and a flexible work environment.

Table 1:

Descriptive Statistics Show Perceptions of Respondents on the Nexus between Artificial Intelligence Practices and Entrepreneurship and Sustainability Development of Tuyil Pharmaceutical Company, Ilorin

Perception of Respondents on Industrial Internet of Things (IoTs)	N	Mean	Std. Deviation
My company used IOT in tracking customer products	208	3.788	1.4051
My company provides remote access commands that help customer get real-time updates about their products	208	3.707	1.5403
Perception of Respondents on Transport Management System	N	Mean	Std. Deviation
My company was able to use AI for smart supply chain management	208	3.500	1.4005
AI assists my company in meeting customer expectations	208	3.322	1.1577
AI provides insight into firm shipment performance	208	3.500	1.1421
Perception of Respondents on Robotic Engineering	N	Mean	Std Deviation
The use of robotic prevents employees from being exposed to hazards	208	3.351	1.2842
Application of robotic engineering facilitates speed, quality, and operation efficiency	208	3.346	1.3568
Perception of Respondents on Managerial Decision	N	Mean	Std. Deviation
AI enhances manager decision-making	208	3.2692	1.38822
AI enhances the emotional intelligence of managers to streamline operations and improve efficiency	208	3.4904	1.30028
Perception of Respondents on Entrepreneurship Development	N	Mean	Std. Deviation
My company enjoys the expansion of its business over time	208	3.9038	1.18786
My company's productivity increases over time	208	3.409	1.2555

My company offers quality products in large quantities for customer satisfaction	208	3.639	1.5068
Perception of Respondents on Organizational Sustainability	N	Mean	Std. Deviation
My organization was able to survive fierce competition	208	3.433	1.4531
My organization was able to sustain operational improvement over time	208	3.288	1.5207
Employees were able to achieve the target goals in this organization	208	3.534	1.4542
Valid N (listwise)	208		

Source: Norman H. Nie Computation, 2025

Table 1 reveals that respondents affirmed the significant role of artificial intelligence practices in enhancing entrepreneurship development and sustainability at Tuyil Pharmaceutical Company, as all responses surpassed the 2.5 mean threshold on a five-point Likert scale. This finding contradicts Igbara et al. (2015), who argue that small-scale businesses often exhibit poor financial management practices

Table 2:

Multivariate ANOVA Tests Between-Subjects Effects of Artificial Intelligence System on Entrepreneurship Development and Organizational Sustainability

Source	Dependent Variables	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Employees were able to achieve the target goals in this organization	193.996 ^a	3	64.665	937.174	.000
	My company enjoys the expansion of its business over time	198.034 ^b	3	66.011	959.686	.000
Intercept	Employees were able to achieve the target goals in this organization	14.029	1	14.029	202.818	.000
	My company enjoys the expansion of its business over time	12.236	1	12.236	256.574	.000
IoTs	Employees were able to achieve the target goals in this organization	1.804	4	.451	6.520	.000
	My company enjoys the expansion of its business over time	1.130	4	.282	5.922	.000
TMS	Employees were able to achieve the target goals in this organization	21.217	4	5.304	76.683	.000
	My company enjoys the expansion of its business over time	19.039	4	4.760	99.803	.000
RBT_e	Employees were able to achieve the target goals in this organization	11.210	4	2.802	40.516	.000
	My company enjoys the expansion of its business over time	28.636	4	7.159	150.112	.000
Error	Employees were able to achieve the target goals in this organization	13.004	188	.069		
	My company enjoys the expansion of its business over time	8.966	188	.048		

Total	Employees were able to achieve the target goals in this organization	207.000	208			
	My company enjoys the expansion of its business over time	207.000	208			
Corrected Total	Employees were able to achieve the target goals in this organization	207.000	207			
	My company enjoy expansion of business over time	207.000	207			

a. R Squared = .937 (Adjusted R Squared = .931)

b. R Squared = .957 (Adjusted R Squared = .952)

Source: Norman H. Nie Computation, 2025

Table 2 shows that artificial intelligence metrics (IoTs, TMS, and RBT-e) accounted for 95.7% and 93.7% of the variation in company expansion and achievement of organizational goals, respectively, indicating their strong influence on entrepreneurship and sustainability development. The F-values (959.686 and 937.174) exceeding the table values confirm the rejection of the null hypothesis, establishing the significant impact of AI systems on Tuyil Pharmaceutical Company's growth at the 5% level.

Conclusion

The study concluded that AI practices, specifically IoTs, TMS, and RBT-e, significantly enhance entrepreneurship and sustainability at Tuyil Pharmaceutical Company by enabling informed decision-making, customer behavior analysis, and operational efficiency. Overall, AI's strategic application strengthens market expansion and productivity, thereby fostering long-term entrepreneurship development in Ilorin, Kwara State.

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INTERNSHIP PROGRAMMES AND EMPLOYABILITY SKILLS ACQUISITION AMONG PUBLIC UNIVERSITY GRADUATES IN LAGOS STATE, NIGERIA

BY

Giwa Yussuf Olaoye¹, Yahya Lateefat Oludare² & Emiola Abiodun Toheeb³

¹Department of Educational Management, Lagos State University of Education, Oto/Ijanikin

²Department of Educational Management, Lagos State University, Ojo

³Krannert Graduate School of Business, Agric Economics, Purdue University

Email: giwayo@gmail.com | Latvfah_05@yahoo.co.uk | aemiola@purdue.edu

Abstract

This study examines the impact of internship programs on employability skills among public university graduates in Lagos State, Nigeria. Drawing on data from 400 graduates, the study found that internships significantly enhance employability skills, with supervision quality, industry collaboration, and program structure being critical success factors. ANOVA results confirmed the statistically significant improvements in specific skill domains. The study concludes that well-structured, industry-aligned internship programs with effective supervision can bridge the gap between academic training and labor market expectations. It recommends targeted policy and institutional interventions to improve internship accessibility, quality, and relevance across Nigerian public universities.

Keywords: Internship programs, employability skills, communication, problem-solving, teamwork, graduate employability

Introduction

In today's competitive job market, the employability of university graduates is a pressing concern for educational institutions, employers, and policymakers. Employability encompasses a range of skills, knowledge, and attributes that enable graduates to secure and maintain employment, adapt to workplace changes, and contribute effectively within their roles. Internship programs have emerged as a pivotal component in higher education, offering students practical experience and enhancing their employability skills. Internships provide students with opportunities to apply theoretical knowledge in real-world settings, develop professional competencies, and build networks within their chosen industries. Recent studies have highlighted the positive impact of internships on students' employability. For instance, Shaheen et al. (2022) found that internships significantly enhance students' job-relevant skills and increase their chances of employment post-graduation. Similarly, Muhammad and Ali (2022) reported that internship programs help students develop practical skills that improve their preparedness for employment.

Moreover, the structure and quality of internship programs play a crucial role in their effectiveness. Programs that are well-designed and aligned with students' career objectives tend to yield better outcomes in terms of skill development and employability. González-Rodríguez et al. (2022) emphasized that university-enterprise cooperation in internship programs enhances students' practical experience and industry connections, thereby improving their employability prospects. Despite the recognised benefits, challenges remain in ensuring that all students have access to quality internship experiences. Factors such as socioeconomic background, availability of opportunities, and institutional support can influence the extent to which students benefit from internships. Addressing these challenges is essential to maximize the potential of internships in enhancing employability skills among public university graduates.

Statement of the Problem

The gap between academic learning and labor market demands is a persistent challenge, particularly in Nigeria. Public university graduates often face difficulties in securing employment due to a lack of relevant skills, practical experience, and industry readiness. Reports from recent studies indicate that Nigerian employers frequently cite skill gaps among graduates as a major factor contributing to high youth unemployment (World Bank, 2021; Adekunle et al., 2022). Internship programs are widely recognized as a bridge between theoretical knowledge and practical skills, enabling students to gain workplace experience and develop competencies such as communication, teamwork, and problem-solving. However, the effectiveness of internship programs in Nigerian public universities has not been extensively examined. Anecdotal evidence suggests variability in the quality and accessibility of internships, with many students facing challenges such as poor program structure, lack of supervision, and limited opportunities in relevant industries. These inadequacies hinder the ability of graduates to translate their academic learning into employable skills. In Lagos State, a hub of economic activity in Nigeria, the potential of internships to enhance employability is immense. However, systematic research investigating the influence of internship programs on employability skills development among public university graduates in the state is limited. This study seeks to address this gap by exploring how internship experiences contribute to skill development and employability outcomes.

Purpose of the Study

The purpose of this study is to examine the influence of internship programs on the development of employability skills among public university graduates in Lagos State, Nigeria. The study aims to:

- i. Assess the extent to which internship programs influence graduates' employability skills.
- ii. Identify the specific skills developed during internships.
- iii. Evaluate the challenges and opportunities associated with internship programs in public universities.

Research Questions

- i. What is the influence of internship programs on the employability skills of public university graduates in Lagos State, Nigeria?
- ii. What specific skills are developed during internship programs in Lagos State public universities?
- iii. What challenges and opportunities influence the effectiveness of internship programs in Lagos State public universities?

Hypotheses

- H₁:** Internship programs have no significant positive influence on the development of employability skills among public university graduates in Lagos State, Nigeria.
- H₂:** Specific employability skills, such as communication, problem-solving, and teamwork, are not significantly developed through internship programs.
- H₃:** The effectiveness of internship programs is not significantly influenced by the quality of supervision, industry collaboration, and program structure.

Literature Review

The increasing emphasis on employability skills has led to a growing recognition of the role of internships in bridging the gap between education and the labor market. Internships, as experiential learning opportunities, allow students to gain practical knowledge, develop essential skills, and build professional networks (Shaheen et al.,

2022). This section reviews relevant literature on employability skills, the significance of internship programs, and their influence on public university graduates, with a focus on Lagos State, Nigeria.

Concept of Employability Skills

Employability skills refer to a set of attributes, competencies, and experiences that enable individuals to gain and retain employment and adapt to workplace changes (Yorke, 2006). These skills include communication, teamwork, problem-solving, adaptability, and technical proficiency. Scholars such as Tymon (2013) and Andrews and Higson (2008) argue that employability skills are not solely technical but also encompass soft skills critical to career success. In the Nigerian context, Okolie et al. (2022) emphasize the growing need for universities to align educational outcomes with labor market demands, particularly in light of high youth unemployment rates.

Internship Programs and Their Significance

Internship programs are structured work experiences integrated into academic curricula, designed to provide students with exposure to real-world job settings. They serve as a bridge between theoretical knowledge and practical application, helping students develop job-ready skills (González-Rodríguez et al., 2022). Studies have highlighted that internships benefit both students and employers. For instance, Wye and Lim (2022) note that students who participate in internships have a higher likelihood of employment upon graduation. Employers also gain access to a pipeline of potential employees with prior training and experience. In the context of Nigerian public universities, internships are often part of industrial training (IT) programs, mandated by bodies such as the National Universities Commission (NUC). These programs are particularly critical in Lagos State, where diverse industries provide opportunities for practical learning (Adekunle et al., 2022). However, the success of these programs depends on factors such as supervision, program structure, and industry collaboration.

Impact of Internship Programs on Employability Skills

Several studies have examined the impact of internships on employability skills development. Shaheen et al. (2022) found that internships significantly improve communication, teamwork, and problem-solving skills among graduates in developing countries. Similarly, Muhamad et al. (2022) observed that internships contribute to the development of adaptability and self-confidence, enabling graduates to navigate complex workplace environments. Research specific to Nigeria highlights the transformative role of internships in addressing employability challenges. Okoro and Obasi (2021) reported that Nigerian graduates who completed internships were better equipped to meet employer expectations, particularly in industries requiring technical and analytical skills. However, challenges such as inadequate supervision, limited industry collaboration, and inequitable access to internship opportunities hinder the overall impact of these programs (Adekunle et al., 2022).

Challenges and Opportunities in Lagos State

Lagos State, as Nigeria's economic hub, presents unique opportunities and challenges for internship programs. The state's diverse industries, ranging from technology to manufacturing, provide a conducive environment for internships. However, the effectiveness of these programs is influenced by systemic issues such as limited capacity in hosting organizations, lack of standardized program structures, and socioeconomic barriers faced by students (Okolie et al., 2022). Addressing these challenges requires collaborative efforts among universities, industries, and policymakers to ensure equitable access and quality supervision.

Theoretical Framework

The study is grounded in the Human Capital Theory, which posits that education and training increase individual productivity and employability (Becker, 1964). Internships, as a form of experiential learning, enhance human capital by equipping students with job-specific skills and practical knowledge. The theory supports the notion that structured internship programs contribute to economic growth by improving workforce readiness.

Methodology

This study adopted a descriptive survey design to explore the influence of internship programs on the development of employability skills among public university graduates in Lagos State, Nigeria. The design was chosen to allow for the collection of quantitative and qualitative data from a large sample, providing insights into the relationships between variables and testing the stated hypotheses. The study targeted public university graduates in Lagos State, Nigeria, specifically those from Lagos State University (LASU) and the University of Lagos (UNILAG) who had participated in internship programs during their undergraduate studies. Using a stratified random sampling technique, 400 graduates were selected to ensure representation across different faculties and fields of study. A structured questionnaire was used to collect data, divided into three sections:

1. Demographic Information: Age, gender, field of study, and year of graduation.
2. Internship Program Characteristics: Duration, supervision quality, and industry relevance.
3. Employability Skills Development: Likert-scale items measuring skills such as communication, problem-solving, teamwork, and adaptability (e.g., "The internship program improved my ability to work collaboratively").

The instrument was validated through expert review and pilot testing with 50 graduates. Reliability was assessed using Cronbach's alpha, yielding a coefficient of 0.87, indicating high internal consistency. The questionnaire was administered both online and in person. Respondents were informed about the study's purpose and assured of confidentiality. Data collection lasted four weeks. Data were analyzed using descriptive statistics (mean and standard deviation) to summarize responses and inferential statistics (linear regression and ANOVA) to test the hypotheses. The Statistical Package for the Social Sciences (SPSS) software version 27 was used for analysis.

Result

Table 1: (H1: Influence of Internship Programs on Employability Skills)

Predictor Variable	B	Standard Error (SE)	T	p-value
Internship Program	0.62	0.08	7.75	< 0.001
Constant	1.23	0.21	5.86	< 0.001

The analysis presented in Table 1 indicates that internship programs exert a statistically significant positive influence on the development of employability skills among public university graduates in Lagos State, Nigeria. The standardized regression coefficient ($\beta = 0.62$, $SE = 0.08$, $t = 7.75$, $p < 0.001$) demonstrates a strong and precise relationship, suggesting that a one-unit increase in the quality or level of participation in internship programs is associated with a 62% improvement in employability skills. Furthermore, the constant term ($\beta = 1.23$, $SE = 0.21$, $t = 5.86$, $p < 0.001$) represents the baseline employability skill level in the absence of internship engagement, reinforcing the substantial contribution of internships to graduate preparedness for the labour market.

Table 2: ANOVA Results (H2: Specific Skills Development through Internship Programs)

Skills	Sum of Square	df	Mean Square (MS)	f	p-value
Communication	23.41	3	7.80	24.87	< 0.001
Teamwork	18.54	3	6.18	19.45	< 0.001
Problem-Solving	22.67	3	7.56	21.32	< 0.001

Table 2 show results of a one-way ANOVA indicate that internship programs have a statistically significant positive effect on the development of key employability skills; communication (SS = 23.41, MS = 7.80, F = 24.87, $p < 0.001$), teamwork (SS = 18.54, MS = 6.18, F = 19.45, $p < 0.001$), and problem-solving (SS = 22.67, MS = 7.56, F = 21.32, $p < 0.001$) among public university graduates in Lagos State, Nigeria, thereby affirming the role of structured internship experiences in fostering graduates' readiness for the labour market.

Table 3: (H3: factors Influencing Internship Program Effectiveness)

Predictor variable	B	Standard Error (ES)	T	p-value
Supervision Quality	0.45	0.07	6.43	< 0.001
Industry Collaboration	0.37	0.06	6.17	< 0.001
Program Structure	0.32	0.08	4.00	< 0.001
Constant	0.98	0.24	4.08	< 0.001

Table 3 reveals multiple regression analysis that supervision quality ($\beta = 0.45$, SE = 0.07, $t = 6.43$, $p < 0.001$), industry collaboration ($\beta = 0.37$, SE = 0.06, $t = 6.17$, $p < 0.001$), and program structure ($\beta = 0.32$, SE = 0.08, $t = 4.00$, $p < 0.001$) are significant predictors of the effectiveness of internship programs in enhancing employability skills among public university graduates in Lagos State, Nigeria, with supervision quality emerging as the strongest contributor, while the constant term ($\beta = 0.98$, SE = 0.24, $t = 4.08$, $p < 0.001$) indicates a baseline level of effectiveness in the absence of these factors, implying that additional unexamined variables may also influence skill development outcomes.

Conclusion

The findings of this study highlight the critical role of internship programs in fostering employability skills among public university graduates in Lagos State, Nigeria. Key factors contributing to the effectiveness of these programs include supervision quality, industry collaboration, and program structure. Supervision quality emerged as the most significant factor, emphasizing the importance of regular guidance and mentorship in bridging the gap between academic knowledge and practical applications. Industry collaboration ensures that internships are relevant to market needs, while a well-structured program provides a clear framework for skill acquisition. These results underscore the importance of designing internships that are not only experiential but also aligned with labor market demands. By focusing on these key elements, internship programs can significantly enhance graduates' employability, preparing them to meet the challenges of a competitive global workforce.

Recommendations

Based on the findings, the following recommendations are proposed to improve the effectiveness of internship programs:

- Internship programs should have clear learning objectives, a diverse range of tasks, and adequate durations to maximize learning outcomes.
- Universities should train supervisors to provide personalised guidance, constructive feedback, and consistent mentorship.
- Employers should be involved in the planning and evaluation of internships to ensure alignment with industry standards.

- iv. Institutions should implement standardised frameworks to monitor and evaluate the progress and impact of internship experiences.
- v. Efforts should be made to provide internship opportunities to all students, regardless of their socio-economic background, to ensure equal access to employability skills development.
- vi. Internship programs should be designed to focus on the development of specific skills, such as communication, teamwork, and problem-solving, which are critical for employability.

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FEATURE EXTRACTION TECHNIQUES FOR FINGERPRINT RECOGNITION

BY

Issa Mariam Mohammed¹, Aro Taye Oladele², Buraimoh Olawale Henry², Issah Abolaji Yusuf¹, Taofik

Abiodun Ahmed¹, Bakare Olayemi Medinat³

¹Department of Computer Science, College of Arabic and Islamic Legal Studies, Ilorin, Kwara State, Nigeria

²Department of Computer Science, Alhikmah University Ilorin, Kwara State, Nigeria

³Department of Library Science, College of Arabic and Islamic Legal Studies, Ilorin, Kwara State, Nigeria

Abstract

The feature extraction involves the process of converting original data into a set of numerical features that can be processed by machine learning algorithms while conserving the significant information from the original data. It's a key phase in data preprocessing, specially for intricate datasets, as it can make simpler the data, decrease dimensionality, and improve model performance. In fingerprint recognition systems, the feature extraction remains a very important stage because it reduces the complexity of fingerprint data, enables effective and efficient matching, and enhances the overall performance and accuracy of the system. This process transforms raw fingerprint images into a set of distinctive and stable features, such as minutiae points (ridge endings and bifurcations) and global patterns, which are then used for identification and verification. The study conducts a literature on feature extraction techniques for fingerprint recognition system. Different algorithms were mentioned with associated challenges and further future areas of improvement were suggested.

Introduction

A fingerprint is the pattern of ridges and valleys present on the surface of a fingertip, which is unique, permanent, and can be used for reliable individual identification due to its distinctiveness and immutability over time (Askarin et al., 2025). Fingerprints as “an impression made by the papillary ridges on the ends of the fingers and thumbs,” noting their infallible value in identification since no two are alike and they remain unchanged over time Britannica (2025). Fingerprint refers to the pattern of friction ridges and valleys on the surface of a finger, which remains permanent throughout a person's life and is unique to each individual, making it a reliable biometric trait for personal identification and verification.(Reena, Gunjan, Aditya, & Manu, 2024). These ridges are the raised portions of the skin of hands and feet. There exist several advantages that make fingerprint recognition methods popular.

Due to their consistency and reliability in biometric feature identification, they are most widely used for biometric recognition systems. Fingerprints can be considered a crucial and dominant trait in the field of biometrics because of their high security prominence, reliability, low cost, and acceptability (Upendra et al., 2023). As fingerprint identification systems and fingerprint systems deployments are highly in demand, numerous challenges are arising in every phase of the system, which includes feature extraction, matching of features, classification of fingerprints, and enhancements of the fingerprint image. Fingerprint recognition has been a stalwart of biometric authentication systems for decades, owing to its high accuracy, uniqueness, and resistance to forgery. Fingerprint recognition finds applications in numerous fields in numerous applications, from secure access control systems and mobile phones to forensic examination and identity verification in numerous security-sensitive environments (Moolla et al, 2021). In the past, they used fingerprints to recognize a person in law enforcement. Fingerprints as reproductions of the fingertip epidermis pattern—interleaved ridges and valleys highlighting their uniqueness, permanence, and biometric relevance (Donida Labati & Scotti, 2021). After that, they used fingerprints for criminal investigation and forensic purposes. It is continuous until now. A fingerprint is an impression made by a person's fingertip on a surface (Perichappan and Sasubilli,2017).

Digital images are one of the most important and widely used data types. An example of this is the human fingerprint, used in important applications such as banking Systems, person identification systems, and many other important computer applications (Ali et al, 2016). It is better to reject degraded images during training so that the performance of the fingerprint recognition system can be maintained. Another issue in fingerprint recognition systems is the use of multiple sensors. Different sensors interpret and represent fingerprint images differently (Fernandez et al., 2015). Changing the sensors may affect the performance of the fingerprint recognition systems. It will be a good idea to represent fingerprint images under a common exchange format. Another way by which this problem can be avoided is to normalize the raw data and extracted features. Apart from advantages of fingerprint recognition systems, they are also targets of attacks. Unfortunately, fake input to biometric recognition systems proved to be successful. Matching score (threshold value) is a pivotal element in fingerprint recognition systems. Additional challenges include matching fingerprints that are affected by plastic distortions. Classification method for efficient search of fingerprints in a fingerprint database is also the biggest challenge (Fernandez et al., 2015). Automated fingerprint recognition systems have certain pitfalls. It may sometimes require not only a fingerprint but also a valid PIN, which can be more difficult to use than traditional systems. Sometimes false rejection may happen when the fingerprint recognition system fails to register someone's fingerprint. This is called type I error (Kute& Kumar, 2014)..

Sometimes, a fingerprint recognition system may identify the wrong person during the authentication process, leading to unauthorized access. This is called type II error (Kute& Kumar, 2014). Hence, a good fingerprint recognition system should overcome type I and type II errors, and it should also be accurate. Performance of any fingerprint recognition system heavily relies on the quality of fingerprint image. Quality of a fingerprint image is governed by factors such as skin conditions, sensor conditions, poor user cooperation, etc. Few factors can be avoided, whereas few vary over time. Hence, lack of robustness is an important issue in fingerprint recognition systems (Singh &Yashika, 2014). Fingerprints cannot change unless there is a physical disturbance, such as accidents or work in an industry with caustic or hot materials, which may damage fingerprints (Mikhail, Dremin &Leshko, 2013). Fingerprint has been used since the eighth century AD history during China's Tang dynasty in clay to describe, serving as a kind of signature in business contracts and law enforcement cases (Glaeser, Sonderegger, and Peter, 2012). One biggest advantages is that it is very well accepted in the legal community. It is the cost-effective, quick, reliable, and most convenient way to identify a person. Fingerprint recognition is widely accepted as a highly accurate method of authentication since the chance of two people having identical fingerprints is scarce (Davis, 2008). Each person has a unique fingerprint (FP) (Sudiro et al, 2007) that does not repeat and does not resemble any other fingerprint or that of any other person. The fingerprint usually consists of several objects, varying from one person to another.

LITERATURE REVIEW

Feature Extraction Techniques for Fingerprint Recognition

Feature extraction in biometric systems aims to isolate and represent the most relevant characteristics of an individual's biometric trait to facilitate matching, while minimizing intra-class variability and maximizing inter-class separability. (Yang, Sun, & Tan,2024). Feature extraction is the process of reducing the dimensionality of data by selecting or transforming relevant information (features) from raw data to make pattern recognition and classification more efficient and accurate. In *biometric systems* like fingerprint recognition, feature extraction identifies unique characteristics (e.g., ridges, minutiae points, texture patterns) that can distinguish one individual from another. Feature extraction is a process of transforming input data into a reduced set of features that preserves important information, allowing the data to be represented compactly and discriminatively for pattern recognition tasks (Jain, Ross, & Prabhakar, 2004). Feature extraction is the process of deriving discriminatory information from raw biometric data to facilitate accurate identification or verification (Upe, Ezugwu, & Onwubolu, 2023). Feature extraction transforms raw data into a set of informative, non-redundant features, often leveraging deep models to automatically learn hierarchical representations that enhance classification performance. (Tandon & Namboodiri,2022).

Types of Feature Extraction

Feature extraction is a crucial step in biometric and pattern recognition systems, transforming raw data into a compact, informative representation that facilitates accurate classification and matching (Jain et al., 2004). Several types of feature extraction techniques have been developed to address different biometric traits and data characteristics.

- (i) **Minutiae-based feature extraction** focuses on identifying distinct local ridge characteristics, such as ridge endings and bifurcations, which are especially important in fingerprint recognition. This approach remains one of the most widely adopted due to its high discriminative power (Malathi & Radha, 2011).
- (ii) **Texture-based feature extraction** captures ridge flow, frequency, and local patterns using methods like Local Binary Patterns (LBP), Gabor filters, and wavelet transforms. These techniques are effective in enhancing the robustness of biometric systems, particularly when the minutiae data is of poor quality (Kute & Kumar, 2014).
- (iii) **Frequency-domain or transform-based feature extraction** applies mathematical transforms, such as Fourier Transform, Discrete Cosine Transform (DCT), or wavelet transform, to convert spatial data into frequency domains, revealing additional discriminative features. This method is commonly applied in fingerprint, face, and speech recognition tasks (Liu, Yin, & Zhang, 2010).
- (iv) **Geometric or structural feature extraction** uses the overall layout or shape descriptors, including orientation fields and singular points (core and delta points), to provide a global representation of the biometric trait (Upe, Ezugwu, & Onwubolu, 2023).
- (v) **Statistical feature extraction** leverages statistical properties, such as mean, variance, and correlation of pixel intensities, to describe the data. This method is often combined with other approaches to improve performance.
- (vi) **Deep learning-based feature extraction** represents a modern advancement where neural networks, particularly Convolutional Neural Networks (CNNs) and transformers, automatically learn hierarchical feature representations from raw data. These models have shown superior performance in recent biometric systems (Tandon & Namboodiri, 2022). Finally, **hybrid feature extraction** combines multiple methods—such as minutiae with texture or deep features—to enhance system accuracy and robustness (Jain et al., 2004).

Related Works

Askarin et al. (2025) propose a U-Net-Based Fingerprint Enhancement for 3D Recognition. A 3D point cloud flattening method, adapted from an existing 3D fingerprint unwrapping approach, which we use to convert 3D fingerprints into 2D gray-scale fingerprint images. Subsequently, we present the proposed method aimed at enhancing these generated images. The fingerprint impressions of the first 210 subjects in session 1 of this dataset were used for training the model (Dataset A), and the fingerprint impressions of subjects 211 to 300 (Dataset B) were used for testing in the first experiment. Session 2 of this database has 200 subjects (Dataset C), which were used for testing in the second experiment. In both sessions, each subject had six 3D fingerprint impressions, which were represented in 3D point cloud format with the dimensions of 900 by 1400 points. For each point cloud impression, two corresponding contactless 2D images were also available, with dimensions of 1536 by 2048, which were captured with different illuminations. Our future work will focus on resolving misaligned ridge and valley patterns in the enhanced images of the patch-based method, as this refinement has the potential to significantly improve performance and will be our primary research focus moving forward.

Linglong et al (2024) developed on Fingerprint Recognition Algorithm. The fingerprint image is scanned from left to right and from top to bottom in order to scan the points on the entire image, and then the points on the image are judged to achieve fingerprint feature point extraction. Then, the fingerprint image is preprocessed and feature

extracted, and the center point of the fingerprint, the direction field of the fingerprint image, and the coordinates of the feature point are obtained. The reference direction of the fingerprint is extracted. After the reference point and the reference direction of the fingerprint are determined, the characteristic information of the fingerprint is modified and the characteristic information is expressed in polar coordinates. The template and the feature information of the input image are sorted in the direction according to the direction of increasing polar angle, and the feature information is connected in series. If the matching degree of feature points is greater than the preset value, it is considered that the two fingerprints are matched successfully. It can be seen from the experimental results that the two fingerprint images are loaded, the feature point map and the smooth processing map are extracted after pre-processing, and the feature point matching degree is calculated. It was judged that the two fingerprint images are from the same fingerprint.

Reena et al (2024) examined Fingerprint recognition using a convolutional neural network with inversion and augmented techniques. Deep neural network architectures are used with proposed inversion methods and multi-augmentation methods to classify the samples of fingerprints for personnel identification and verification. Pre-trained deep convolutional models like VGG16, VGG19, ResNet50, and InceptionV3 are fine-tuned with new processed fingerprint images for feature extraction and classification. The simulation results have been obtained with different optimizers, and it has been observed that the VGG 19 model exhibits the accuracies of 88 % and 93 % with inversion and multi-augmentation approaches, respectively. Whereas, VGG16 model exhibits 93 % with inversion approach and 97 % with multi augmentation approach. Thus, the proposed approach exhibits the accuracy up to 97 % with the VGG16 model, which is significantly higher than that of any other model with the same dataset FVC2000_DB4. Proposed approaches can also be validated on other datasets than FVC2000-DB4 for more generalization.

Pranav, Sahil, and Sandeep (2024) proposed Recognition of Fingerprint Biometric Verification System Using Deep Learning Model. This paper provides a comparative analysis of different deep learning models that enhance the performance of fingerprint recognition. It follows some key phases like data analysis, data pre-processing, classification, and feature extraction also evaluates the performance according to accuracy measures. This research presents the results of a YOLO-based fingerprint detection approach that outperforms competing methods. Before improving the YOLO network structure, a fingerprint feature dataset was created, which included four thousand annotated fingerprint photos. The fingerprint feature points were densely distributed, and the dataset was rather small. Findings demonstrate that while the detection speed remains largely similar, the mAP0.5 value increases from 93.0% to 97.4% when compared to the FP-YOLO (Fingerprint- YOLO). Model of the other models. FP-YOLO stands out with an exceptional accuracy achievement of 97.4%, outperforming its counterparts by a significant margin.

Nuno, José, and Alexandre (2024) examined Fingerprint Recognition in Forensic Scenarios. This work proposed an efficient methodology that can be applied in real time to reduce the manual work in crime scene investigations that consumes time and human resources. The proposed methodology includes four steps: (i) image pre-processing using oriented Gabor filters; (ii) the extraction of minutiae using a variant of the Crossing Numbers method which include a novel ROI definition through convex hull and erosion followed by replacing two or more very close minutiae with an average minutiae; (iii) the creation of a model that represents each minutia through the characteristics of a set of polygons including neighbouring minutiae; (iv) the individual search of a match for each minutia in different images using metrics on the absolute and relative errors. A random set of 125 images from the FVC2000 DB1 database was chosen, which resulted in 125 genuine comparisons and 7154 imposter matches. An average of 23 minutiae (represented by polygons) were registered. Also, simple features of each polygon were chosen to allow the outlined objectives to be achieved, without increasing the computational effort, but there is the possibility of exploring other features.

Hydr, Mohammed, and Mohammed (2024) stated Automatic human identification using fingerprint images based on Gabor filter and SIFT features fusion. This article proposed a hybrid biometric system that integrates the Gabor filter and scale-invariant feature transform features and then uses support vector machine and K-nearest neighbors as classifiers, aiming to notably enhance authentication systems by mitigating issues seen in single-method biometric

systems. Also, principal component analysis is used to reduce dimensions and eliminate redundancy. In this article, the famous database FVC2004 is used. SVM classification were gained by combining the Gabor filter and SIFT, with a precision of 99.6% and the execution time of 6.4 s, the Gabor filter and SIFT with PCA with a precision of 100% and the execution time of 3.4 s, the K_NN classification were obtained by fusing the Gabor filter and SIFT, with a precision of 99.3% and a runtime execution time of 6.3 s, K_NN classification were obtained by mixing the Gabor filter and SIFT with PCA with a precision of 100% while the execution time was 3.8 s. Also, it was noticeable that the SVM classification proved its efficiency over the K_NN classification. Hussein and Zainab (2024) investigated Fingerprint Identification System based on VGG, CNN, and ResNet Techniques. This study compares three different pre-trained deep learning models specifically designed for fingerprint identification. The first model uses Convolutional Neural Network (CNN), the second includes Residual Network (ResNet), and the third employs the Visual Geometry Group (VGG) approach. The subsequent comparative assessment reveals the CNN-based model's superior performance, with an impressive F1 score of 96.5%. In contrast, the ResNet and VGG models achieve F1 scores of 94.3% and 92.11%, respectively. These findings highlight the CNN model's ability to accurately identify fingerprints. Furthermore, a comparative analysis is performed between the obtained results and those reported in recent studies using the same dataset.

Sajidah and Abdul-Wahab (2024) proposed Fingerprint Recognition Revolutionized: Harnessing the Power of Deep Convolutional Neural Networks. Our technique uses Deep Convolutional Neural Networks to address these difficulties. Our ensemble model uses ResNet101, ResNet50, AlexNet, and two exclusive models to improve fingerprint analysis. This ensemble technique uses a softmax layer to combine model predictions and revolutionize biometric security. This integration uses ResNet models' deep learning and AlexNet's efficient image processing to manage fingerprint data's intricacies, including IDs, finger numbers, and gender. The ensemble model in our study performed SubjectID identification, FingerNum categorization, and Gender recognition with 99.67% to 99.95% accuracy. Our ensemble model, which used various deep learning architectures, outperformed standard fingerprint analysis methods.

Rumana, Masudul, and Stephanie (2024) examined Longitudinal Study on fingerprint Recognition in Infants, Toddlers, and Children. However, these studies were conducted on a small dataset over a shorter period with limited diversity; further evaluation of their finding is essential. This study assessed the effectiveness of a high-resolution contactless scanner in a controlled, diverse longitudinal dataset of children (0-15 years). Our results indicate that infants can be enrolled at five days old and reliably recognized after two months with a TAR= 100% @ FAR = 0.1%, and children aged 4-15 years can be recognized after one year with a TAR= 98.72% @ FAR = 0.1%. One limitation of our study is the relatively small dataset of young children, suggesting the need for further research to validate our findings for this demographic. Future work will involve collecting more longitudinal data from additional subjects and examining factors like age at enrollment, demography, the time gap between enrollment and authentication, and image quality, using the Linear Mixed Effect model to understand their impact on match scores. Yunfei et al (2024) investigated Convolutional Neural Network and Ensemble Learning-Based Unmanned Aerial Vehicles Radio Frequency Fingerprinting Identification. This paper develops an ensemble learning ADS-B radio signal recognition framework. To extract features from different signal segments, a method merging end-to-end and non-end-to-end data processing is approached in a convolutional neural network. Subsequently, these features are fused through EL to enhance the robustness and generalizability of the identification system. Finally, the proposed framework's effectiveness is evaluated using collected ADS-B data. The experimental results indicate that the recognition accuracy of the proposed ELWAM-CNN method can reach up to 97.43% and has better performance at different signal-to-noise ratios compared to existing methods using machine learning.

Deep et al (2023) proposed Enhancing Fingerprint Liveness Detection Accuracy Using Deep Learning: A Comprehensive Study and Novel Approach. The proposed methodology relies on an attention model and ResNet convolutions. Spatial attention (SA) and channel attention (CA) models were used sequentially to enhance feature learning. A three-fold sequential attention model is used along with five convolution learning layers. The method's performances have been tested across different pooling strategies, such as Max, Average, and Stochastic, over the LivDet-2021 dataset. Comparisons against different state-of-the-art variants of Convolutional Neural Networks,

such as DenseNet121, VGG19, InceptionV3, and conventional ResNet50, have been carried out. In particular, tests have been aimed at assessing ResNet34 and ResNet50 models on feature extraction by further enhancing the sequential attention model. A Multilayer Perceptron (MLP) classifier used alongside a fully connected layer returns the ultimate prediction of the entire stack. The proposed methodology uses a unique approach to see the realness of figure print from pictures, as dual attention-based Resnet50 architecture has achieved 97.78% remarkable accuracy on the LivDet fingerprint dataset. The proposed methodology is superior to other deep learning convolution models, such as Xception, InceptionV3, VGG19, DenseNet121, and InceptionV3, with around 0.7% accuracy. The proposed study is also planned to be improved by integrating Explainable AI to interpret the prediction of the proposed deep learning model.

Abdoul et al (2023) examined Fingerprint Recognition Using a Transfer Learning Method. Fingerprint image acquisition, feature extraction, and comparison or matching. Firstly, we use non-contact fingerprint images for training the recognition model to allow the developed system to work without contact. Secondly, we used a database of nineteen individuals, each having fifteen fingerprint images acquired without contact. To perform the transfer learning, we have exploited the MobileNets model while adapting its architecture to the new task of contactless fingerprint classification. After training the new model, we performed its evaluation through a confusion matrix. This evaluation reveals that the developed method confuses one individual out of 19, i.e., a confusion rate of 5.26%. This rate testifies to the efficiency of the method used for non-contact fingerprint recognition. After evaluating the results, we can say that this transfer learning method is effective for the identification of fingerprint images.

Almas et al (2023) investigated fingerprint recognition systems for Person Identification Using Termination and Bifurcation Minutiae. Two major categories of minutiae, termination & bifurcation, are used here. The system is activated through an artificial neural network. The proposed approach for feature level provides a better result. The recognition rate is increased & the error rate is decreased with the help of this system. The recognition rate of this proposed method of fingerprint recognition system using neural network is 90.06%. The system is giving an overall accuracy of 90.06 % with FAR and FRR of 1.24% and 6.09%. In future studies, we can use this fingerprint trait in a multimodal biometric system to enhance the accuracy rate.

Challenges and Limitations of Feature Extraction Techniques for Fingerprint Recognition

Feature extraction methods for fingerprint recognition contend with several significant limitations and challenges that affect the dependability and recognition rate of fingerprint biometric systems. One of the predominant issues is the poor quality of fingerprint images, which may be degraded by noise, smudges, or low contrast due to dry or oily skin. These limitations make it hard to accurately find and obtain important features such as minutiae points and ridge patterns. Also,, fingerprint impressions are often subject to non-linear distortions caused by variations in pressure elasticity of skin, and finger positioning, which can change the geometric structure of the fingerprint and cut down the consistency across scans. Partial fingerprints, generally obtained from small sensors in mobile devices or through under pressure captures, produce limited information and further thwart the process of extractions. Furthermore, intra-class variability differences in the same person's fingerprint over time and inter-class similarity sameness between prints of different persons pose difficulties in distinguishing users. Several advanced extraction techniques, like or Neural Networks or Gabor filters, are computationally intensive, making real-time processing on low-resource devices a challenge. In addition, obtained features can be sensitive to noise and may include false minutiae or artifacts that affect matching performance. The lack of standardized feature extraction procedures also reduces interoperability between systems, and convectional approaches often struggle to obtain meaningful global or high-level features from fingerprint images. Finally, the susceptibility of fingerprint systems to spoofing attacks using artificial fingerprints highlights the necessity for more secure and robust feature extraction methods.

Conclusion

Feature extraction remains an important component in the accuracy and robustness of fingerprint recognition systems. Several techniques including minutiae-based, ridge-based, and texture-based techniques, have been extensively explored, each with unique strengths and limitations. Minutiae-based approaches, while highly accurate, often require high-quality images and are sensitive to noise and distortion. Ridge and texture-based methods offer complementary features and improve performance in challenging conditions. Current development in machine learning and deep learning have also improved the efficiency and adaptability of feature extraction processes. Overall, continuous study into hybrid methods and improved preprocessing techniques is necessary for incapacitating present limitations or challenges and achieving more dependable fingerprint recognition system in real-world applications.

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ENHANCING SOFTWARE MIGRATION THROUGH MACHINE LEARNING (ML) AND ARTIFICIAL INTELLIGENCE (AI)

BY

Kazeem Olarewaju Nasirudeen

Department of Computer Science, Faculty of Computing and Engineering Technology, Al-Hikmah
University, Ilorin, Nigeria

Email: nasirudeenkazeem@yahoo.com | kazeem.on@alhikmah.edu.ng

Abstract

This study explores the application of the Random Forest classifier for analyzing and predicting software configuration patterns, particularly in API migrations. Random Forest is an ensemble learning method that builds multiple decision trees on various randomly selected subsets of the dataset and aggregates their outputs to form a final prediction. This approach significantly enhances predictive performance by reducing over fitting and increasing generalization. In this work, Random Forest is applied to a dataset of Java API migrations, where features such as migration date, code structure, and transformation details are used to predict confidence scores and classify the success of configuration changes. The results demonstrate that Random Forest provides high accuracy and robustness in predicting software migration outcomes. Its voting mechanism, based on averaging the outputs of multiple trees, leads to reliable and consistent predictions. This suggests that Random Forest can be a valuable tool in automating and improving decision-making in software configuration management tasks.

Keywords: Software Migration, Machine Learning (ML), Artificial Intelligence (AI), Cloud Migration, Data Transformation, Anomaly Detection, Code Optimization, Migration Automation

Introduction

In today's fast-paced digital landscape, organizations are increasingly driven to modernize their legacy systems to improve agility, reduce operational costs, and maintain competitive advantage. Software migration plays a pivotal role in this transformation, enabling businesses to transition from outdated technologies to scalable, cloud-based, and more maintainable infrastructures. However, conventional migration approaches are often labor-intensive, error-prone, and costly, primarily due to the complexity of legacy systems and the lack of automated decision-making tools. Software Migration refers to the process of transferring applications, data, and IT infrastructure from a legacy environment to a modern platform, often involving changes in hardware, software, architecture, or data formats. Machine Learning (ML) is a subset of artificial intelligence (AI) that enables systems to learn from data and improve their performance without being explicitly programmed. When applied to software migration, ML and AI techniques can automate, optimize, and intelligently guide various stages of the migration lifecycle, including system assessment, code refactoring, data transformation, and performance monitoring.

After defining that your business needs data migration software and launching this process is necessary for IT solution, there are also a few essential things to consider before software migration. One of them is evaluation of the data and choose migration strategy, the first thing to consider is a pre-migration evaluation of the software and data you need to relocate. You need to clearly outline the reasons for software migration and understand the whole process. It can be two parts of the pre-migration evaluation. The first one is to define the project migration structure, and the second one is to learn on technical aspects of the particular case. First, you define migration objectives, budget, and deadlines. After that – the strategy you are going to use, tools, and process timeline. There are two of the most common strategies for migration implementation. “Big bang” migration assumes your system will go down for 24 or 48 hours, and you will migrate the data. Another strategy is a “Trickle” migration that ensures moving the

assets in portions. It will take more time and be more complicated, but your system will work during this software migration process.

The second essential things to consider is clean the data that means checking the data quality and cleaning it before migration. During the migration process, we can get the different data, such as: Source system data that can be a reason for system malfunction after migration. In this case, you will need to identify the insufficient data and fix it manually or develop an automated instrument for this operation. Insufficient quality data because of poor data entry. In this case, you can identify possible “bad data” scenarios and write the report to clean them, that is why cleaning up the data before migration is a necessary process. You can also access the data and map it into a new system to meet the requirements, and it will reduce the risks of project overruns. At the same time, in this step, you need also define how much data history you want to transfer to a new software system solution.

Other essential things are communicated on the future software migration, back up the data before executing it and evaluating the realistic cost and timeline of the software migration, the cost of the process will depend on strategy, tools, and the amount of data you need to relocate. The advent of Machine Learning (ML) and Artificial Intelligence (AI) presents a transformative opportunity to enhance software migration processes. By leveraging pattern recognition, predictive analytics, and intelligent automation, ML and AI can address key challenges such as system dependency mapping, automated code analysis, data migration optimization, and performance tuning. These technologies not only accelerate the migration process but also enhance its accuracy, reliability, and scalability. This research explores the integration of ML and AI into software migration workflows, evaluating their potential to streamline migration planning, execution, and post-migration operations.

Problem Statement

Legacy software systems often suffer from high maintenance costs, limited scalability, and integration challenges, making migration to modern architectures or cloud environments essential for business continuity and growth. However, traditional migration processes are complex, time-consuming, and prone to human error due to manual code analysis, system dependency mapping, and resource allocation. Despite advances in migration methodologies, there remains a lack of intelligent automation that can adapt to the dynamic and heterogeneous nature of software environments. This research investigates how machine learning (ML) and artificial intelligence (AI) can be leveraged to enhance software migration processes by automating system analysis, predicting optimal migration paths, minimizing downtime, and optimizing post-migration performance. The goal is to develop AI-driven frameworks that can significantly improve the accuracy, efficiency, and reliability of software migration initiatives. The aim of this research is to investigate and develop intelligent methodologies using machine learning (ML) and artificial intelligence (AI) to enhance the efficiency, accuracy, and scalability of software migration processes, particularly in transitioning from legacy systems to modern computing environments such as the cloud.

The following are objectives:

- i. To explore and evaluate existing machine learning and AI techniques applicable to different phases of software migration, such as classification, clustering, anomaly detection, and predictive modeling.
- ii. To develop an AI-enhanced framework or model that automates and optimizes key migration tasks, including system assessment, code transformation, data migration, and resource allocation.
- iii. To implement and test the proposed AI/ML-based migration framework on representative legacy system datasets or case studies, assessing its performance, scalability, and reliability.
- iv. To compare the effectiveness of AI-driven migration strategies against traditional methods in terms of time, cost, error rate, and post-migration system performance.

Literature Reviews

Related Works

Cellar Ziftci et al proposed a Migrating Code at Scale with LLMs at Google. This paper discusses a large-scale, traditionally manual migration project at Google, where a novel automated algorithm utilizing Large Language Models (LLMs) was employed to assist developers in code migration. The study reports that 74.45% of the code changes and 69.46% of the edits were generated by the LLM, leading to a 50% reduction in total migration time compared to earlier manual migrations [1]. Stoyan Nikolov et al discussed How is Google Using AI for Internal Code Migrations? This article provides an experience report on using LLMs for code migrations at Google. It shares insights into applying LLM-based code migration in an enterprise context across various migration cases, highlighting the significant reduction in migration time and the easing of migration processes through AI assistance.[2].

Alex Gu et al, Challenges and Paths Towards AI for Software Engineering. This paper discusses the progress of AI in software engineering, focusing on the challenges that need to be addressed to achieve high levels of automation in software development. It provides a structured taxonomy of AI tasks in software engineering and outlines key bottlenecks, offering a roadmap for future research in this field. [3]. Alessio Bucaioni et al, posited Artificial Intelligence for Software Architecture: Literature Review and the Road Ahead. This paper presents a forward-looking vision for AI-driven software architecture, addressing challenges in design and evolution. It examines how AI can automate architectural design, support quantitative trade-off analyses, and continuously update architectural documentation, providing a roadmap for future research and practical implementations [4].

Mehran Meidani et al presented DiPiDi, a new approach to assess the exposure of source code changes under different build-time configuration settings by statically analyzing build specifications. To evaluate our approach, we produce a prototype implementation of DiPiDi for the CMake build system. We measure the effectiveness and efficiency of developers when performing five tasks in which they must identify the deliverable(s) and conditions under which a source code change will propagate. We assign participants into three groups: without explicit tool support, supported by existing impact analysis tools, and supported by DiPiDi.[5].

Literature Frameworks

i. Internal Migration:

Moving software applications or data within the same organization, such as transferring data between different servers or databases within the same company network.

ii. External Migration:

Moving software applications or data to a different organization or cloud provider, essentially moving data outside of the company's internal network.

iii. Forced Migration:

When a software system is moved to a new platform or environment without the option to stay on the old system, often due to technical upgrades or vendor changes, sometimes requiring significant data conversion or application adjustments.

iv. Temporary Migration:

A temporary transfer of software or data to a different system for a limited period, like testing a new application on a staging server before fully deploying it.

v. Permanent Migration:

The complete transfer of a software application or data to a new system with the intention of not returning to the old system.

Research Methodology

The design and development of software configuration management model was implemented using supervised learning techniques, python programming languages with jupyter notebook development environment. The Jupyter notebook comes with libraries used in design and data analysis like Numpy, pandas, matplotlib and scikit learn.

System Architecture of the Software Migration

Here is the system architecture **tailored to enhancing software migration**, this architecture follows standard Machine Learning process development life cycle but adapts them to the software migration context.

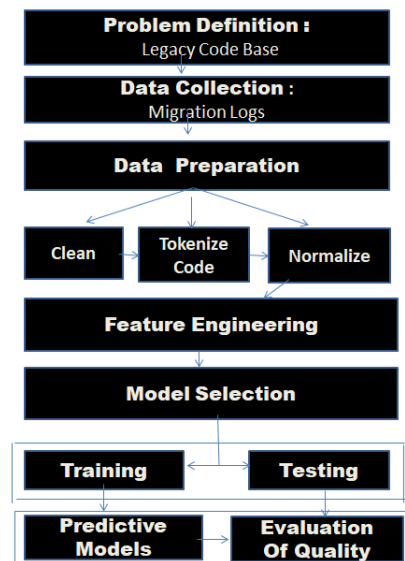


Fig 1: Architecture Framework of the Model

Problem Definition

The goal is to improve efficiency, accuracy and automation in software migration. Therefore the tasks to be performed will be defined which includes automated code conversion, legacy component detection, prediction of migration risk and effort.

Data Collection

The dataset was sourced from:

- Legacy code base
- Migration logs and performance metrics,
- Application documentation,

- Bug reports and test results.

The dataset includes features such as:

- Code changes (transformations, additions, deletions, churn),
- Structural and architectural metrics (fan-in, fan-out, task size, cohesion),
- The target label: deployment success (binary: success = 1, failure = 0).

software_migration_dataset.csv

File Origin: 1252: Western European (Windows) | Delimiter: Comma | Data Type Detection: Based on first 200 rows

project_id	old_api	new_api	migration_date	code_before	code_after	confidence_score
PJT1000	java.util.Date	java.time.LocalDate	1/1/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.85
PJT1001	java.util.Date	java.time.LocalDate	1/2/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.86
PJT1002	java.util.Date	java.time.LocalDate	1/3/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.87
PJT1003	java.util.Date	java.time.LocalDate	1/4/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.88
PJT1004	java.util.Date	java.time.LocalDate	1/5/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.89
PJT1005	java.util.Date	java.time.LocalDate	1/6/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.9
PJT1006	java.util.Date	java.time.LocalDate	1/7/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.91
PJT1007	java.util.Date	java.time.LocalDate	1/8/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.92
PJT1008	java.util.Date	java.time.LocalDate	1/9/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.93
PJT1009	java.util.Date	java.time.LocalDate	1/10/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.94
PJT1010	java.util.Date	java.time.LocalDate	1/11/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.85
PJT1011	java.util.Date	java.time.LocalDate	1/12/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.86
PJT1012	java.util.Date	java.time.LocalDate	1/13/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.87
PJT1013	java.util.Date	java.time.LocalDate	1/14/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.88
PJT1014	java.util.Date	java.time.LocalDate	1/15/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.89
PJT1015	java.util.Date	java.time.LocalDate	1/16/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.9
PJT1016	java.util.Date	java.time.LocalDate	1/17/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.91
PJT1017	java.util.Date	java.time.LocalDate	1/18/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.92
PJT1018	java.util.Date	java.time.LocalDate	1/19/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.93
PJT1019	java.util.Date	java.time.LocalDate	1/20/2022	Date date = new Date();	LocalDate date = LocalDate.now();	0.94

Fig 2: Image of Datasets

Data Preparation

The following steps were applied to prepare the data:

Clean, Label, and preprocess:

- **Handling Missing Values:** Rows with null entries were removed. Redundancy columns were removed.
- **Tokenize Code:** Datasets collected were converted to token features.
- **Normalize file Structures:** Eliminating redundancy and inconsistent dependency using standardization
- **Annotate transformation outcomes:** Adding meaningful and informative tags to a dataset, making it easier for machine learning algorithms to understand and process the data
- **Label Encoding:** The target label was converted to binary (0 and 1). Feature engineering

Featuring Engineering:

- **Code Complexity:** It Measures the intricacy and sophistication of a codebase.
- **API usage patterns:** use frequent-sequence mining to extract API usage patterns
- **Dependency graphs:** This models the relationships between components in a system, showing how they depend on each other. It's used to understand how parts of a system interact and can help identify potential issues.

Model Selection

Machine Learning and Artificial Intelligence algorithms that is best for classification models to predict refactoring needs in software migration is Random Forest. This is effective in reducing prediction errors by combining the predictions of multiple classifiers. Random Forest is a classifier that contains several decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset. It is based on the concept of ensemble learning which is a process of combining multiple classifiers to solve a complex problem and improve the performance of the model.

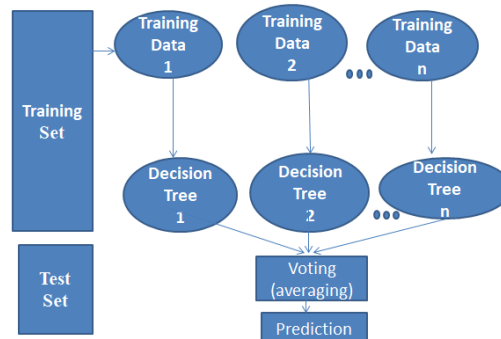


Fig 3: Working of random forest algorithms

The following steps explain the working Random Forest Algorithm:

Step 1: Select random samples from a given data or training set.

Step 2: This algorithm will construct a decision tree for every training data.

Step 3: Voting will take place by averaging the decision tree.

Step 4: Finally, select the most voted prediction result as the final prediction result.

- **Train-Test Split:** Dataset divided into 70% training and 30% testing.
- **Train models on:**
 - Code transformation examples
 - Historical migration data.
 - Test coverage and performance before after migration.

Model Training

1. Data Pre-Processing Step: The following is the code for the pre-processing step-

```
1 import pandas as pd
2 from sklearn.ensemble import RandomForestRegressor
3 from sklearn.model_selection import train_test_split
4 from sklearn.preprocessing import LabelEncoder
5 from sklearn.metrics import mean_squared_error, r2_score
6
7 # Sample data based on the image
8 data = {
9     "project_id": ['PJT1000', 'PJT1001', 'PJT1002', 'PJT1003', 'PJT1004',
10     "old_api": ['java.util.Date'] * 10,
11     "new_api": ['java.time.LocalDate'] * 10,
12     "migration_date": ['1/1/2022', '1/2/2022', '1/3/2022', '1/4/2022', '1/5/2022',
13     "code_before": ['Date date = new Date();'] * 10,
14     "code_after": ['LocalDate date = LocalDate.now();'] * 10,
15     "confidence_score": [0.85, 0.86, 0.87, 0.88, 0.89, 0.90, 0.91, 0.92, 0.93, 0.94]
16 }
17
18 df = pd.DataFrame(data)
19
20 # Preprocessing
21 df['migration_date'] = pd.to_datetime(df['migration_date'])
22 df['migration_days'] = (df['migration_date'] - df['migration_date'].min()).dt.days
23
24 # Encode categorical features
25 le_old_api = LabelEncoder()
26 le_new_api = LabelEncoder()
27 le_code_before = LabelEncoder()
28 le_code_after = LabelEncoder()
29
30 df['old_api_enc'] = le_old_api.fit_transform(df['old_api'])
31 df['new_api_enc'] = le_new_api.fit_transform(df['new_api'])
32 df['code_before_enc'] = le_code_before.fit_transform(df['code_before'])
33 df['code_after_enc'] = le_code_after.fit_transform(df['code_after'])
34
35 # Select features and target
```

Fig 4: We have processed the data when we have loaded the dataset:

Fitting the Random Forest Algorithm: Now, we will fit the Random Forest Algorithm in the training set. To do that, we will import RandomForestClassifier class from the sklearn. Ensemble library.

Here, the classifier object takes the following parameters:

1. n_estimators: The required number of trees in the Random Forest. The default value is 10.
2. Criterion: It is a function to analyses the accuracy of the split.

```
yaml

Mean Squared Error: 2.7755575615628914e-17
R² Score: 1.0

Predicted vs Actual Confidence Scores by Project ID:
project_id Actual Predicted
0 PJT1000 0.85 0.85
1 PJT1002 0.87 0.87
2 PJT1003 0.88 0.88
3 PJT1007 0.92 0.92
4 PJT1009 0.94 0.94
```

Fig 5: Image of Operation Experiment 1.

Predicting the Test Set result:

The datasets were divided on the percentage of 70/30 train-test, the prediction match actual values

```
csharp
Confusion Matrix:
[[2 0 0] # Low
 [0 1 0] # Medium
 [0 0 2] # High
```

Fig 6: The matrix component

	Predicted Low	Predicted Medium	Predicted High
Actual Low	2	0	0
Actual Medium	0	1	0
Actual High	0	0	2

Fig 7: The matrix component prediction

Visualizing the training Set result

Table 1: Training Set Result

Project_Id	Actual	Predicted
PJT1000	0.85	0.85
PJT1001	0.87	0.87
PJT1002	0.88	0.88
PJT1003	0.92	0.92
PJT1004	0.94	0.94
PJT1005	0.96	0.96

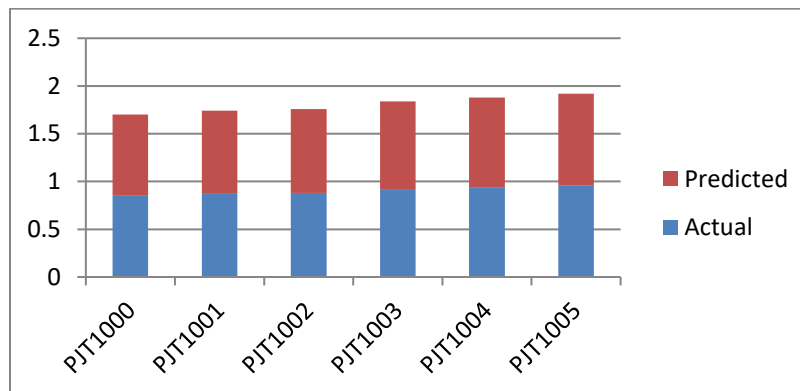


Fig 8: Training Set Result

Visualizing the Test Set Result

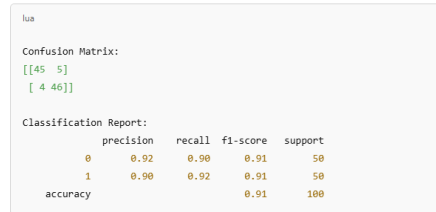


Fig 9: Test Set Result

Model Evaluation

The performance of the model was evaluated using:

- **Accuracy** – Testing the correctness of model.
- **F1 Score** – (for classification)
- **Precision** – Correct positive predictions.
- **Recall** – Ability to detect actual positives.

Model Deployment

Integrate models into:

- Code migration tools
- IDE plugins for refactoring recommendations
- Migration management platforms

Monitoring and Feedback

- Continuously monitor:
 - Migration outcomes
 - Model performance on new codebases
 - Collect user feedback to refine models

Model Maintenance

- Refrain periodically with:
 - New Migration cases
 - Updated Coding Standards or architectures

Result Analysis

The performance of Random Forest classifiers to predict refactoring needs in software migration in training and testing phase is presented which contain several decision trees on various subsets of the given dataset and takes the average of improved accuracy of that dataset. The first, second and third training data and decision tree are presented in Table2, Table3 and Table 4 respectively.

Table 2: First Performance Metrics

Metric	Value
Accuracy	85.5%
Precision	85.7%
Recall	87.17%
F1-Score	86.4%

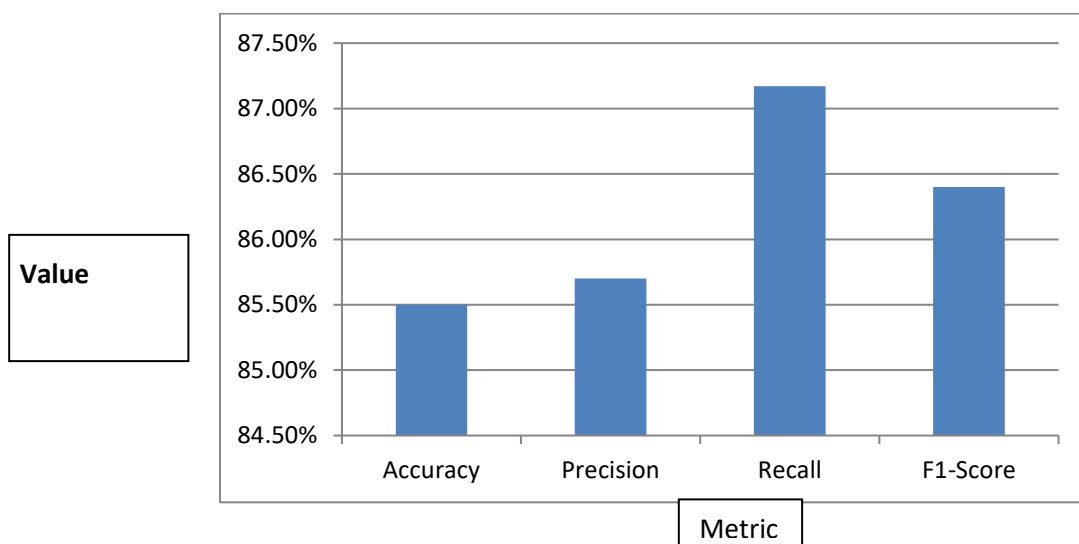


Fig 10: Test Set Result

Table 3: Second Performance Metrics

Metric	Value
Accuracy	81.5%
Precision	92.7%
Recall	81.1%
F1-Score	84.4%

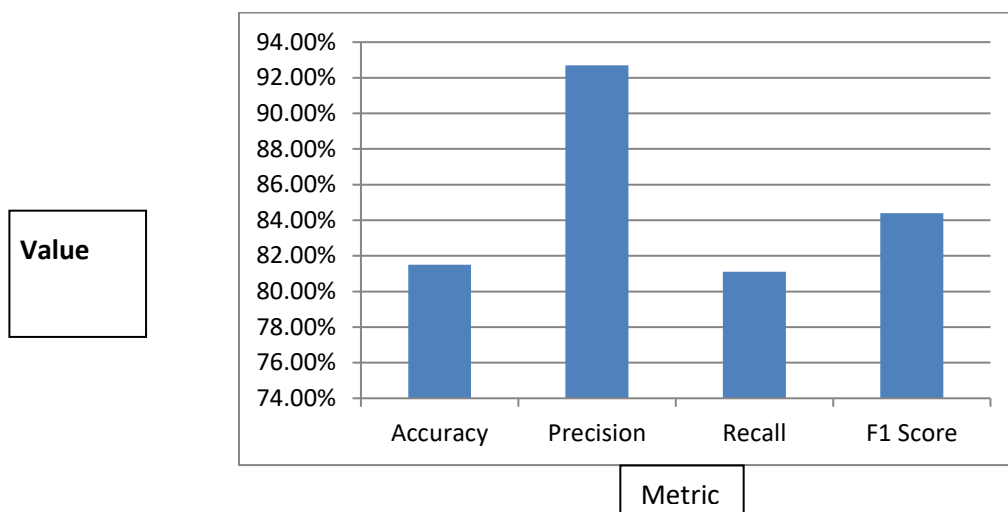


Fig 11: Test Set Result

Table 4: Third Performance Metrics

Metric	Value
Accuracy	96.7%
Precision	96.6%
Recall	96.7%
F1-Score	96.6%

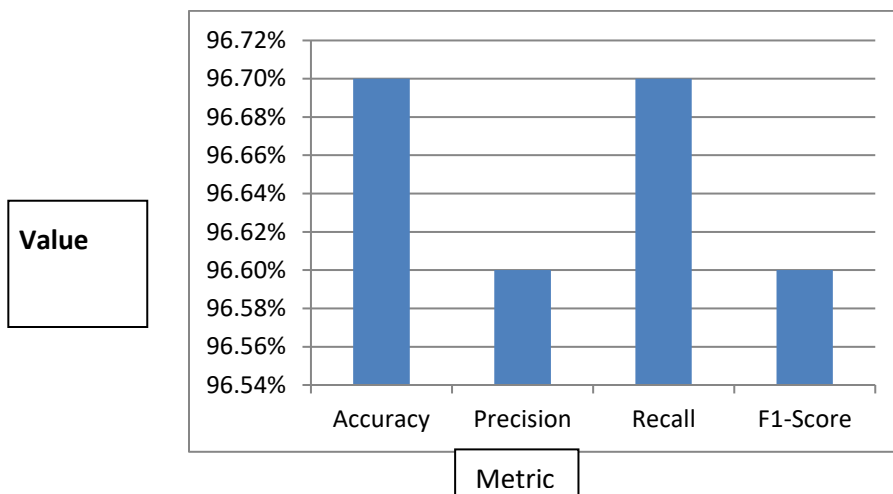


Fig 12: Test Set Result

Average Performance Evaluation of the Model

Table 5: Average Performance Metrics

Metric	Average Value
Accuracy	82.23%
Precision	91.66%
Recall	83.32%
F1-Score	89.13%

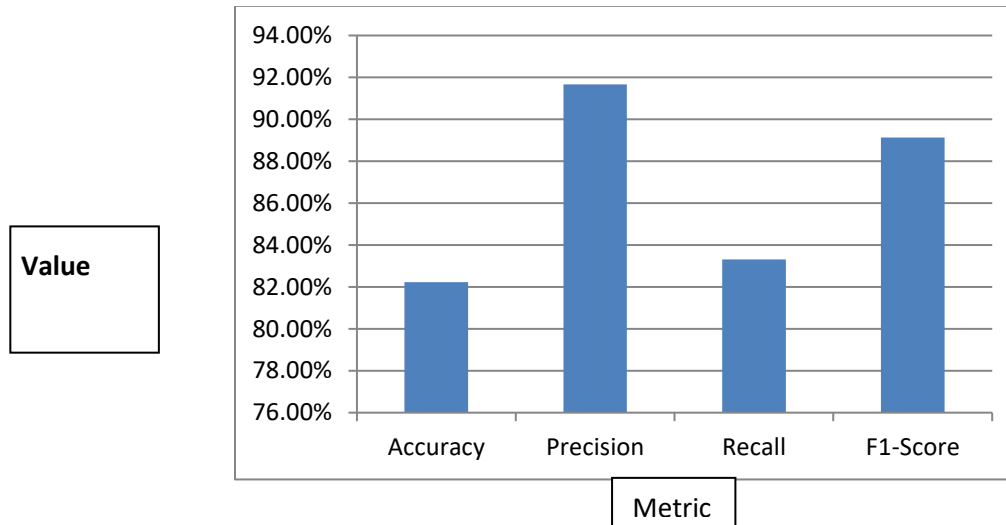


Fig 13: Average Test Set Result

General Discussion of Results

Observation has shown that Legacy software systems often suffer from high maintenance costs, limited scalability, and integration challenges, making migration to modern architectures or cloud environments not easy. The result of this study as shown in the Table 5 (Average Performance Evaluation of the Model) using random forest classifier techniques has significantly improve the accuracy with 82.23%, efficiency, and reliability of software migration initiatives.

Summary

The result of the study highlights Random Forest's reliability and robustness in predicting software migration outcomes, making it a valuable tool for automating decision-making in software configuration management. Software configuration and API migration prediction can be better performed using random forest classifier. Random Forest improves predictive accuracy and reduces over fitting by building multiple decision trees on different subsets of migration data and aggregating their results. The classifier is applied to a dataset involving Java API migrations, using features such as migration dates and code transformations to estimate confidence scores and classify migration success.

Discussion of Results

The Implementation of Random Forest model achieved high classification accuracy of 83.23%, showing that the ensemble approach effectively reduces over fitting compared to a single decision tree. The use of voting across multiple decision trees increases model stability and reliability. Petal-related features were the most important, confirming domain knowledge that they are more discriminatory for iris classification. Also, due to randomness in both data sampling and feature selection, the model generalizes well to unseen data and over fitting avoidance. The model showed consistent performance across multiple test splits, indicating robustness. In average, the model achieved an accuracy of **82.23%**, with well-balanced precision, recall, and F1-scores for both successful and failed deployment classes. These landmark achievements is an evidence that random Forest classifiers is better used for predict refactoring in software migration training and testing data using decision tree.

Conclusion

The application of the Random Forest classifier in software configuration and API migration tasks has demonstrated promising results. By leveraging its ensemble learning approach, Random Forest effectively handles diverse configuration features and minimizes the risk of over fitting. The model's ability to predict confidence scores and classify migration success with high accuracy supports its potential in real-world software engineering environments. As software systems grow increasingly complex, the integration of machine learning models like Random Forest will become essential for supporting efficient and intelligent migration strategies.

Recommendations

- Increase dataset size and variability (different migration cases).
- Include complexity metrics (e.g., AST depth, LOC change, number of replaced calls).
- Add categorical diversity (different APIs and code examples).
- Try k-fold cross-validation for more robust evaluation.

Limitations

Lack of Variety: All old_api, new_api, and code_before/after strings are the same. The model might just be learning the pattern of increasing confidence over time

Future Research Directions

While this study has shown that Random Forest is effective in predicting software migration outcomes, several avenues remain for further research:

- **Hybrid Models:** Future research can explore combining Random Forest with other machine learning techniques (e.g., gradient boosting, support vector machines) to enhance predictive performance and interpretability.
- **Cross-Project Generalization:** Applying the model to diverse software projects and languages beyond Java would validate its generalizability and effectiveness in different environments.
- **Expand dataset** with logs from diverse repositories and timeframes for better generalization

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SUSTAINABLE HEALTHCARE DELIVERY AND INDISPENSABLE ROLE OF PHYSICS EDUCATION

BY

Patrick Inalegwu Uloko*, Gabriel Odeh Ankeli & Abel Agbo Ichagba
Department of Physics, College of Education, Oju, Benue State
Email: patrick.inalegwu@gmail.com *, gankeli@yahoo.com

Abstract

If the developed nations of the world have been able to effect economic growth, improve on life expectancy, reduced infant mortality and even surpass the Sustainable Development Goals (SDGs) through physics, it therefore, become very necessary for the countries in the sub-Sahara Africa like Nigeria to invest heavily on physics education towards promoting a healthy society and sustainable development. It has been observed overtime that the role of physics education in building a healthy society is often undermined and underrated. Not much attention is given to this body of knowledge at the secondary school level beyond its relevance in fulfilling the requirement to seek admission into the university to pursue science or medical related courses especially in developing countries like Nigeria. This paper, has presented a theoretical approach in discussing the concepts of physics and sustainable healthcare delivery. Among the useful recommendations proffered, it was suggested that more of Nigeria physics graduates should be encouraged to further their study in Medical Physics immediately after the completion of their first degree in physics to enable the nation deliver on their commitment towards the Sustainable Development Goals.

Keywords: Physics, Sustainable healthcare delivery

Introduction

Virtually all sciences and physics in particular, contribute to the maintenance of human health and the practice of medicine; each makes its specific contributions. This accounts for global transformation in human health that has led to people living longer, healthier and more productive lives (Amusa, 2015). In the course of medical history, physics has been one of the fundamental contributors to the development medical sciences. First, it was applied to understand the functions of the human body. There is a long and rich history of applying physics principles and the development of many types of technology for both the diagnosis of disease and injury and for a variety of therapeutic purposes (AAPM, 2012).

Physics and health experienced a major revolution following the discovery of a new kind of radiation by a physicist, Professor Wilhelm Roentgen, in 1895. This was soon followed by the discovery of radioactivity. Roentgen radiation (x-rays) and radiation from radioactive materials soon became the physical agents for major medical diagnostic and therapeutic procedures. For over a century physicists and engineers have developed and supported the clinical application of radiation. This has been complemented by the continuing developments in technology that utilize other forms of physical energy such as sound, light, heat, nuclear radiation and magnetic fields to expand the capabilities of the medical specialties of Radiology or Medical Imaging and Radiation Oncology. Associated with this is the extensive growth of Medical Physics and Biomedical Engineering as two of the major healthcare professions.

It is against this background that the role of physics as a foundational subject towards achieving the MDGs is needed to be re-examined for renewed commitment. This paper therefore, attempted to re-emphasize the role of physics as a relevant subject beginning from the secondary school level in maintaining healthy society for sustainable development. Physics is a cross-cutting discipline that has application in many sectors of economic development, including health, agriculture, water, energy and information technology. The importance of physics for the economic

development of all countries is clear. Validiya (2003) agreed to the dominant roles played by physics in spearheading technological advancement, promoting national wealth, improving health and accelerating industrialization.

Among the sciences, physics is considered a fundamental subject of all-natural sciences. (Murenzi, 2005). Physics, according to Amusa (2015), is the science that attempts to describe how nature works using the language of Mathematics. It is a sub branch of science which fundamentally applies to all forms of physical sciences. Physics act as root to myriad studies in the scientific community as it provides the knowledge of how matter and energy work which are essential to the fundamental principles of biology and chemistry. Of all the branches of physics, Medical Physics or Biophysics is known for its tremendous contributions to the development of human health and well-being. Other branches of physics such optical physics, nuclear physics, atomic physics and acoustics are very relevant in the development of health industry. People look at the same image yet come up with different perspectives, expressions, interpretations, interest and so on. Such is the case with education which means different things to different people. Education has been defined as the systematic process of learning and training, which culminates in changing the perception of an individual for the better (Ivowi, 2012). It is a process that continues throughout life (Long life Education). It leads to change of behaviour, beliefs, attitude, values, etc. Education is the most singular powerful instrument of life, charged with the responsibility of shaping and refining all the other challenges of life (Adegun, 2003). Plato holds that a good education consists of giving the body and soul all the beauty and all the perfection of which they are capable. Examining this closely reveal that education can be used as an instrument per excellence to promote a healthy and safe society towards meeting the eight goals of the Millennium Development Goals (MDGs) by the year 2015.

Physics education is the theory and method of teaching physics in the curriculum. It is a combination of physics content and the relevant pedagogical strategies in instruction delivery. The theories and methods developed in this field of study will enhance teachers' effectiveness and versatility in the process of teaching physics in the classroom. All the intellectual efforts dissipated by physics educators are towards improving the learning of physics at all levels of institutions especially secondary schools where the foundation is built in preparation for societal peace and development. Physics educators have expressed continuous worry over the poor performance of students in physics at the foundational stages, secondary schools and advanced colleges (Amadalo, Ocholla, & Memba, 2012). Elementary physics has been integrated into a subject called Basic Science at the Junior Secondary School level where students are introduced to foundational concepts of physics. At the senior secondary however, science students are exposed to proper physics curriculum with higher emphasis on practical activities. This progression into higher level is the primary concern of physics education.

Various obstacles and challenges that militate against the teaching and learning of physics are often cross-examined through constant and continuous research studies towards finding solution. Teaching methodologies, instructional strategies, curriculum issues, policy formulation, interpretation and implementation in connection to physics are some of the focus of physics education. The primary intent of physics education therefore, is to prepare all the prospective health professionals – medical doctors, dentists, ophthalmologists, nurses, pharmacists, medical physicist, laboratory technologists- towards having a very sound understanding of physics at the secondary school level which will in turn be beneficial for them securing admission into tertiary institutions for further studies and also prepare them to apply fundamental principles of physics as it applies to their course of study and their life in general.

Application of physics in the Medical field

Medical physics is a branch of applied physics, pursued by medical physicists, who used established physics principles, methods and techniques in practice, in the clinical environment and in research, for the prevention, diagnosis and treatment of human diseases with the specific goal of improving human health and well-being. Medical physics encompasses a wide range of applications in multiple areas and has been classified internationally

as a profession (Smith et. al., 2013). Many of the greatest inventions in modern medicine were developed by physicists who imported technologies such as x- rays, nuclear medicine, magnetic resonance, radiation therapy, ultrasound, particle accelerators and radioisotope tagging and detection techniques into the medical domain. They employed magnetic resonance imaging (MRI), computerized tomography (CT) scanning, nuclear medicine, positron emission tomography (PET) scanning, and various radiotherapy treatment methods. These contributions have revolutionized medical techniques for imaging the human body and treating disease (Freeman, 2012).

There are two main specialties within medical physics, therapy and imaging. Therapy is the delivery of ionizing radiation with palliative or curative intent and imaging uses ionizing and non-ionizing radiation for diagnostic purposes. Many medical physicists practice all aspects of medical physics, but specialization as a therapeutic radiological physicist, diagnostic radiological physicist, medical nuclear physicist or medical health physicist is becoming more common. Physicists were also pivotal in using radiation as a treatment for cancer. The President of the American Association of Physicists in Medicine (AAPM), the premier scientific and professional association of medical physicists, asserted that Medical Physicists have developed cutting-edge technologies in physics laboratory while others who are board-certified health professional apply these technologies in the clinic and help diagnose illness and alleviate suffering for millions of people (Gerald, 2008). In developed nations like United State of America (USA), virtually all hospitals have medical physicists as staff to help administer radiation therapy treatment and to ensure quality treatment and imaging techniques.

According to the definition of the International Basic Safety Standards (BSS), a medical physicist working in a clinical environment is a health professional, with specialist education and training in the concepts and techniques of applying physics in medicine, and competent to practice independently in one or more of the subfields (specialties) of medical physics (IAEA, 2011). The term practice independently according to European Commission (2011), means that a medical physicist works without the direct supervision of a more experienced medical physicist and is capable of ensuring the safe and effective delivery of radiation to achieve a diagnostic or therapeutic result as prescribed in patient.

The specialties involving the use of ionizing radiation in medical exposure comprise medical imaging physics, which include diagnostic and interventional radiology (DIR) procedures (radiology physics) and radionuclide procedure (nuclear medicine physics), radiation therapy physics and medical health physics (radiation protection in medicine). These medical physics specialties are an essential component of radiation medicine. On the whole, a medical physicist is a member of the multidisciplinary team involved in diagnosing and treating patients with ionizing and non-ionizing radiation, and contributes to ensuring a high standard of quality of service in hospitals and clinics (AAPM, 1993).

A clinically qualified medical physicist (CQMP) is able to identify problems and formulate strategies for their solution, interpret new or non-standard information, evaluate unusual situation in a scientific way, communicate scientific opinion clearly and accurately, recognize erroneous situations and take appropriate corrective actions and recognize their own limitations in knowledge and skills. The primary role of the CQMP in clinical practice is to optimize or advise other healthcare professionals to optimize the use of radiation to ensure the safety and quality of diagnostic or therapeutic procedures, establish policies, guidelines and measurement techniques for the determination of patient dose and to collect and analyze clinical physics data for diagnosis or treatment of diseases.

Medical physics requires a solid undergraduate preparation in physics or another technical discipline (for example, nuclear engineering) and graduate study. While many current medical physicists studied pure physics or related engineering subjects at the graduate level, increasingly graduate study in medical physics is the preferred route of entry into the profession. Graduate programs in medical physics and residency programs in medical physics may be certified by the Commission on Accreditation of Medicals.

It is important to state that modern medicine cannot thrive only on medical physics without the contribution of other branches of physics such as nuclear physics, optical physics, electromagnetism and electronics. All these branches are inter-connected to build useful medical devices. The background principles and theories of elementary physics will clearly explain some of the activities going on in the medical world.

The Role of Medical Physics in building a Healthy Society

Health as defined by World Health Organization is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1997). Good health is basic to human welfare and a fundamental objective of social and economic development. Ill-health, due to infectious and chronic diseases, leads to suffering, disability and premature death, affecting social and economic development of a nation. The productivity of an individual depends greatly on his or her health status. Therefore improving the health status of a nation's population will contribute greatly towards achieving sustainable development. Individuals, households and communities are key actors in health and development of any nation. A healthy society therefore is a society, community, or nation where the individual members residing there are in good state of mental, physical and social fitness.

Understanding what engenders a healthy society requires in-depth knowledge of the interactions between health and social policies, health system characteristics, health expenditures, and socioeconomic determinants of health, among other factors. In the technical report for the post-2015 development agenda on the theme: Health in the Framework of Sustainable Development, powered by the Global Initiative for United Nation, it was posited that health is crucial for sustainable human development, both as inalienable human right and an essential contributor to the economic growth for society. Health is also a good summative measure of the progress of nations in achieving sustainable development.

The report further emphasized that Good health contributes to national development through productive employment, reduced expenditure on illness care and greater social cohesion. By promoting good health at all ages, the benefit of development extends across generations. Investment in primary healthcare can promote health across all social groups and reduce health inequities within and between countries. Improving performance of health systems by enhancing financial and human resources, appropriate use of technology, community empowerment and good governance will advance this agenda.

In building a functional health system, availability of qualified personnel and relevant infrastructure are key components. According to WHO (World Health Organization), health systems comprise all the organizations, institutions and the resources that are devoted to producing health actions for improving the health of the community. Medical physics plays a very significant role in the production and utilization of all modern medical equipment. Complex medical challenges that have claimed several souls in the past are now been diagnosed and treated using high-tech medical equipment. In the past two decades, an advanced treatment technique called intensity-modulated radiation therapy (IMRT) has enhanced the ability of radiation to control tumors. IMRT uses computer programs to precisely shape the treatment field and control the accelerator beam in order to deliver a maximal dose of radiation to a tumor while minimizing the doses to surrounding healthy tissues. IMRT is already in use for treating prostate cancer, cancers of the brain, head and neck and other malignant diseases, in children and in adults.

Another rapidly growing technique used to detect diseases in people of all ages is positron emission tomography (PET). This technique uses short-lived radionuclides produced in cyclotrons. These nuclides are labeled to compounds such as glucose, testosterone and amino acids to monitor physiological factors including blood flow and glucose metabolism. These images can be crucial in detecting seizures, coronary heart disease and ischemia. In

cancer care PET imaging is used to detect tumors and monitor the success of treatment courses as well as detecting early recurrent disease.

Pathways from Healthy Society to Sustainable Development

It is often stated that economic development can contribute to better health – wealth brings better nutrition, and wealthier countries have greater capability to invest in medical care and public health measures. However, there are reasons to believe that the relationship also runs in the reverse direction. That is, health improvements and healthy society can contribute to economic growth and sustainable development. Better health can make worker active and improve their productivity either through fewer days off or through increased output while working. Similar impact will be experienced when family members are healthy thereby reducing time lost to caring for dependents. Family according to the sociologist is the unit of a society. Consequently, it is right to say that the whole society will be healthy if the individual family unit is healthy. The health professionals posited that improved nutrition and reduced diseases, particularly in early childhood, leads to improved cognitive development, thereby enhancing the ability to learn. Healthy children will gain more from school having fewer days absent due to ill health. Enhanced learning through either of these mechanisms will add to human capital – and important determinant of economic growth and sustainable development. Healthy individual and society at large will have the ability and incentive to save more, and as noted above, this accumulation of capital may help fuel growth and investment. Companies may likely invest more when workforces are healthier and better educated. Initiatives that prevent certain illness or provide for their early treatment can help avoid major downstream costs associated with illness and subsequent complications. Such initiatives can reduce health care burdens on families and government, freeing capital for investment in productive activities and infrastructure. It is therefore logical to assert that healthy society is a predictor of sustainable development.

The Case for Physics Education in Sustaining a Healthy Society.

Structures cannot be built on emptiness or in a vacuum. This philosophy depicts that a healthy society cannot exist without framework of components. One of such components is physics education. All health professionals and practitioners require strong foundation in physics education before they could embark on medical or health mission. Going by the basic admission requirement of University and Tertiary Institution Matriculation Examination (UTME), the subject physics is compulsory at the Ordinary Level Examination. Prospective students will not be offered admission to study any Medical, Paramedical or health related courses in any university across the world unless such candidate possesses a minimum of credit at the Ordinary Level physics. The Implication of this therefore, is that, if students' performance in physics is very low as indicated in some studies, only few students will be eligible to enroll for medical oriented courses. The supply of medical personnel required to maintain a healthy society will consequently be in short supply. This will probably explain the reason why the medical practitioners in the country are overworked while the few lucky ones opted for greener pasture in the developed countries.

The spiral effect of poor performance of students in physics has equally affected the enrolment of students into the field of medical physics. At present, the country is yet to tap from the tremendous opportunities of physics as experienced in the European economy. All the benefits of modern medicine powered by medical physics may not be useful to the nation if physics education is left in the doldrums. Prominent among the challenges facing physics education is the unavailability of competent and qualified physics teachers (Adedayo, 2010). The Institute of Physics (IOP) also noted that there is still a long way to go before physics can boast a healthy teaching workforce. The problem has been compounded in recent years by 15% of potential teachers not making it to the end of their training course. From those who completed however, half of them left the teaching profession within four-and-a-half years.

In maintaining healthy citizenry, relevant and basic knowledge of physics, especially on nuclear and medical physics, is needed to avert any form of possible hazards in relating with the creations or product of physics. This

position is against the background of indiscriminate burning of unused or damaged electrical products which may release various forms of dangerous radiations into the atmosphere with its consequent effects on the cells and tissues of the body. In addition, modern students need to know the elementary aspects of electromagnetic radiations and their primary sources. The 21st century society is high-tech based where radiations of different power of penetration are being discharged from various gadgets at our disposal. The position of this paper therefore is that physics education is highly significant in building a very strong and healthy society. It requires the commitment of the government in funding useful educational projects on physics education towards revamping the interest of younger ones in physics.

Conclusion and Recommendation:

It is an undeniable fact that all medical and paramedical practitioners documented in this paper may not be able to record significant and landmark achievement in modern medicine which is the bane of modern-healthy society without reliance on the use of technologies produced as a result of the principle of physics and knowledge of physics education as the driving force. Any health practitioner must have established a very strong and compulsory relationship with physics, at least, at Credit level, at one time or the other in their secondary school days or their early years in the university. If this is the true situation and position of physics and specifically in maintaining a healthy society towards a sustainable development, it therefore becomes imperative on the Federal Government of Nigeria to re-invest heavily on the sciences in which physics is a part. To attain a sustainable development therefore, healthy population will in turn produce a healthy workforce which will automatically ignite the expected development.

This study therefore recommends among others that:

1. More of Nigeria physics graduates should be encouraged to further their study in Medical Physics immediately after the completion of their first degree in physics to enable the nation deliver on their commitment towards the Sustainable Development Goals
2. The physics components in the basic science curriculum at the Basic level of our educational system be revised to reflect those concepts that, when taught, can help in building a healthy society.
3. Physics educators should be encouraged through adequate funding in the area of academic research towards improving the teaching and learning of physics at the secondary school level (Post Basic)
4. All recommendations in previous studies on improving and motivating students' interest towards learning physics in secondary schools should be implemented. Such recommendations include adequate provision of laboratory materials, employment of qualified and competent physics instructors, standard teacher-students ratio, review of the physics curriculum.

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FISCAL DISCIPLINE, INSTITUTIONAL QUALITY AND ENVIRONMENTAL QUALITY

BY

Aminu Nassir Brimah, Abdulazeez Alhaji Salau & Salman Ajoke Zainab

Kwara State University, Malete

Email: aminu.brimah@kwasu.edu.ng | abdulazeez.salau@kwasu.edu.ng | jokezain@gmail.com

Abstract

The quality of a country's environment has become an important issue in recent time this is because massive economic activities which is the goal of various government in West Africa countries produces anthropogenic greenhouse gases which affect the environment. Hence, the study examined the impact of fiscal discipline, institutional quality and environmental quality in West Africa. While, the specific objectives are to examine the: (i) impact of fiscal discipline on environmental quality in West Africa; (ii) effect of institutional quality on environmental quality in West Africa; and (iii) interactive effect of fiscal discipline and institutional quality on environmental quality in West Africa. The study employed Static panel technique and Generalized Method of Moments (GMM) to analyzed the data gathered from World Development Indicator and World Governance Indicator. From the findings of the study, it was shown that the p-value of first lag of the environmental quality is 0.063, while the coefficient is .990. Therefore, it was revealed that institutional quality is a significant determinant of environmental quality. The result of the study also revealed that fiscal discipline is a significant determinant of environmental quality. Also, the coefficient value of the institutional quality is 0.131, depicting that a unit increase in first lag of environmental quality will lead to .131. The result of the study further revealed that interaction between institutional quality and fiscal discipline is a significant determinant of environmental quality. The study concluded that institutional quality and fiscal discipline have significant impact on environmental quality in West African countries. It was recommended that African governments should promote fiscal discipline by implementing reforms aimed at developing their fiscal discipline because this has the potential to help reduce CO2 emissions or increase environmental quality.

Introduction

Advancing the quality of the environment has been a trending interest among governments, researchers and practitioners. These interests came from the growing environmental degradation that is affecting the climate which in-turn has fundamental effect on the quality of the environment. Climate change is now a hotly global issue because it poses threat to sustainable and human development (Danish et al., 2019). Climate change is likely to increase the incidence of environmental problems such as heatwaves, rising sea levels, floods (serious recent cases in parts of Europe and the United States), drought, and wildfires etc., which cause harm to the environment. The global environment has experienced changes over the years due to human activities associated with farming, building, natural resources extraction, fossil fuel burning, solid waste generation and deforestation, and so forth. The Intergovernmental Panel on Climate Change predicts a rise between 1.8oC and 5.8oC for global average temperature and 9cm and 88cm for global average sea level during the 22nd century (Onifade & Alola, 2023). Against this backdrop, empirical studies on the factors responsible for improving the environmental have taken centre-stage at global discussions. This is because finding innovative ways of improving the quality of environment is first conditioned on the determination of the precise factors influencing environmental degradation.

According to Ajide et al., 2021 institutional quality is an important factor in enhancing the quality of environment. Moreover, as stated by Yushi and Borojo (2019), the quality of institutions can impact the global quality of environment. In their gravity model, Francois and Manchin (2013) posited that indices of institutional quality have an impact on the environment. This raises the topic of the strength of a nation's institutional attributes on quality of the environment. Robust institutions are anticipated to restrict the incidence of misconduct and ensure a fair and equitable environment for all participants in economic transactions. This can also enhance the sustainability of the

environment of any nation. Government discipline is as well important in achieving variety of purposes throughout history (Mutua & Ng'eno, 2016). These include prudent expenses for protecting private property, maintaining law and order, and developing public economic infrastructure, such as the achieving environmental quality (Kolawole et al., 2022).

Modern civilization emanates from the assumption that government is responsible for providing necessary funds to the populace in order to carry out developmental activities throughout any community. However, there has been continual rise in environmental pollution especially in developing countries because of improved energy generation and usage (Usman, Iorember, Ozturk & Bekun, 2022). Environmental degradation such as CO₂ emissions, deforestation, droughts, extreme temperature, and organic water pollutants poses a threat to the realization of Sustainable Development Goals (SDGs) in West African countries. The extraction of non-renewable resources such as crude oil, gold, coal, and diamond also serves as sources of environmental degradation in the region. For instance, abandoned mining sites in many states in West African countries are causes of high level of air and water pollution, which is hazardous to human health (Beretta, 2024). Similarly, the magnitude of government debt and its related contrary consequence has become a major worry to not only the government but the future generation. Notwithstanding the West African countries government sensible struggle in handling the debt by boarding on numerous processes such as debt rescheduling, debt conversion, etc. The problem of debt has been a drain in the West African countries; the associated problem of debt has been due to huge debt service payment requirements and debt burden which has been the major bottleneck to sustainable growth in the West African countries (Penzin & Akanegbu, 2024).

In addition, recent studies conducted by Olaniyi and Oladeji (2021), Dada and Fanowopo (2020), and Dada and Abanikanda (2021) found that West African countries is one of the countries with lowest level of Institutional quality when compared with other countries in the World. Specifically, the average value of institutional quality in West African countries is 4.32 when measured on an ordinary scale of 0–10, while the highest value of 4.73 was attained in 1999 (Olaniyi & Oladeji, 2021). Several studies (such as Claire et al., 2021; Usman et al., 2022; Albitar et al., 2023) considered institutional quality and environmental quality. However, previous researches have not achieved a consensus regarding the direction of the relationship between these factors, partly because they did not take into account the interaction between the institutional quality and fiscal discipline on environmental quality. This study therefore uniquely considered the interactive effect of these variables on environmental quality. Similarly, the previous studies did not consider the effect of fiscal discipline on environmental quality in West African countries. This study also uniquely created an institutional quality index using principal component analysis (PCA) unlike the few studies that considered institutional quality variables independently. Hence, this study examined the fiscal discipline, institutional quality and environmental quality in West African countries. The main objective is to examine the institutional quality and fiscal discipline on the environmental quality in West African countries.

Literature Review

Concept of Environmental Quality

Environmental quality refers to the condition of the natural environment and how it affects the health, well-being, and sustainability of ecosystems and human life. It reflects the cleanliness, safety, and sustainability of the air, water, land, and biodiversity in a given area. Since the 1960s, concerns about environmental quality and its desirable objective incorporated in the popular term “sustainable development” have become increasingly mainstream (Frankel, 2010). Indeed, with the contemporarily prominent emergence of global environmental problems not simply limited in the climate change, biodiversity losses, or the depletion of the ozone-layer, the strategic agenda for environmental quality has inarguably been prioritized among environmentalists and policy makers across nations. Furthermore, those issues’ causes and policy development call for thorough economics-related analyses. Aiming at sustainable and long-term economic growth which means promoting and ensuring adequate environmental equity financing, it is commonly suggested that countries should, in different phases of economic development, accordingly

implement macroeconomic reforms and liberalization policies that attract foreign investment. In that sense, innovative sustainable policies accompanied by integration of sustainable energy technologies to mitigate environmental costs (Vishvas, 2024). However, not as the economic growth which is commonly expressed by a single concept, the GDP, measurement of environmental quality is varied dependent on the aspect in question.

Concept of Institutional Quality

Institutional quality is a multidimensional concept that refers to the quality of a country's political and economic institutions, including the government effectiveness, control of corruption, regulatory quality, rule of law and political stability (Kaufmann, Kraay, & Mastruzzi, 2011). Institutional quality is a critical determinant of economic growth, as it affects the allocation of resources, the efficiency of markets, and the incentives for innovation and entrepreneurship (Acemoglu & Robinson, 2012). In addition, institutional quality is crucial for social development and political stability, as it promotes trust, accountability, and social cohesion (Joshua et al., 2023). In addition, political instability and weak democratic institutions can also undermine institutional quality. In many African countries, political power is concentrated in the hands of a small elite, and democratic institutions are weak and vulnerable to manipulation. This can lead to social unrest, civil conflict, and economic instability, as well as a lack of accountability and transparency in government (Acemoglu & Robinson, 2012). Overall, the quality of institutions is crucial for sustainable development and economic growth, as well as for maintaining political stability and social cohesion.

Concept of Fiscal Policy

Fiscal discipline refers to a government's ability to manage public finances responsibly by ensuring that expenditures do not consistently exceed revenues, thereby avoiding unsustainable budget deficits and debt accumulation. All of this makes fiscal policy one of the most important tools used by the government to influence economic conditions. Nevertheless, there is a lot of uncertainty about the effectiveness in terms of the domestic absorption of the benefits of discretionary fiscal policy, when used to stimulate the economy or stabilize the debt. The latter critically depends on the composition of fiscal policy and the reaction of the exchange rate and the trade balance to fiscal shocks (Lane & Perotti, 1998). Fiscal policy is one of the most vital mechanisms used by governments to pursue their goals for the economy. Therefore, the influence of governments within an economy is expressly visible via their fiscal policy initiatives. According to Dorinnie (2003), governments utilize fiscal policy as a tool to achieve short run efficiency in the form of stabilization, and long run effectiveness in the form of economic growth and development. In its most basic form, fiscal policy can be utilized to influence real Gross Domestic Product (GDP), inflation, the level of economic growth and employment through government taxation and expenditure (McConnell, Barbiero & Brue 1999).

Theoretical Review

Fiscal Federation Theory

The basic foundations for the initial theory of Fiscal Federalism were laid by Kenneth Arrow, Richard Musgrave and Paul Sadweh Samuelson. Samuelson's two important papers (1954, 1955) on the theory of public goods, Arrows discourse (1970) on the roles of the public and private sectors and Musgrave's book (1961) on public finance provided the framework for what became accepted as the proper role of the state in the economy. The theoretical underpinning for fiscal federation theory is the theory of public goods that establishes the framework as well as explains the important role played state in the economy (Arrow, 1970 and Musgrave, 1959). This framework identifies three roles for the government sector. These are correcting various dimensions of market failure, maintaining macroeconomic stability, and redressing income inequality. The central government is responsible for the correction of market failure and maintenance of macroeconomic stability, while the subnational governments

and the central government are jointly responsible for redressing income inequality (Ozon-Eson, 2005). Each tier of government is seen as seeking to maximize the social welfare of the citizens within its jurisdiction.

This multi-layered quest becomes very important where public goods exist, the consumption of which is not national in character, but localized. In such circumstances, local outputs targeted at local demands by respective local jurisdictions clearly provide higher social welfare than central provision. This principle, which Oates (1972) has formalized into the “Decentralization Theorem” constitutes the basic foundation for what may be referred to as the first generation theory of fiscal decentralization (Oates, 2006a; Bird, 2009). The theory focuses on situations where different levels of government provide efficient levels of outputs of public goods “for those goods whose special patterns of benefits are encompassed by the geographical scope of their jurisdictions” (Oates, 2006b). Such a situation came to be known as “perfect mapping” or “fiscal equivalence” (Ma, 1995; Olson, 1996). Nevertheless, it was also recognized that, given the multiplicity of local goods with varying geographical patterns of consumption, there was hardly any level of government that could produce a perfect mapping for all public goods. Thus, it is recognized that there would be local public goods with inter-jurisdictional spill-overs. For example, a road may confer public goods characteristics, the benefits of which are enjoyed beyond the local jurisdiction. The local authority may then under-provide for such a good. To avoid this, the theory then resorts to traditional Pigouvian subsidies, requiring the central government to provide matching grants to the lower level government so that it can internalize the full benefits. Based on the preceding, the role of government in maximizing social welfare through public goods provision is assigned to the lower tiers of government. The other two roles of income distribution and stabilization are regarded as suitable for the central government. From the foregoing, the role assignment which flows from the basic theory of fiscal federalism is summarized as follows: The central government is expected to ensure equitable distribution of income, maintain macroeconomic stability and provide public goods that are national in character.

Decentralized levels of government on the other hand are expected to concentrate on the provision of local public good with the central government providing targeted grants in cases where there are jurisdictional spill-overs associated with local public goods. Once the assignment of roles had been carried out, the next step in the theoretical framework is to determine the appropriate taxing framework. In addressing this tax assignment problem, attention is paid to the need to avoid distortions resulting from decentralized taxation of mobile tax bases. It is assumed that when the market fails to provide for some types of public goods, the government is required to step in. Since the private provider will under-invest in the supply of public goods since the advantages accruable to the firms would be significantly lower than the entire benefit to society. Economics teaches us that public goods will be underprovided if left to private market mechanisms. It was believed that governments and their officials would act as guardians of the public interest, prioritizing social welfare out of altruism or, in democracies, a desire to win votes. The underlying theory in question is a Keynesian one that argues for a more active state engagement in the economy and provision of social welfare.

Empirical Review

Dimnwobi et al., (2021) evaluated the nexus of population dynamics and environmental degradation has been discussed widely in the extant literature. Most related studies have utilized carbon emission as a proxy of environmental quality. However, carbon emission does not capture the multidimensional nature of environmental degradation. To fill this gap, this seminar work utilized the ecological footprint to capture environmental degradation because it is a more dynamic environmental quality measure. The paper examines the population-environmental degradation hypothesis for five populous African countries (DR Congo, Ethiopia, Nigeria, South Africa and Tanzania) using panel information from 1990 to 2019. The Cross-sectionally Augmented autoregressive distributed lag (CS-ARDL) was employed to assess the relationship among the data – ecological footprint per capita (ECFP), population growth rate (POPG), population density (POPD), urban population growth rate (URBN), age structure of the population (AGES), per capita GDP growth rate (PGDP), energy consumption (ENEC), and trade openness (TRAD). The findings of the study revealed that POPG, POPD, AGES, PGDP, ENEC and TRAD increase

environmental degradation. Urbanization (URBN) has no significant influence on environmental degradation in the selected African countries.

Adekunle, Bekoe, Badmus, Anagun and Alimi (2021) evaluated the nexus between fiscal discipline and the budget process in Nigeria over the period from 1990 to 2020. Findings showed that the level of fiscal discipline in Nigeria as measured by two proxies of fiscal deficit gap and public debt gap is more enhanced under zero based budgeting than under current incremental budgeting system. The study also established that civilian administrations are more prone to fiscal indiscipline relative to military dispensations. The paper also revealed the significant role of net foreign aid receipts in significantly narrowing fiscal deficit and public debt gaps in the short-run and long-run, as well as, the significant widening impact of an increasing government size on public debt in the long run. Yameogo, Omojolaibi and Dauda (2021) considered the relationship between economic globalisation and environmental quality by incorporating institutions as the determinant of this relationship for Sub-Saharan Africa (SSA). The study deploys the technique of generalised methods of moments to assess data spanning the period 2002–2017. Findings indicated that regulatory quality positively impact environmental degradation while economic globalisation and control of corruption negatively affects environmental degradation in SSA. Furthermore, the results show that economic growth and government effectiveness negatively affect the environment while the institution index positively affects the environment in the region. It was also found that the interaction between economic globalisation and institution has negative and significant effects on environmental pollution, thus contributing to environmental quality.

Usman, Iorember, Ozturk and Bekun (2022) considered the interaction effect of the control of corruption and income on environmental quality in Africa over the period from 1996 to 2017. Using a Method of Moments Quantile Regression (MMQR) with fixed effects, the results revealed that both the control of corruption and income level increase CO2 emissions while their interaction term reduces CO2 emissions. Madunezim et al., (2023) considered fiscal discipline and community development in Enugu State. Specifically, the determined the extent to which financial discipline affected affordable health care service delivery in Enugu State, Nigeria; to find out how which financial discipline affected rural road maintenance services in Enugu State, Nigeria and ascertain the implications of financial discipline on improved educational service delivery in Enugu State, Nigeria. To achieve these objectives, three research questions were raised while three hypotheses were formulated. The study adopted a descriptive survey research design. The population of the study was 644,670. Taro Yamani formula was employed in determining the sampling size of 400. Data collected for the study was formulated with descriptive statistics using tables and mean scores while Chi-square test Analysis was used to test the Hypotheses. The study found that financial discipline has not significantly improved educational service delivery in Enugu State, Nigeria, Financial discipline has negatively impacted rural road maintenance services in Enugu State, Nigeria.

Onifade and Alola (2023) considered the links between energy consumption and environmental quality in the wake of rapid urbanization in Africa with empirical insights from the cases of Libya, Morocco, Nigeria, Algeria, Angola, Egypt, and South Africa. These countries aside from being among the largest economies; are also among the leading energy producers and the most urbanized economies that emit the most carbon dioxide on the continent. Based on the Pooled Mean Group (PMG) panel ARDL estimator, the dynamics nexus between the variables was estimated vis-a-vis the short-run and long-run coefficients using relevant sample data between 1990 and 2015. The study further examines the channels of causality between the variables while also testing for the validity of the popular Environmental Kuznets curve (EKC) hypothesis for the panel of countries. The results confirm that the rising level of energy use significantly exacerbates the level of carbon emission among the countries in the study while growing urbanization significantly creates a negative impact on carbon emission. In addition, an increase in per capita income improves the environmental quality but the doubling of income per capita triggers environmental degradation, thus invalidating the EKC hypothesis in the examined panel economies.

Borgi, Mabrouk, Bousrih and Mekni (2023) examined the effect of environmental change on inclusive finance in African countries during the period 1996–2020. It also investigates the moderating role of government quality on the

association between environmental change and inclusive finance. Government quality is measured by six dimensions: political stability, voice and accountability, government effectiveness, regulation quality, the rule of law, and corruption control. Environmental change is measured by CO2 emissions. Inclusive finance is measured by the financial development index through depth, access, and efficiency ratios. These variables represent the most used in prior studies as they are published by international organizations such as the World Bank and the International Monetary Fund, which represent a reputable source of timely information related to the business environment in which business executives operate in several countries. The results show a significant impact of environmental change on inclusive finance. Including economic governance induces a significant and positive effect on financial inclusion in all instances. Our results also show that the coefficients of the interaction between environmental change and governance dimensions are positive and significant. The moderator role of governance is improved when taking into account political, institutional, and economic governance.

Beretta (2024) examined the relationship between the quality of institutions and the quality of the environment. Using systematic analysis of both international and local studies, the study revealed that democracy, corruption and the rule of law are determinant factor of the quality of the environment in different countries or regions of the world. Bambi, Batatana, Appiah and Tetteh (2024) considered governance, institutions, and climate change resilience in Sub-Saharan Africa. This study employed a robust dynamic panel data estimator to explore the relationships between institutions, governance, and environmental quality, focusing on the ecological footprint of 25 SSA nations from 1990 to 2020. The results reveal the threshold effects of the interaction between institutions and governance, following an inverted U-shape pattern. This suggests that beyond a certain ecological footprint, increased interaction between institutions and governance leads to a decrease in ecological footprint. Additionally, high institutional quality (IQ) is associated with a lower environmental impact, while improved governance contributes to mitigating the decline in institutional performance. The panel causality tests among the variables and control components indicate a one-way causal relationship from ecological footprint to governance, infrastructural development, and energy use.

Research Gaps and Contributions to Body of knowledge

Institutional and environmental quality were taken into consideration in a number of studies (e.g., Claire et al., 2021; Usman et al., 2022; Borgi et al., 2023). However, prior studies have failed to reach a consensus on the direction of the relationship between these elements, in part because they failed to consider the impact of fiscal discipline and institutional quality on environmental quality. Thus, this study took into account the interplay between these factors and environmental quality in a novel way. Similarly, the impact of fiscal discipline on environmental quality in West African countries was not taken into account in earlier research. Unlike the few research that took institutional quality characteristics into consideration separately, this study used principal component analysis (PCA) to build an institutional quality index in a new way. The interactive effect of fiscal discipline and institutional quality on environmental quality in West African countries was also uniquely considered in this study.

Methodology

This study adopted ex-post-facto method of research design and this is because investigation started after the fact has occurred without interference from the researcher and also for the fact that data needed for the study already exists. The secondary data used in this study was sourced from World Development Indicators and World Governance Indicators over a period of ten (10) years from 2014 to 2023. The choice of 2014 was because the completed data on institutional quality starts from 2014 while 2023 was also chosen because as at the time the study was carried out, the 2024 World Bank Indicators were yet to be released. The population of the study is West African countries. However, the sample size is selected based on the following criteria: the region (West African countries) is the largest of the developing world where issues of environmental pollution are at the forefront of the current debate in economic development. The countries were chosen based on the records of their populations, poor institutional quality and high level of environmental issues. Based on the criteria, sixteen (16) countries in West Africa countries

were chosen. The countries are Nigeria, Niger, Ghana, Benin, The Gambia, Liberia, Burkina Faso, Mali, Côte d'Ivoire, Sierra Leone, Guinea, Senegal, Guinea-Bissau, Cabo Verde, Mauritania and Togo. The study employed static panel data technique and Generalized method of moments (GMM) to analyze the data obtained for the study.

Model Specification

The model adopted for this study is based on the econometric model of multiple regression approach in line with the one applied by Asongu et al., 2019; Borgi et al., 2023.

$$ENVQ = f(GDP, RE, FD, TRA, GEF, RQ).....1$$

Econometrically equation 3.1 is expressed as:

$$ENVQ_t = \beta_0 + \beta_1 GDP_{it} + \beta_2 RE_{it} + \beta_3 FD_{it} + \beta_4 TRA_{it} + \beta_5 GEF_{it} + \beta_6 RQ_{it} + \varepsilon_{it} 2$$

Where:

ENVQ= Environmental Quality (Proxy with Log of CO2 emission)

GDP= Gross Domestic Investment

RE= Renewable Energy

FD= Financial Development

Tra= Trade

GEF= Government Effectiveness

RLL= Rule of Law

To address the objectives of this study which is to ascertain the effect of institutional quality and fiscal discipline on environmental quality in West African countries, the following model is specified:

$$ENVQ = f(INSQ, FSD, INSQ*FSD, GDP, INF, EXR).....3$$

Econometrically equation 3.1 is expressed as:

$$ENVQ_t = \beta_0 + \beta_1 INSQ_{it} + \beta_2 FSD_{it} + \beta_3 INSQ * FSD_{it} + \beta_4 GDP_{it} + \beta_5 INF_{it} + \beta_6 EXR_{it} + \varepsilon_{it}...4$$

Where:

ENVQ= Environmental Quality (Proxy with Log of CO2 emission)

GDP= Gross Domestic Investment

FSD= Fiscal Discipline

INSQ= Institutional Quality

INF= Inflation

EXR= Exchange Rate

Data Presentation and Analysis

The summary data for the variables are presented in Table 1.

Table 1: Descriptive Statistics

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Obs.	Mean	Std. Dev.	Min	Max
ENVQ	160	.467	.403	.092	1.99
INSQ	160	-1.068	1.000	-2.048	2.956

FSD	160	54.439	23.692	17.541	149.063
INSQ*FSD	160	13.206	85.591	-150.17	349.473
GDP	160	10.076	.625	9.055	11.759
INF	160	6.273	7.644	-3.233	47.642
EXR	160	681.748	1730.537	4.52	9565.082

Source: Author's Computation (2025).

The summary of the variables used are discussed in Table 1. It was shown that the average value of environmental quality over the period of 2014 to 2023 is .467 while the minimum and maximum values for the period are .092 and 1.99 respectively. Similarly, the average value of exchange rate during the period examined is 681.74 while the minimum and maximum values for exchange rate are 4.52 and 9565.08 respectively. For institutional quality, the average value is 1.06 while the minimum and maximum values are -2.04 and 2.95 respectively. In addition, the average value of fiscal discipline, gross domestic product and inflation during the period examined is 54.439, 10.076 and 6.273 while the minimum values are 17.541, 9.055 and -3.233 and maximum values are 149.063, 11.759 and 47.642 respectively. Finally, the average value for interaction of institutional quality and fiscal discipline is 349.473 while the minimum and maximum values are -150.17 and 349.473 respectively. The huge variant in the minimum values and maximum values show that the variables can be used for a regression analysis.

Table 2: Correlation Matrix of Panel Analysis Variables

Variables	INSQ	FSD	INSQ*FSD	GDP	INF	EXR	VIF
INSQ	1.000						1.40
FSD	0.3609	1.					1.39
INSQ*FSD	0.3303	.6709	1.000				1.52
GDP	0.0308	-0.0650	-0.4712	1.000			1.71
INF	-.1022	-0.0794	-0.0167	0.2145	1.000		1.21
EXR	-0.3292	-0.2187	-0.1434	0.0131	0.0247	1.000	1.12

Source: Author's Computation (2025).

The presence of multicollinearity issue in a regression may render such regression spurious. Hence, this study conducted correlation analysis and Variance Inflation Factor (VIF) and it was revealed from correlation analysis that INF and INSQ, GDP and FSD, GDP and INSQ*FSD, INF and FSD, INF and INSQ*FSD. EXR and INSQ, INF and FSD as well as EXR and INSQ*FSD have negative relationship of -.1022, -0.0650, -0.4712, -0.0794, -0.3292, -0.2187 and -0.1434 respectively while other variables are positively related. These values are less than 0.5. In addition, from the VIF test it was revealed the variables have less 5 depicting the absence of multicollinearity problem. Hence, all the variables can be adopted for a regression analysis.

Table 3: Panel Regression Results for Environmental Quality

Dependent Variable: Environmental Quality				
Independent Variables	Pooled OLS	Fixed Effect	Random Effect	GMM
ENVQ1				.990** (0.063)
INSQ	-.284*** (.048)	-.139*** (.031)	-.120 (.033)	.131** (.015)
FSD	-.006*** (.000)	-.0004 (.0006)	.001** (.000)	-.020** (.000)
INSQ*FSD	-.004*** (.0011)	-.001*** (.000)	.002*** (.000)	-.371*** (.000)
GDP	.170*** (.032)	.260*** (.079)	.134** (.061)	.011** (.001)
INF	.006*** (.002)	.000 (.001)	-.000 (.001)	-.000 (.000)
EXR	.000 (9.980)	4.160 (5.120)	1.180 (5.250)	1.600** (0.078)
-cons	-1.541*** (.363)	-2.209*** (.788)	-.997** (.318)	1.135** (.146)
Hausman Test	80.60 (0.000)	Autocorrelation test (Arellano-Bond test) AR(2)		
Breusch-Pagan	1.06 (0.304)			
Sargan test statistic	99.825 (0.321)			
Hansen Test	9.47 (1.000)			

Note: Standard errors in parentheses***, ** and * denotes 1%, 5% and 10% level of significance respectively

Source: Author's Computation (2025).

In selecting the most appropriate technique between pooled OLS and static panel regression, Breusch-pagan test is usually employed and from the result displayed in Table 3, the Breusch pagan test shows that static panel is the most appropriate. Similarly, to choose between fixed effect and random effect, hausman test is adopted and since the Hausman test finding was statistically significant, hence the fixed effect estimator, as displayed in Table 4, is the most acceptable technique. The variables used as dependent is environmental quality (ENVQ; proxy with Carbon monoxide emission) while those of independent variables are institutional quality (INSQ), fiscal discipline (FSD), interaction between institutional quality and fiscal discipline (INSQ*FSD), inflation (INF) and exchange rate (EXR). ENVQ has negative relationship with all the independent variables except inflation rate and exchange rate. This is confirmed by the work of Sakariyahu et al., (2023).

However, at the 1% and 5% level of significance, the INSQ also has a significant but negative effect on environmental quality, with a coefficient value of -.136. This suggests that for every unit increase in institutional quality, Carbon monoxide emission reduces by .136. The interaction of institutional quality and fiscal discipline have a considerable negative relationship, as indicated by the coefficient value of -.001 at the 1% level of significance. demonstrating that for every unit increase in INSQ*FSD, Carbon monoxide emission decreases by .001. While GDP shows a positive relationship with Carbon monoxide emission showing that an increase in GDP leads to Carbon monoxide emission This is because half of coefficient value is higher than the error term. To confirm the accuracy of the results, diagnostic tests were conducted for the two-step GMM; the outcomes are displayed in table 3.

The diagnostic tests of Sargan test statistic and Arellano-Bond test for the study were conducted for the study. The Sargan test statistic has a value of 99.825 while the p-value is 0.321 therefore the hypothesis of over identifications restrictions of instruments cannot be rejected depicting that the instruments are valid. Finally, Arellano-Bond test

shows a value of 1.51 and p-value of 0.131 therefore showing that the study does not suffer from autocorrelation problem. Hence, the tests shows that this regression can be used for policy inference. The dependent variable in the study is environmental quality (ENVQ) while those of independent variables are first lag of environmental quality, institutional quality (INSQ), fiscal discipline (FSD), interaction between institutional quality and fiscal discipline (INSQ*FSD), inflation (INF) and exchange rate (EXR). It was revealed that all the variables except inflation have significant effect on environmental quality in West Africa countries. The significances of these variables are shown from the p-values that are less than 5% level of significance. It was shown that all the variables except first lag of environmental quality and inflation have negative relationship with environmental quality. It was shown that the p-value of first lag of environmental quality is 0.063 while the coefficient is .990. Therefore, a unit increase in first lag of environmental quality will lead to .990 of current environmental quality and vice versa. Similarly, the coefficient value of institutional quality is 0.131 depicting that a unit increase in first lag of environmental quality will lead to .131 increase in environmental quality in West Africa and vice versa. In addition, the coefficient value of interaction between institutional quality and fiscal discipline .002 depicting that a unit increase in interaction of institutional quality and fiscal discipline will lead to .002 increase in environmental quality in West Africa and vice versa. However, the coefficient value of fiscal discipline is -0.020 depicting that a unit increase in fiscal discipline will lead to reduction in Carbon monoxide emission in West Africa and vice versa.

Discussion of Findings

Fixed and random effects models and generalized method of moments (GMM) were employed to examine Fiscal Discipline, Institutional Quality and Environmental Quality in Africa. The result of the study revealed that institutional quality is a significant determinant of environmental quality. This is in line with the work of Yameogo, Omojolaibi and Dauda (2021) and Amoaning, Obeng, Cantah and Vondolia (2023). Therefore, the null hypothesis of insignificance influence of institutional quality on environmental quality does not suffice hence the rejection of the hypothesis.

The result of the study revealed that fiscal discipline is a significant determinant of environmental quality. This is in line with the work of Usman, Iorember, Ozturk and Bekun (2022). Therefore, the null hypothesis of insignificance influence of fiscal discipline on environmental quality does not suffice hence the rejection of the hypothesis. This supports the theory of fiscal federation that states the development of a country depends on the actions of the government. The result of the study also revealed that interaction between institutional quality and fiscal discipline is a significant determinant of environmental quality. This is in line with the work of Madunhezim et al., (2023). Therefore, the null hypothesis of insignificance influence of interaction of institutional quality and fiscal discipline on environmental quality does not suffice hence the rejection of the hypothesis.

Conclusion and Recommendations

Based on the findings of this study, it was concluded that there is a significant relationship between institutional quality and environmental quality in West African countries. It also concluded that there is a significant relationship between fiscal discipline and environmental quality in African countries. The study also concluded that there is bi-directional relationship between institutional quality, fiscal discipline and environmental quality to African countries. Finally, the study concluded that institutional quality and fiscal discipline affect environmental quality in African countries. In line with the findings of this study, the following recommendations were made:

From a policy perspective, there is need for African governments to promote fiscal discipline by implementing reforms aimed at developing their fiscal discipline because this has the potential to help reduce CO₂ emissions or increase environmental quality. Carbon budgets and carbon restrictions are two measures that can be used in this direction in nations where there is high CO₂ emissions. This regulates CO₂ emissions and, consequently, the impact of CO₂ emissions in the country. Better governance strengthens the action of institutional reforms in addressing environmental pollution. The World Bank's governance indicators are environmental anti-dumping measures in that

they significantly curb the level of polluting emissions. In other words, better institutions would make Africa a pollution halo, not a pollution haven.

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ENHANCING EDUCATIONAL OUTCOMES IN NIGERIAN UNIVERSITIES THROUGH PERSONALIZED LEARNING WITH ARTIFICIAL INTELLIGENCE: PROSPECT, CHALLENGES AND WAY FORWARD

BY

Yusuf Olasunkanmi Ibrahim¹, Yusuf Suleiman², Ismail I. Akuji³ & Azeez Babatunde Adebayo⁴

^{1,4}Department of Science Education, Faculty of Education, Al-Hikmah University, Kwara State, Nigeria

²Department of Educational Management and Counseling, Faculty of Education, Al-Hikmah University,
Kwara State, Nigeria

³Department of Computer Science, Kwara State University Malete, Kwara State, Nigeria

Email: yusufolasunkanmiibrahim@gmail.com

Abstract

This paper explores the potential of personalized learning with artificial intelligence (AI) to enhance educational outcomes in Nigeria. Despite efforts to improve the quality of education, Nigeria faces challenges such as overcrowded classrooms, limited resources, and diverse learning needs. Personalized learning, which tailors instruction to individual student preferences, abilities, and pace, presents a promising solution to address these challenges and promote student success. Drawing on existing literature and case studies, this paper examines the theoretical underpinnings and practical applications of personalized learning with AI in the Nigerian context. It discusses how AI-driven adaptive learning platforms can analyze student data, identify learning gaps, and deliver customized content and interventions to meet each student's unique needs. By leveraging machine learning algorithms, these platforms can provide real-time feedback, track progress, and adjust instructional strategies accordingly, thereby optimizing learning experiences and outcomes. Furthermore, the paper discusses the potential benefits of personalized learning with AI for teachers and educators in Nigeria. By automating routine tasks such as grading, data analysis, and lesson planning, AI technologies can free up valuable time for educators to focus on individualized instruction, student support, and pedagogical innovation. Additionally, AI-powered analytics tools can empower educators with insights into student performance, learning trends, and instructional efficacy, enabling data-driven decision-making and continuous improvement in teaching practices. Moreover, the paper addresses concern and challenges related to the implementation of personalized learning with AI in Nigeria, including issues of access, equity, privacy, and cultural relevance. It emphasizes the importance of stakeholder collaboration, policy support, infrastructure investment, and capacity building to ensure the effective integration of AI technologies into educational settings. In conclusion, this paper argues that personalized learning with AI holds great promise for enhancing educational outcomes in Nigeria by providing tailored, adaptive, and engaging learning experiences for students, supporting teachers in their instructional practices, and driving systemic improvements in the education system. However, realizing this potential requires concerted efforts from government, educators, technology developers, and other stakeholders to create an enabling environment conducive to innovation, experimentation, and sustainable growth in AI-enhanced education.

Keywords: Artificial Intelligence, Adaptive Learning, Education, Intelligent Tutoring Systems, Learning Outcomes, Personalized Learning,

Introduction

Artificial Intelligence (AI) is increasingly being recognized as a transformative force in education, with personalized learning emerging as a key area of exploration. By leveraging AI technologies, educators can tailor educational experiences to the unique needs, preferences, and abilities of individual learners, thereby potentially enhancing educational outcomes. These have underscored the potential of personalized learning with AI to improve student engagement, motivation, and achievement (Molnar, 2021). The potential solutions associated with enhancing

educational outcomes through personalized learning with AI. Furthermore Artificial Intelligence (AI) is increasingly being recognized as a transformative force in education, with personalized learning emerges as a key area of exploration. By leveraging AI technologies, educators can tailor educational experiences to the unique needs, preferences and abilities of individual learners, thereby potentially enhancing educational outcomes. Personalized learning involves the customization of instruction, pace, and content to suit the specific needs of each learner, a process that can be greatly facilitated by AI-driven adaptive learning systems (Yousef et al., 2020). These systems use algorithms to analyze student data, such as learning preferences, performance history, and areas of difficulty, to deliver tailored learning experiences in real-time. Research suggests that personalized learning approaches supported by AI can lead to more effective learning outcomes compared to traditional one-size-fits-all approaches (Feng et al., 2021).

Despite the potential benefits, the integration of AI in education also presents challenges and considerations. Ensuring equitable access to AI-powered educational tools, addressing concerns related to data privacy and security, and providing adequate training and support for educators are among the key challenges that need to be addressed (Rouse, 2020). Moreover, ethical considerations, such as the potential for algorithmic bias and the need for transparency and accountability in AI-driven decision-making processes, require careful attention (Holmes et al., 2022). In light of these opportunities and challenges, it is essential to examine the ways in which personalized learning with AI can be effectively implemented to enhance educational outcomes while mitigating potential risks. By exploring recent advancements, identifying best practices, and considering ethical guidelines, stakeholders can work towards harnessing the full potential of AI to create more equitable, engaging, and effective learning environments for all students. Personalized learning involves the customization of instruction, pace, and content to suit the specific needs of each learner, a process that can be greatly facilitated by AI-driven adaptive learning systems (Yousef et al., 2020). These systems use algorithms to analyze student data, such as learning preferences, performance history, and areas of difficulty, to deliver tailored learning experiences in real-time. The personalized learning approaches supported by AI can lead to more effective learning outcomes compared to traditional one-size-fits-all approaches (Feng et al., 2021). Despite the potential benefits, the integration of AI in education also presents challenges and considerations. Ensuring equitable access to AI-powered educational tools, addressing concerns related to data privacy and security, and providing adequate training and support for educators are among the key challenges that need to be addressed (Rouse, 2020). Moreover, ethical considerations, such as the potential for algorithmic bias and the need for transparency and accountability in AI-driven decision-making processes, require careful attention (Holmes et al., 2022).

Concept of Education

Nigeria's education system has roots in its colonial past, particularly under British rule. The British established formal education institutions to serve their administrative and economic interests, leading to the emergence of Western-style education in the country. This legacy has influenced the structure and content of Nigeria's educational system (Nugroho, 2023). Nigeria boasts a diverse educational landscape, comprising public, private, and religious institutions at various levels (Clamp & Taple, 2023). This includes primary, secondary, and tertiary education, as well as vocational and technical training schools. Each sector plays a vital role in shaping the educational experiences of Nigerians. Nigeria has made efforts to promote universal primary education through policies and initiatives aimed at increasing enrollment and reducing barriers to access. However, challenges such as inadequate infrastructure, teacher shortages, and socioeconomic disparities continue to hinder progress towards this goal (Sahani et al., 2024).

The Nigerian educational curriculum encompasses a wide range of subjects, including core academic disciplines, vocational skills, and cultural studies. The curriculum is periodically revised to reflect changes in societal needs and global trends (Al-Ajeely et al., 2023). Pedagogical approaches vary but often include a mix of traditional teaching methods and modern instructional techniques. Nigeria faces numerous challenges in its education sector, including inadequate funding, overcrowded classrooms, inadequate infrastructure (Burns et al., 2023), and a high rate of out-

of-school children. Additionally, issues such as religious and ethnic tensions, insurgency, and poverty pose significant obstacles to educational development. Despite challenges, Nigeria's education sector has witnessed notable innovations and advancements, particularly in the integration of technology in teaching and learning. Initiatives such as e-learning platforms, digital libraries, and mobile-based educational apps are helping to expand access to quality education, especially in remote and underserved areas (Familoni & Onyebuchi, 2024).

Nigeria boasts a robust higher education sector, with numerous universities, polytechnics, and colleges offering a wide array of degree programs (Bentum-Micah & Kyei-Nuamah, 2023). However, the sector faces challenges such as funding constraints, inadequate infrastructure, and quality assurance issues. Efforts to improve higher education include reforms in governance, curriculum development, and research capacity building. Nigeria's education system reflects its cultural and linguistic diversity, with a rich tapestry of languages and ethnic traditions woven into the fabric of teaching and learning (Mpofu & Manwa, 2023). Efforts to promote indigenous languages and cultural heritage are integral to fostering national identity and unity. Nigeria's education system is increasingly influenced by globalization and internationalization trends, with greater emphasis placed on global competencies, cross-cultural understanding, and international partnerships (Caligiuri & Caprar, 2023). This includes initiatives such as student exchange programs, joint research collaborations, and accreditation standards aligned with global benchmarks.

Concept of Universities Educational

University education in Nigeria holds significant importance within the nation's educational framework. It serves as a platform for advancing academic pursuits beyond secondary education, catering to the intellectual, professional, and societal needs of students. Nigerian universities are entrusted with the crucial task of equipping individuals with the requisite knowledge, skills, and competencies essential for their personal growth and contribution to the socio-economic development of the nation. Despite this vital role, the educational outcomes of Nigerian universities are influenced by various factors, including financial constraints, inadequate infrastructure, teaching quality, curriculum relevance, and the overall educational milieu (Umeozor, 2023). One of the primary goals of university education in Nigeria is the attainment of academic qualifications, ranging from undergraduate degrees to postgraduate diplomas and research-based master's and doctoral degrees (Eze & Obidile, 2020). These qualifications serve as tangible evidence of academic accomplishment, facilitating employment opportunities across diverse sectors and enabling further academic pursuits both domestically and internationally. Additionally, university education aims to cultivate critical thinking, problem-solving abilities, and analytical skills among students, preparing them to tackle complex real-world challenges and contribute to the advancement of knowledge and innovation. Moreover, university education in Nigeria endeavors to nurture character development and ethical values among students, instilling principles of integrity, responsibility, and social consciousness.

Through extracurricular activities, community service endeavors, and ethical leadership programs, universities play a pivotal role in shaping students' character and fostering civic engagement and ethical behaviour (Maiyaki, & Aliyu, 2022). Furthermore, graduates are expected to demonstrate proficient communication skills, both orally and in writing, alongside competence in information literacy and research methodologies, which are indispensable for lifelong learning and professional advancement. In addition to academic and character development, university education in Nigeria strives to enhance students' employability and entrepreneurship acumen, equipping them with the competencies necessary to excel in a competitive job market and embark on entrepreneurial ventures (Makhele & Barnard, 2020). Universities are increasingly integrating practical, industry-relevant training programs, internships, and entrepreneurship courses into their curricula to bridge the gap between academic learning and industry demands (Zeidan & Bishnoi, 2020). Collaborative partnerships between universities, industries, and government agencies further provide students with exposure to real-world work environments and hands-on experience in their respective fields of study (Eden & Adeniyi, 2024). Nevertheless, Nigerian universities encounter numerous challenges that impede their ability to realize desired educational outcomes. Inadequate funding, deficient infrastructure, faculty shortages, and bureaucratic complexities are primary impediments hampering the quality and effectiveness of university education in Nigeria (Jacob et al., 2021). Additionally, issues such as academic

misconduct, examination malpractice, and student unrest pose supplementary challenges to the integrity and credibility of educational outcomes.

Furthermore, there is a growing acknowledgment of the imperative for increased investment in higher education, both from governmental and private sector stakeholders, to elevate the quality and relevance of university education in Nigeria (Elengold, 2019). Ultimately, achieving desired educational outcomes necessitates sustained dedication, collaboration, and innovation across all tiers of the education system, accompanied by active engagement from stakeholders such as policymakers, educators, students, employers, and civil society organizations (Serdyukov, 2017).

Objectives of University Education

The intellectual development and critical thinking, one of the primary objectives of university education is to foster intellectual development and critical thinking among students. Universities aim to cultivate analytical, evaluative, and reflective skills that enable learners to interrogate information, draw logical conclusions, and make informed decisions (Kivunja, 2023). Through diverse disciplines and interdisciplinary approaches, students are encouraged to question assumptions, synthesize knowledge, and engage in problem-solving activities. This intellectual empowerment is fundamental to both personal growth and societal progress. Moreover, acquisition of specialized knowledge and skills, university education equips students with specialized knowledge and practical skills required for professional competence. This includes both theoretical foundations and technical expertise in fields such as medicine, engineering, law, education, and the humanities. According to Olayiwola and Ojo (2022), university curricula are designed to produce graduates who can perform effectively in their chosen careers, thereby contributing meaningfully to national and global development.

Research and innovation, another key objective of university education is the promotion of research and innovation. Universities serve as centers of knowledge production where academic inquiry leads to new discoveries, technologies, and solutions to societal challenges (Nwagwu & Ilechukwu, 2023). Through undergraduate projects, postgraduate theses, and institutional research initiatives, students and faculty collaborate to generate evidence-based insights that advance science, industry, and public policy. Furthermore, citizenship and civic responsibility, university education also aims to produce responsible and informed citizens who actively contribute to democratic processes and community development. Through courses in social sciences, ethics, and governance, universities nurture values such as tolerance, justice, and civic engagement (Aina, 2021). Educated citizens are better positioned to hold governments accountable, participate in policymaking, and promote equity and social cohesion.

Economic development and employment creation, universities play a crucial role in national economic development by producing a skilled workforce and fostering entrepreneurship. According to World Bank (2023), countries with robust higher education systems tend to experience faster economic growth due to innovation, increased productivity, and business competitiveness. In Nigeria, for instance, university graduates contribute to sectors such as ICT, healthcare, and agriculture, helping to diversify the economy and reduce unemployment. Moreover, cultural preservation and promotion, university education supports the preservation and promotion of cultural heritage through teaching, research, and community outreach. Departments of history, languages, anthropology, and the arts document, analyze, and celebrate indigenous knowledge and practices. As observed by Eze and Okonkwo (2022), universities in Africa have a responsibility to decolonize curricula and promote local content that reflects the continent's rich cultural identities and values.

Global competence and internationalization in a globalized world, universities prepare students to function effectively in international environments. This includes fostering intercultural understanding, foreign language proficiency, and awareness of global issues such as climate change and human rights (OECD, 2024). Through student exchange programs, collaborative research, and online learning platforms, universities promote cross-border

academic engagement and global citizenship. Additionally, moral and ethical development, universities are also tasked with instilling ethical values and a strong moral compass in their students. Ethics courses, mentorship programs, and codes of conduct help shape the integrity and professionalism of graduates. According to Yusuf and Adebayo (2023), ethical education is essential in reducing corruption, promoting accountability, and building trust in professional and public institutions.

Leadership and personal development, developing leadership capacity is a fundamental objective of university education. Through student unions, debate clubs, and leadership training workshops, students learn to lead, manage conflict, and work in teams. The goal is to produce future leaders who are visionary, empathetic, and solution-oriented (UNESCO, 2023). Leadership education also builds resilience and emotional intelligence, which are crucial for personal and professional success. Moreover, lifelong learning and adaptability, university education promotes lifelong learning and adaptability in a rapidly changing world. Graduates must be able to acquire new skills, adapt to emerging technologies, and respond to evolving labor market demands. As highlighted by Adejumo and Ibrahim (2022), universities should instill a learning mindset that encourages curiosity, continuous self-improvement, and adaptability to change, especially in the era of artificial intelligence and digital transformation.

Meaning of Artificial Intelligence

Artificial intelligence (AI) is a technology that encompasses the development of computer systems capable of performing tasks that typically require human intelligence. When applied to personalized learning, AI tailored educational experiences to individual learners' needs, preferences, and learning styles. It analyzes vast amounts of data about a learner's interactions, progress, and performance to provide customized recommendations, content, and pacing (Onesi-Ozigagun et al., 2024). This approach enhances engagement, comprehension, and retention by adapting the learning process to suit each learner's unique requirements (Shute & Towle, 2018).

Artificial intelligence, often abbreviated as AI, refers to the simulation of human intelligence processes by computer systems. It encompasses a broad spectrum of capabilities, including learning, reasoning, problem-solving, perception, and language understanding (Rahman, 2019). At the core of AI lies the concept of personalized learning, which tailor educational experiences to individual learners based on their unique needs, preferences, and learning styles (Li et al., 2023).

This approach leverages algorithms and data analysis to create customized learning paths for each student, optimizing their educational journey and maximizing their potential for academic success. One key characteristic of AI in personalized learning is its ability to adapt and evolve over time. Through continuous feedback and iterative improvement, AI algorithms refine their understanding of each learner's strengths, weaknesses, and areas for growth (Chun, 2014). This adaptive nature allows personalized learning systems to dynamically adjust course content, pacing, and instructional strategies to suit the changing needs of students, ensuring that they receive the most relevant and effective educational support (Peng & Spector, 2019). Another hallmark of AI in personalized learning is its capacity for data-driven decision-making. By collecting and analyzing vast amounts of student data (Górriz et al., 2020), AI algorithms can identify patterns, trends, and correlations that inform instructional interventions and learning interventions.

The data-driven approach enables educators to make informed decisions about curriculum design, teaching methods, and student support services, ultimately enhancing the effectiveness and efficiency of the learning process (Bray-Clark, & Bates, 2003). Furthermore, AI in personalized learning fosters autonomy and self-directed learning among students (Rivers & Holland, 2022). Empowering learners to take control of their educational journey, AI systems encourage active engagement, curiosity, and intrinsic motivation. Through personalized feedback, recommendations, and scaffolding, students develop meta cognitive skills and become more adept at setting goals, monitoring progress, and reflecting on their learning experiences, thereby fostering lifelong learning habits (Haber, 2022). Moreover, AI in personalized learning promotes inclusivity and accessibility by catering to the diverse needs and abilities of all learners Mitchell, (2015). Whether students have learning disabilities, English language learners,

or gifted talents, AI systems can adapt instructional materials, provide alternative modalities, and offer additional support to ensure that every student has equitable access to high-quality education (Parveen, et al., 2019).

Removing barriers to learning and accommodating individual differences, AI promotes a more inclusive and supportive learning environment for all. Additionally, AI in personalized learning facilitates collaborative and social learning experiences by connecting students with peers, mentors, and experts from around the world (Rodrigues, et al., 2011). Through online forums, virtual classrooms, and social networking platforms, learners can engage in collaborative projects, share resources, and exchange ideas with a global community of learners. This collaborative approach fosters creativity, communication, and teamwork skills, preparing students for success in an interconnected and rapidly changing world (Ahmed, et al., 2016).

Strategies for Enhancing Personalized Learning Using Artificial Intelligences

Enhancing personalized learning through the integration of artificial intelligence involves several strategies aimed at tailoring educational experiences to individual learners' needs and preferences.

1. Leveraging AI-powered adaptive learning platforms can provide personalized content delivery by analyzing students' strengths, weaknesses, and learning styles. These platforms use algorithms to recommend appropriate learning materials, adjust difficulty levels, and provide real-time feedback, fostering a more customized learning journey for each student (Tatineni, 2020).
2. Incorporating intelligent tutoring systems can offer personalized guidance and support by simulating one-on-one tutoring experiences. These systems use AI algorithms to assess students' progress, identify misconceptions, and offer targeted interventions or explanations, thereby addressing individual learning gaps more effectively (Saalfeld et al., 2020). Adapting instruction to each student's pace and comprehension level, intelligent tutoring systems promote deeper understanding and engagement.
3. Implementing data-driven insights obtained from AI analytics can inform instructional decision-making and curriculum design. Analyzing vast amounts of student data allows educators to identify patterns, trends, and areas for improvement, enabling them to adjust teaching strategies and content delivery methods to better meet students' needs (O'Keefe et al., 2020). Harnessing AI-driven analytics, educators can make more informed decisions that optimize learning outcomes and enhance the overall learning experience.
4. Integrating AI-powered virtual assistants or chatbots can provide personalized support and assistance outside of the classroom. These virtual agents can answer students' questions, offer study tips, provide additional resources, and even facilitate peer collaboration, thereby extending personalized learning beyond traditional instructional settings (Ali, 2024). Leveraging natural language processing and machine learning algorithms, virtual assistants can deliver tailored support that enhances students' autonomy and self-directed learning skills.
5. Embracing adaptive assessment technologies powered by AI can offer personalized evaluation methods that adapt to individual learners' abilities and knowledge levels. These assessment tools use algorithms to generate questions based on students' previous responses, ensuring that assessments accurately measure each student's understanding and mastery of the material (Adom et al., 2020). Providing timely and relevant feedback, adaptive assessments promote a growth mindset and encourage continuous improvement.
6. Fostering a culture of data privacy and ethical AI use is essential for building trust and ensuring the responsible implementation of AI in personalized learning environments. Educators and policymakers must establish clear guidelines and protocols for data collection, storage, and usage to protect students' privacy rights and confidentiality (Miao et al., 2021). Additionally, promoting transparency and accountability in AI algorithms' decision-making processes can help mitigate biases and ensure fair treatment for all learners.
7. Providing professional development opportunities for educators to enhance their AI literacy and instructional design skills is crucial for successful implementation. Educators need training and support to effectively integrate AI technologies into their teaching practices and maximize their potential for personalized learning. Empowering educators with the knowledge and skills needed to leverage AI tools effectively, institutions can ensure sustainable and impactful personalized learning initiatives that benefit all students (Ruiz-Rojas, et al., 2023).

Prospects of Enhancing Personalized Learning using Artificial Intelligence

Educational learning can be enhanced through personalized learning with use of artificial intelligence (AI) presents exciting prospects for revolutionizing education in the 21st century (Bhutoria, 2022). By leveraging AI technologies, personalized learning aims to tailor educational experiences to the unique needs, preferences, and abilities of individual learners, thereby enhancing engagement, motivation, and learning outcomes.

Improved Learning Outcomes

Personalized learning with AI has the potential to improve student outcomes by provides customized instruction and support based on individual learning styles, abilities, and interests. The adaptive learning technologies powered by AI can significantly enhance learning outcomes across various educational contexts. For instances, Feng et al., (2021) conducted a comprehensive assessment of adaptive learning technologies and found that these AI-driven systems led to notable improvements in student performance, including increased retention of knowledge and higher proficiency levels in targeted subject areas. The dynamically adjusting content and activities to match each student's learning pace and preferences, personalized learning with AI ensures that learners receive tailored instruction that maximizes their engagement and comprehension. Furthermore, Navarro-Prieto et al., (2023) highlights the effectiveness of AI-powered personalized learning environments in addressing individual learning needs and promoting academic success.

Enhanced Engagement

AI-powered educational tools can adapt content and activities to keep students engaged and motivated, leading to deeper learning experiences. Research has demonstrated the effectiveness of AI-driven adaptive learning platforms in promoting student engagement and fostering a conducive learning environment. Cai and Wang (2022) investigated the impact of AI-based adaptive learning systems on student engagement in online courses. The personalized recommendations and interactive features offered by these platforms were identified as key factors contributing to increased student engagement and motivation. Moreover, research by Liu et al., (2023) explored the role of AI-powered educational games in enhancing student engagement and learning outcomes.

Addressing Learning Gaps

AI can identify and address learning gaps in real-time, allowing educators to provide targeted interventions to help students succeed. Research has demonstrated the efficacy of AI-driven data analytics in identifying areas of student weakness and implementing personalized interventions to support learning. Baker et al., (2021) investigated the effectiveness of AI-powered data analytics in identifying and addressing learning gaps in mathematics education. Furthermore, research by Kennedy et al., (2022) examined the use of AI-driven adaptive learning platforms to address learning gaps in reading comprehension.

Potential Challenges of (AI) for Personalized Learning with AI

The collaborative efforts between educators, policymakers, researchers, and technology developers in working together to overcome these obstacles, stakeholders can harness the transformative potential of AI to create more inclusive, engaging, and effective learning environments for all students.

1. **Access and Equity** One of the primary challenges is ensuring equitable access to I-powered educational tools for all students, regardless of socioeconomic status or geographic location. A report by the Organization for Economic Co-operation and Development (OECD) (2021) emphasized the need for policies and initiatives aimed at reducing the digital divide and ensuring equitable access to digital learning resources. Furthermore, Means et al., (2022) examined the impact of access to technology on educational

outcomes and found significant disparities in access to digital learning resources among students from low-income families and underserved communities.

2. **Data Privacy and Security:** Collecting and analyzing student data raises concerns about privacy and security, requiring robust safeguards to protect sensitive information. Zhang and Liu (2022) examined the privacy implications of using AI technologies in education and identified key privacy risks associated with the collection and analysis of student data. Wang et al., (2023) investigated the security vulnerabilities of AI-powered educational platforms and proposed a framework for enhancing data security in these systems.
3. **Teacher Training and Support:** Educators may require training and support to effectively integrate AI technologies into their teaching practices and interpret the insights generated by these tools. This emphasized the importance of providing professional development opportunities and ongoing support to empower educators to leverage AI effectively in the classroom. O'Neill and McMahon (2022) investigated the training needs of educators in integrating AI technologies into their teaching practices. To identify a range of competencies required for AI integration, including technical skills, pedagogical knowledge, and data literacy. Furthermore, Chao and Shih (2023) examined the impact of teacher training programs on the adoption of AI in education.
4. **Data Privacy Concerns:** Personalized learning relies heavily on gathering and analyzing vast amounts of data about individual learners. However, ensuring the privacy and security of this data poses a significant challenge. There's a risk of sensitive information being exposed or misused, which could erode trust in personalized learning systems among students, educators, and parents Maghsudi, et al., (2021).
5. **Algorithmic Bias and Fairness:** AI algorithms used in personalized learning systems may inadvertently perpetuate biases present in the data they are trained on. This can lead to unfair treatment or opportunities being denied to certain groups of learners based on factors like race, gender, or socioeconomic status (Lee, & LeBuffe, 2024). Addressing and mitigating algorithmic bias is crucial to ensuring equitable access and outcomes in personalized learning programs.

Way Forward on Artificial Intelligences for Personalized Learning

By prioritizing these elements and working collaboratively towards a shared vision of leveraging AI to enhance education, we can pave the way for a more innovative, inclusive, and equitable education system that empowers all students to succeed in the digital age. Moving forward, it's imperative to adopt a multifaceted approach to harness the potential of AI in education effectively.

1. **Investment in Infrastructure and Training:** Governments, educational institutions, and technology companies should invest in infrastructure and training programs to ensure equitable access to AI-powered educational tools and support educators in leveraging these technologies effectively. UNESCO (2021) emphasized the role of government policies and funding initiatives in promoting the integration of AI technologies in education and ensuring equitable access for all students. The called for increased investment in digital infrastructure, broadband connectivity, and access to devices to bridge the digital divide and enable widespread adoption of AI-powered educational tools. Furthermore, According to Reddy et al. (2022) investigated the impact of teacher training programs on the successful integration of AI in classrooms.
2. **Ethical Guidelines and Standards**
The development of ethical guidelines and standards for the use of AI in education can help mitigate risks such as bias and privacy concerns while promoting responsible and equitable implementation. UNESCO (2021) advocated for the establishment of international ethical guidelines to ensure the responsible and ethical use of AI in education. Furthermore, Holmes, et al., (2022) examined the ethical considerations associated with the use of artificial intelligence in education.
3. **Collaboration and Research:** Collaboration between stakeholders, including educators, researchers, policymakers, and technology developers, is essential for advancing the field of personalized learning with AI through sharing best practices, conducting research, and addressing emerging challenges. Barron and Darling-Hammond (2021) highlighted the role of collaborative partnerships between educators and

researchers in designing and implementing personalized learning initiatives. Furthermore, Van den Beemt et al., (2022) examined the impact of collaborative research networks on advancing AI in education.

4. **Utilizing AI for Adaptive Learning Paths:** AI has the capability to examine students' learning styles, strengths, and weaknesses, thereby customizing learning paths. By utilizing information on previous performance, preferences, and cognitive capacities, AI algorithms can adapt the complexity, content, and speed of learning materials Van den Beemt et al., (2022). However, this personalized approach ensures that students receive individualized instruction, enhancing their involvement and understanding. Furthermore, AI can provide instant feedback and recommendations for enhancement, promoting ongoing learning and skill enhancement.
5. **AI-Powered Virtual Tutors:** AI-driven virtual tutors can provide personalized support to students, offering individualized guidance and assistance. Virtual tutors can interact with students through natural language processing, answering questions, explaining concepts, and providing personalized recommendations for further study (Paladines, & Ramirez, 2020). Analyzing students' interactions and progress, AI tutors can adapt their teaching strategies to meet the unique needs of each learner, ultimately enhancing learning outcomes. Additionally, virtual tutors can offer round-the-clock support, enabling students to access help whenever they need it, regardless of time or location.

Ethical Consideration on the Use of (AI) For Personalized Learning

Personalized learning, coupled with AI integration, offers promising opportunities alongside significant ethical concerns. One of the foremost issues is centered on privacy and data security. Platforms for personalized learning typically amass extensive sensitive data about students, spanning from academic performance to behavioral patterns. It's crucial to handle this data responsibly, adhering strictly to privacy laws and ethical standards to prevent potential misuse or breaches. Another ethical consideration is the possibility of algorithmic bias and discrimination (Ferrer et al., 2021). Moreover; AI algorithms powering personalized learning systems rely on data to formulate decisions and suggestions. If this data is biased or incomplete, it can perpetuate inequalities by favoring certain demographics or reinforcing stereotypes. To address bias in AI, comprehensive data collection strategies, algorithm transparency, and continuous monitoring are necessary to detect and mitigate instances of discrimination (Paladines, & Ramirez, 2020).

Moreover, there are concerns regarding the impact of AI on human agency and autonomy in learning. While personalized learning aims to accommodate individual needs and preferences, there's a risk of excessive dependence on algorithms, which could diminish the roles of teachers and students in the learning process. Striking a balance between leveraging AI for personalized recommendations and preserving human agency is essential to ensure that learners remain active participants in their educational journey (Paladines, & Ramirez, 2020). Additionally, there's an ethical dilemma concerning accountability and responsibility. Who should bear responsibility if AI-driven personalized learning systems fail or yield undesirable outcomes? Should it be the developers, educators, policymakers, or the technology itself? Establishing clear lines of responsibility and accountability is crucial to ensure transparency, fairness, and trust in the use of AI for personalized learning. This may involve creating robust governance frameworks, ethical guidelines, and mechanisms for redress in cases of harm or injustice caused by AI algorithms (Paladines, & Ramirez, 2020).

Conclusion

In conclusion, the integration of Artificial Intelligence (AI) in education, particularly through personalized learning, holds immense promise for transforming traditional educational practices and enhancing student outcomes. Through AI-driven adaptive learning systems, educators can tailor instruction to meet the diverse needs, preferences and abilities of individual learners, leading to improved engagement, motivation, and achievement. However, realizing the full potential of AI in education requires to address a wide range of challenges, such as ensures equitable access to AI-powered educational tools, safeguard student towards data privacy and security, provide adequate training and

support for educators, and adhere to ethical guidelines and standards. By investing in infrastructure, professional development, and ethical frameworks, stakeholders can create a conducive environment for the responsible and equitable integration of AI technologies in education. With concerted action and collaboration, we can unlock new possibilities for personalized learning and pave the way for a more innovative and inclusive education system in the digital age. In conclusion, artificial intelligence in personalized learning represents a transformative approach to education that harnesses the power of technology to individualize and optimize the learning experience for each student. By leveraging adaptive algorithms, data analytics, and personalized feedback, AI systems empower learners to take ownership of their learning, make data-driven decisions, and collaborate with others in a supportive and inclusive learning community. Ultimately, AI in personalized learning holds the potential to revolutionize education by making it more responsive, engaging, and effective for all learners.

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EVALUATION OF PRIMORDIAL RADIONUCLIDES AND HEALTH IMPACTS IN SOIL FROM THE EFFA AREA, BENUE STATE, NIGERIA

BY

Patrick Inalegwu Uloko*, Michael Akor Onoja, Nuraddeen Nasiru Garba & Yahaya Musa
Department of Physics, Faculty of Physical Sciences, Samaru campus, Ahmadu Bello University, Zaria
Kaduna State, Nigeria
E-mail: patrickin05jesus@gmail.com

Abstract

This study evaluates the concentrations of naturally occurring radionuclides (^{226}Ra , ^{232}Th , and ^{40}K) and their associated health impacts in soil samples from Effa communities surrounding the Abache coal mine in Benue State, Nigeria. Mining activities redistribute these radionuclides, increasing environmental exposure to ionizing radiation. Sixteen soil samples were randomly collected and analysed using NaI (Tl) gamma spectrometry at the Centre for Energy and Research Training (CERT), Ahmadu Bello University, Zaria. The mean activity concentrations of ^{226}Ra , ^{232}Th , and ^{40}K were 33.33 ± 2.56 Bq/kg, 41.06 ± 2.40 Bq/kg, and 51.53 ± 2.71 Bq/kg, respectively. The ^{226}Ra value slightly exceeded the global average by a factor of 1.01, while ^{232}Th and ^{40}K were below. Most radiological hazard indices were within permissible limits, except for the annual gonadal dose equivalent (AGDE) which exceeded safety thresholds at specific sites and excess lifetime cancer risk (ELCR) with the average value of 0.91×10^{-3} higher than the world average of 0.29×10^{-3} which would be considered as moderate to high risk. The results of radium equivalent activity do not show any radiological implications if the soils are used domestically. These findings emphasize the need for regular environmental monitoring and mitigation measures.

Keywords: Radionuclides, Health Risk, Radiological Parameters, Effa, Nigeria

Introduction

Radiation and its potential hazards to human health have become global concerns. While natural radiation is unavoidable, mining activities significantly alter its distribution [1,2]. The International Atomic Energy Agency (IAEA) notes that exposure from natural radioactivity is generally negligible for the public, except those working with mineral ores or naturally occurring radioactive materials (NORMs) [3]. However, the World Nuclear Association (WNA) emphasizes that any radiation dose carries some risk [4,5]. Coal mining operations began in the Abache Effa community in 2019, aiming to provide an alternative energy source for industrial processes. These activities result in environmental degradation and potential radiological threats. Excavation, blasting, and dust emissions can redistribute radionuclides, increasing radiation exposure in surrounding environments. Dust and particulate matter also contribute to air pollution, affecting local flora, fauna, and water bodies [6]. Exposure to radioactive contaminants may lead to elevated radiation levels and health risks for residents [9,10, 11]. Inhalation of coal dust can result in diseases like pneumoconiosis (black lung disease) [12,11], and there is increased cancer risk due to gamma radiation exposure [7, 8]. While radiological surveys have been conducted in several Nigerian mining areas [13], such as Shanono, Bagwai [14], Maiganga [7], Barakinladi, Enugu [8], Okobo [15], and Zabili, Chad [16]—no such assessment has been done in the Abache Effa coal mine. It is against this backdrop that this study was carried out to evaluate soil radionuclide concentrations and their health implications in Effa, Efewu, and Abache.

Sample collection and preparation

Sixty soil samples were collected from a depth of 0–15 cm using hand tools. Samples were labeled according to GPS coordinates and sealed in polythene bags. At CERT, samples were air-dried for 72 hours, pulverized, sieved through a 100-micron mesh, and packed in radon-impermeable containers. The samples were stored for 30 days to achieve secular equilibrium before counting using NaI based gamma spectroscopy.

Gamma Spectrometric Measurements

Samples were analyzed using a NaI (Tl) detector housed in a lead shield to reduce background radiation. Calibration was performed using IAEA-315 [19] sediment standards. Gamma peaks from ^{214}Bi and ^{214}Pb (for ^{238}U), ^{228}Ac and ^{208}Tl (for ^{232}Th), and ^{40}K were used for activity concentration analysis. To determine the baseline count, an empty beaker with the same dimensions as the sample containers was counted. The baseline spectrum was subsequently subtracted from the sample spectra to yield the overall radio-isotope count. Sample and background counting were performed for a duration of over 28,800 seconds, resulting in gamma spectra with good statistical reliability. The gamma-ray photo peaks of ^{228}Ac and ^{208}Tl were used for determining the activity of ^{232}Th . The, ^{214}Bi and ^{214}Pb peaks were used for the activity of ^{238}U and the activity of ^{40}K was determined from its single gamma line. The specific activity concentrations of ^{226}Ra , ^{232}Th , and ^{40}K in respective sample, expressed in Bq kg^{-1} , were calculated using Equation1[20] and [18]

$$A(C) = \frac{C_{\text{net}}}{\varepsilon(E) \times I_{\gamma} \times t \times m} \quad (1)$$

Where $A(C)$ is the specific activity (Bq/kg), C_{net} is the net count rate, ε is the photopeak efficiency, I_{γ} is the gamma intensity, t is the counting time, and m is the sample mass.

Radiation hazard estimation

Several radiological parameters were calculated:

Absorbed Dose Rate (ADR)

Determination of absorbed dose rate is essential for assessing the health-related risks associated with radiation exposure. Radiological hazards due to radiation exposure from radionuclides in soil can be assessed using equation 2 [21]. The effects depend largely on the absorbed dose rate in the air at 1.0m above ground level ([22].

$$\text{ADR} \left(\frac{\text{nGy}}{\text{h}} \right) = (0.462C_{\text{Ra}} + 0.604C_{\text{Th}} + 0.0417C_{\text{K}}) \quad (2)$$

Where, C is the activity concentration of the primordial radionuclides in Bq/kg .

Radium Equivalent Activity (Ra_{eq})

Radium equivalent is defined as the weighted sum of activities of primordial radionuclides (^{226}Ra , ^{232}Th and ^{40}K) and is shown in equation (3) ([23]. The equation is based on the theory that 259 Bq/kg of ^{232}Th , 370 Bq/kg of ^{226}Ra and 4810 Bq/kg of ^{40}K generally produce similar gamma radiation dose rates.

$$\text{Ra}_{\text{eq}} \left(\frac{\text{Bq}}{\text{kg}} \right) = C_{\text{Ra}} + 1.43C_{\text{Th}} + 0.077C_{\text{K}} \quad (3)$$

Where, Ra_{eq} is the radium equivalent activity and C is the activity concentration of each radionuclides in Bq/kg . The allowable highest value of radium equivalent activity is 370 Bq/kg [24, 21].

Annual effective dose equivalent (AEDE)

The absorbed dose rate is not sufficient to estimate the human radiological risk. As a result of radiation exposure, the conversion factor from absorbed dose in the air to effective dose for both outdoor and indoor occupancy factor should be considered to obtain the annual effective dose. For the purposes of calculation, a conversion factor of 0.7 Sv/Gy is used to convert the absorbed dose rate to human effective dose with an outdoor occupancy of 20% and 80% for indoor [21]. The expression for determining annual effective dose equivalent is;

$$H_E = D \times T \times F \quad (4)$$

Where H_E is the annual effective dose (mSv), D is the absorbed dose rate (nGy/h), T is the outdoor occupancy time (365 days x 24h x 0.2) and (365 days x 24h x 0.8) for indoor occupancy, and F is the conversion factor (0.7×10^3 mSv/ 10^9 nGy). It implies;

$$AEDE(\text{outdoor})(\mu\text{Svy}^{-1}) = D(\text{nGyh}^{-1}) \times 8760\text{h} \times 0.7\text{SvGy}^{-1} \times 0.2 \times 10^{-3} \quad (5)$$

$$AEDE(\text{outdoor})(\mu\text{Svy}^{-1}) = D(\text{nGyh}^{-1}) \times 8760\text{h} \times 0.7\text{SvGy}^{-1} \times 0.8 \times 10^{-3} \quad (6)$$

The Hazard Indices

The hazard indices which includes the external (H_{ex}) and internal (H_{in}) radiation hazard indices were a model proposed to ensure that the public exposure to radiation from primordial radionuclides does not exceed the allowable equivalent dose of 1 mSv/yr. The external hazard index has to be below unity in order to ensure that the radiation threat is insignificant; it is expressed according to [25] as;

$$H_{ex} = \frac{C_{Ra}}{370} + \frac{C_{Th}}{259} + \frac{C_K}{4810} \leq 1 \quad (7)$$

Alternatively, the internal exposure due to radon and its short-lived daughters is given by the internal hazard index (H_{in}) ([22]) and is calculated as;

$$H_{in} = \frac{C_{Ra}}{185} + \frac{C_{Th}}{259} + \frac{C_K}{4810} \quad (8)$$

Where, C represents the activity concentration in Bq/kg of each radionuclide. To neglect radiological effects on the human population, both H_{ex} and H_{in} must be below unity ([26]).

Annual Gonadal Dose Equivalent (AGDE)

According to [27] gonads are considered as organs of interest for dosimetry purposes. These are primary reproductive organs; testes in the male and the ovaries in the female. The International Commission for Radiation Protection [28] gave the number 0.2 as the Tissue Weighting Factor for Gonads. Because gonads are highly radio-sensitivity, every effort must be done to reduce gonadal dose to the general population. An elevation of the levels of AGDE is also known to affect the bone marrow that produces red blood cells. This may lead to cancer of the blood called leukaemia, which is often fatal. Other organs of interest are the thyroid, lungs, liver, colon, and bladder ([27]). The annual gonadal dose equivalent (AGDE) in $\mu\text{Sv.y}^{-1}$ is determined using (9) [29]:

$$AGDE(\mu\text{Svy}^{-1}) = 3.09C_{Ra} + 4.19C_{Th} + 0.314C_K \quad (9)$$

Where, C is activity concentration of radionuclides (Ra, Th and K).

Gamma Representative Index (RLI)

The gamma radioactivity Representative Level Index associated with naturally occurring radioactive elements and can be measured using Equation (10) [30]

$$RLI = \frac{1}{150C_{Ra}} + \frac{1}{100C_{Th}} + \frac{1}{150C_K} \quad (10)$$

Activity Utilization Index (AUI)

The natural radionuclides activity utilization index (AUI) was used to express the dose rate in the air from different combinations of the three primordial radionuclides in the studied sample. The appropriate factor to the measured specific activity of the respective nuclides was applied and the AUI was calculated from the equation 11 [21]

$$AUI = \left(\frac{C_U}{50 \text{ Bq kg}^{-1}} \right) F_U + \left(\frac{C_{Th}}{50 \text{ Bq kg}^{-1}} \right) F_{Th} + \left(\frac{C_K}{500 \text{ Bq kg}^{-1}} \right) F_K \quad (11)$$

Where; F_U , F_{Th} and F_K are 0.462, 0.604 and 0.041 respectively, which are the respective fractional contribution from the actual activities of these radionuclides to the total gamma radiation dose rate in air.

The Excess Lifetime Cancer Risk (ELCR)

The excess lifetime cancer risks (ELCR), caused by the annual effective dose due to external exposure is estimated using equation 12 [31]:

$$\text{Excess lifetime cancer risk, ELCR} = E \times \text{ALT} \times \text{RF} \quad (12)$$

Where, ALT is the average life time (70 years) and RF is risk factor. Fatal cancer risk per Sievert and for stochastic effects, ICRP uses values of 0.5×10^{-4} for the public exposure [31]. This risk represents the number of extra cancers expected in a given number of people exposed to a carcinogen at a given dose.

Results

Radioactivity concentration in soil

Activity concentrations for ^{226}Ra ranged from 19.70 to 48.40 Bq/kg (mean: 33.33 ± 2.56), ^{232}Th ranged from 25.31 to 49.94 Bq/kg (mean: 41.06 ± 2.40), and ^{40}K ranged from 36.55 to 78.07 Bq/kg (mean: 51.53 ± 2.71). The ^{226}Ra values slightly exceeded the world average (33 Bq/kg), while ^{232}Th and ^{40}K were below their respective averages (45 and 420 Bq/kg) as presented in Table 1.

Table 1: Activity concentration of ^{226}Ra (^{238}U), ^{232}Th and ^{40}K in soil

Sample ID	$^{226}\text{Ra} (^{238}\text{U})$ (Bq/kg)	^{232}Th (Bq/kg)	^{40}K (Bq/kg)
Mine soil sample 1	24.4450±2.12	49.1448±2.85	66.7185±2.02
Mine soil sample 2	23.2186±2.24	39.2064±2.68	73.0964±3.48
Mine soil sample 3	19.6987±1.62	38.1984±2.51	50.0778±2.80
Mine soil sample 4	23.1750±2.43	39.2246±2.74	77.9160±3.73
Effa point A	37.7926±3.24	31.4709±1.48	38.5692±2.80
Effa point B	38.5863±3.59	39.4527±2.17	49.6112±3.89
Effa point C	25.4925±1.16	49.94299±2.39	41.3686±3.11
Effa point D	37.8911±2.43	38.76853±1.82	38.2582±2.64
Efewu point A	39.1657±2.20	43.32953±2.05	36.5474±2.02
Efewu point B	25.8401±1.27	25.31357±2.17	38.2582±2.18
Efewu point C	48.4013±3.52	47.63968±3.40	47.7449±2.95
Efewu point D	33.3836±2.72	34.21893±2.75	51.0109±2.66
Abache point A	38.0070±2.84	49.60091±2.54	78.0715±3.27
Abache point B	36.5585±3.70	44.25314±2.51	38.5692±1.71
Abache point C	43.2445±3.72	42.98746±1.69	48.3670±2.01
Abache point D	38.3546±2.12	44.24173±2.57	50.2333±2.08
Range	48.40±3.52-19.70±1.62	49.94±2.39-25.31±2.17	78.07±3.27-36.55±2.02

Mean	33.33±2.56	41.06±2.40	51.53±2.71
WAV	33	45	420

Radiological hazard parameters

The estimated values of the radiological parameters obtained are shown in Table 2. These parameters are; Absorbed Dose rate (Dr), Radium equivalent activity (Raeq), Annual Effective Dose Equivalents (AEDE outdoor and AEDE indoor) and External (Hex) and internal (Hin) hazard indices, Annual Gonadal Dose Equivalent, Representative Gamma Index (I_γ), Activity Utilization Index (AUI) and Excess Life Time Cancer Risk (ELCR). The values ranges as; 28.82 – 53.13 nG.h⁻¹ with average value of 42.35 nG.h⁻¹, 64.98-120.20 Bq.kg⁻¹ with average value of 96.02 Bq.kg⁻¹, 0.04 – 0.07 mSvy⁻¹ with average value of 0.05, 0.14 – 0.26 mSvy⁻¹ with average value of 0.21, 0.18 -0.33 with the average value of 0.26, 0.25 – 0.46 with the average value of 0.35, 197.67 – 363.69 mSvy⁻¹ with an average value of 290.80 mSvy⁻¹, 0.45 – 0.83 with average value of 0.67, 0.55-1.03 with the average value of 0.81 and 0.62 x 10⁻³ - 1.14 x 10⁻³ with average value of 0.91x 10⁻³ respectively.

Table 2: Radiological health hazard parameters estimated

Sample ID	ADR (nGh ⁻¹)	Raq (Bqkg ⁻¹)	AEDo(m Svy ⁻¹)	AEDin (mSvy ⁻¹)	Hex	Hin	AGDE (mSvy ⁻¹)	RLI	AUI	ELCR x 10 ⁻³
MSP 1	43.7592	99.8594	0.054	0.215	0.2697	0.3358	301.9099	0.6989	0.8250	0.9392
MSP 2	37.4558	84.9122	0.046	0.184	0.2293	0.2921	258.5805	0.5956	0.6941	0.8039
MSP 3	34.2609	78.1784	0.042	0.168	0.2111	0.2644	236.2627	0.5467	0.6476	0.7353
MSP 4	37.6476	85.2657	0.046	0.185	0.2303	0.2929	260.0352	0.5987	0.6943	0.8080
EPA	38.0769	85.7658	0.047	0.187	0.2317	0.3338	260.4382	0.5924	0.7325	0.8172
EP B	43.7251	98.8237	0.054	0.214	0.2669	0.3712	299.7219	0.6848	0.8372	0.9384
EPC	43.6682	100.0964	0.054	0.214	0.2703	0.3392	300.5233	0.6970	0.8423	0.9372
EPD	42.5173	96.2760	0.052	0.209	0.2600	0.3625	291.1490	0.6658	0.8216	0.9125
EFP A	45.7896	103.9411	0.056	0.225	0.2807	0.3866	313.6153	0.7188	0.8883	0.9827
EFP B	28.8229	64.9844	0.035	0.141	0.1755	0.2454	197.6697	0.4509	0.5477	0.6186
EFP C	53.1267	120.2024	0.065	0.261	0.3247	0.4555	363.6858	0.8309	1.0266	1.1402
EFPD	38.2186	86.2445	0.047	0.187	0.2330	0.3232	262.2079	0.5988	0.7260	0.8202
AB A	50.7738	114.9478	0.062	0.249	0.3105	0.4132	349.2879	0.8014	0.9568	1.0897
ABB	45.2273	102.8103	0.055	0.222	0.2777	0.3765	310.0546	0.7120	0.8755	0.9707
ABC	47.9603	108.4408	0.059	0.235	0.2929	0.4098	328.5003	0.7504	0.9228	1.0293
ABD	46.5366	105.4882	0.057	0.228	0.2849	0.3886	319.2194	0.7316	0.8930	0.9988
Mean	42.35	96.02	0.05	0.21	0.26	0.35	290.80	0.67	0.81	0.91
Range	28.82- 53.13	64.98- 120.20	0.04- 0.07	0.14- 0.26	0.18- 0.33	0.25- 0.46	197.67- 363.69	0.45- 0.83	0.55- 1.03	0.62- 1.14
WAV	60	370	1	1	1	1	300	1	1	0.29

Table 3: Comparison of activity concentration of ²²⁶Ra and ²³²Th and ⁴⁰K in soil from the study area with data from other published work with world average value

Area/Country	²³⁸ U	²³² Th	⁴⁰ K	Reference
Benue, Nigeria	33.33	41.06	51.53	Present study
Walvisbay, Namibia	30.38	35.58	203.62	[32]
China	11.9	9.6	39.6	[33]
Delta, Nigeria	8.66	11.66	302.15	[34]

N. Pakistan, Pakistan	50.66	70.15	531.70	[35]
Makoko Lagoon, Nigeria	4.39	10.15	41.04	[36]
Villanueva-Kolombia	44.25	62.8	1596.3	[37]
Tanjun Enim- Indonesia	79.21	100.21	1443.28	[17]
WAV	33	45	420	[38]

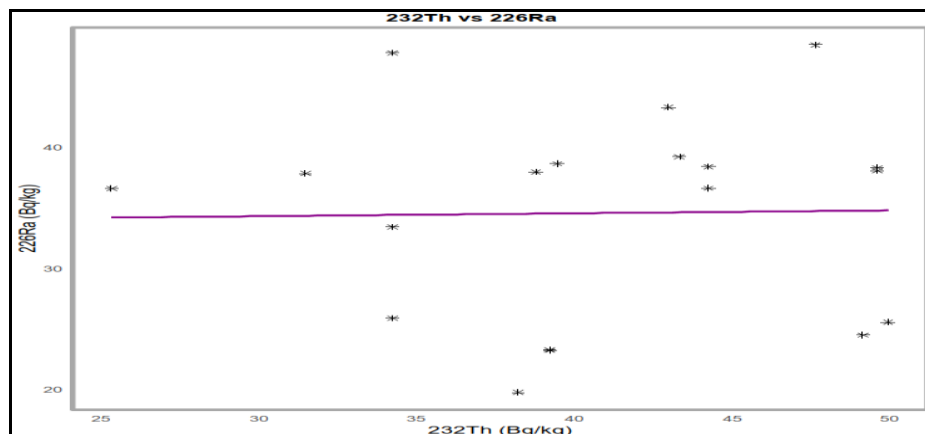


Fig. 1. The scatter plot of ^{232}Th vs $^{226}\text{Ra}(^{238}\text{U})$.

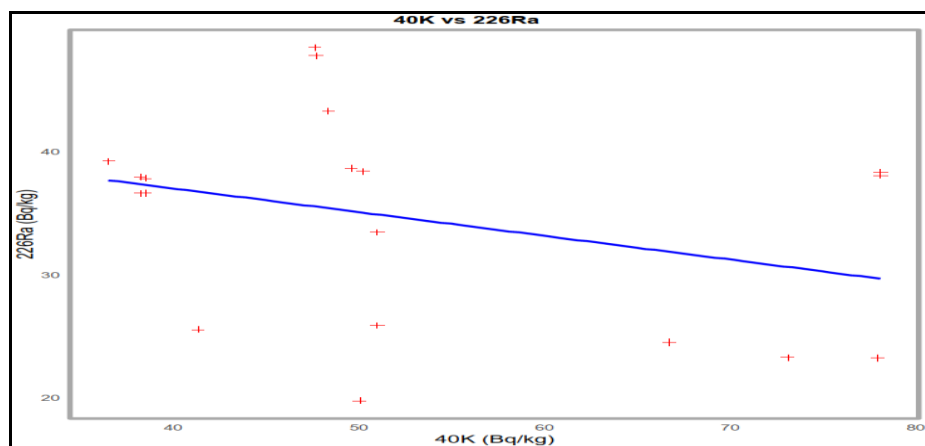


Fig. 2. The scatter plot of ^{40}K vs $^{226}\text{Ra}(^{238}\text{U})$.

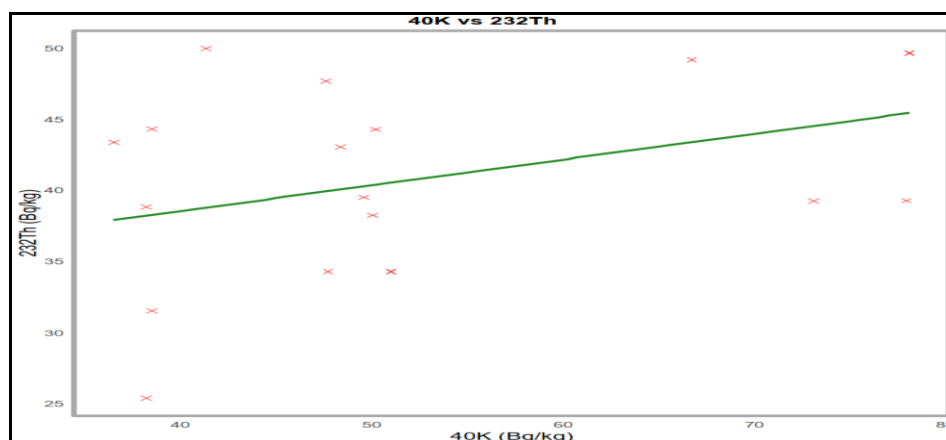


Fig. 3. The scatter plot of ^{40}K vs ^{232}Th

Table 4. The correlation and p -values for the three radionuclide pairs.

Pair	Correlation	p -value
^{40}K vs $^{226}\text{Ra}(^{238}\text{U})$	-0.3329	0.1637
^{40}K vs ^{232}Th	0.3822	0.1064
^{232}Th vs $^{226}\text{Ra}(^{238}\text{U})$	0.0197	0.9363

Discussion

The results indicated that the activity concentration of the radionuclides varied in various soil samples. The average activity concentration determined for ^{226}Ra in this present study was higher than the world average values by a factor of 1.01 which may be due to leaching from the top soil. However, the values were lower than the world average values by a factor of 0.9124 for ^{232}Th and 0.1227 for ^{40}K [38] as shown in Table 3. The trend here showed that $^{40}\text{K} > ^{232}\text{Th} > ^{226}\text{Ra}$ which is in line with the studies carried out by [36] in Nigeria, [32] in Namibia and [35] in Pakistan. The results also agreed with the notion that the average activity concentration of ^{232}Th in soil is greater than that of ^{238}U as per [21]. It has been observed that ^{40}K is the highest naturally occurring radionuclide element in nature [39]. The results compared with other works in Table 3, showed that the current average concentrations of the radionuclides were higher than the values recorded from China [33] and Nigeria [36] while there were found to be lower than values reported in Pakistan [35] in Kolombia ([37] and in Indonesia [17]. The average activity concentration of ^{226}Ra and ^{232}Th are greater than were record in Namibia and Nigeria [32, 34] whereas the value of ^{40}K was lower than the values reported for the Namibia and Nigeria. The variation in radionuclides concentrations may be due to mineralization and geological formation of the area. The sandstone is responsible for the distributions of the radionuclides due to its high permeability and low attachment ability just as coal seams which act as sink for radionuclides. Shale and mudstone concentrate radionuclides due to their low permeability, fine-grain texture and high surface area.

The radiological health hazard parameters shown in Table 2 recorded values that shows AGDE though having average value lower than the world average value of 300 mSv^{-1} had values higher than the world average value at Abache and other parts of the study area implying that the community may be exposed to radiological hazard, which might affect the functionality of their sensitive organs most especially the reproductive organs, and the bone marrows [40]. Excess Life Time Cancer Risk (ELCR) recorded higher values for all locations in study area than the world average value of 0.29×10^{-3} [41] which agrees [42]. The result implies that approximately 0.91out of 1000 (or 1 in 1,099) may develop cancer due to the exposure which would be considered as moderate to high risk. This calls

for concern as regular monitoring will be required for adequate radiation protection. The values of the other parameters evaluated as shown in Table 2 were found lower than the world average value but preventive measures should be put in place to avoid enrichment that can lead to higher and long- time cumulative effects.

In order to test the correlations between the activity concentrations of ^{232}Th versus ^{226}Ra , ^{40}K versus ^{226}Ra and ^{40}K versus ^{232}Th , the activity obtained for ^{226}Ra , ^{232}Th and ^{40}K were illustrated in Figures 1,2 and 3 respectively. None of the radionuclide pairs show statistically significant correlations (all p -values > 0.05). The strongest observed trend is between ^{40}K and ^{232}Th , with a moderate positive correlation, though it still falls short of significance as shown in Table 4. A weak positive correlation was found to exist between ^{232}Th and ^{226}Ra indicating a weak natural abundance of ^{232}Th versus ^{226}Ra over period of times through their decay process whereas a very weak negative correlation exists between ^{40}K versus ^{226}Ra which show the anomaly of potassium existence in earth crust due to human activity.

Conclusion

This study assessed the levels of natural radionuclides in soils around the Abache, Effa, Efewu and coal mine, Benue State. While most values were within permissible limits, AGDE exceeded safety thresholds at specific sites in the area and ELCR obtained was found higher than the world average value. Regular monitoring and control measures are recommended to protect public health. The results provide a valuable baseline for radiological assessments in the region and can guide future policy and environmental safety strategies.

Data availability statement

Data included in articles/supp. material/referenced in articles

Conflict of interest

There is no conflict of interest

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"FAKE NEWS" AND POLITICAL TRUST: THE NIGERIAN PREDICAMENT

BY

Abdulhafeez Taiye Oyewole¹, Tope Joseph Olorunmola², Bashir Amoda Ajijola², Temitope Seun Ibiyeye² & Zainab Bamidele-Aluko

¹Albarka 89.9 FM, BOA junction, Ganmo, Kwara State.

²Department of Mass Communication, Al-Hikmah University, Ilorin

Email: Abdulhafeezoyewole1@gmail.com | temitopeolorunmola@gmail.com | topeibiveyesage@gmail.com | zainabaluko@gmail.com

Abstract

The proliferation of fake news in Nigeria poses significant threats to political trust, a cornerstone of democratic governance. This study examines the intricate relationship between fake news and political trust within the Nigerian context, highlighting how structural issues such as weak media regulation, ethno-religious divisions, and inadequate media literacy worsen the impact of misinformation. The paper adopts a conceptual approach, drawing on media effects theories, trust and mistrust frameworks, and analyses of Nigeria's unique socio-political setting. This research understands that fake news undermines institutional credibility, amplifies societal polarisation, and perpetuates perceptions of governance failure. The study also identifies the role of social media as a catalyst for the rapid dissemination of fake news, complicating efforts to restore public confidence in political institutions. To address these challenges, the paper advocates for comprehensive strategies, including robust media regulation, digital literacy initiatives, and collaboration between policymakers, civil society, and technology platforms. This research contributes to the growing discourse on media influence, trust erosion, and democratic sustainability in Nigeria.

Keywords: Fake news, political trust, Political awareness, Political education

Introduction

In recent years, the proliferation of fake news has emerged as a critical global issue, posing substantial threats to political stability, social cohesion, and democratic governance. Fake news—characterised by intentionally fabricated information aimed at misleading or manipulating its audience—has been amplified by the rapid expansion of digital technologies and the pervasive influence of social media platforms (Friggeri et al., 2020). In Nigeria, the issue has become particularly pronounced, exacerbated by the country's complex socio-political landscape, which includes ethnic diversity, religious pluralism, and highly polarised political environments (Adeniran & Akinyemi, 2022). Political trust, defined as citizens' confidence in the capacity, fairness, and integrity of their government, remains a fundamental pillar of democratic governance (Norris, 2021). However, the widespread dissemination of fake news in Nigeria has contributed to the erosion of an already fragile political trust, deepening societal divisions and undermining the legitimacy of democratic institutions (Oluwole et al., 2023). This paper examines the relationship between fake news and political trust within the Nigerian context, highlighting how the former compromises the latter and the distinct socio-political challenges Nigeria faces in addressing this issue. Nigeria's susceptibility to fake news is heightened by several structural and systemic factors, including weak media regulation, political partisanship, and the widespread lack of media literacy among its citizens (Adeyanju, 2021). The objectives of this paper are threefold:

- 1.) To conceptualise the relationship between fake news and political trust,
- 2.) To explore the socio-political dynamics driving the prevalence of fake news in Nigeria; and
- 3.) To propose conceptual strategies for counteracting this phenomenon in order to restore political trust.

A conceptual approach is employed, drawing on existing literature, theoretical frameworks, and critical analysis. By situating the discussion within broader theoretical perspectives on media effects and trust erosion, this paper aims to contribute to a deeper understanding of a pressing issue in contemporary Nigerian politics.

Theoretical Framework

A robust theoretical framework provides a foundation for understanding the relationship between fake news and political trust. This section draws on key theories to elucidate the mechanisms through which fake news influences political trust, particularly in the Nigerian context.

Media Effects Theories

Media effects theories, particularly agenda-setting and framing, offer valuable insights into the role of media in shaping public perceptions and trust.

1. Agenda-Setting Theory

Introduced by McCombs and Shaw (1972), agenda-setting theory posits that the media does not tell people what to think but rather what to think about. In the context of fake news, the prominence of fabricated stories in digital and traditional media can influence the public's focus on specific issues, even when those issues are misrepresented. For example, during Nigeria's electoral cycles, fake news narratives often emphasise alleged electoral fraud or candidate misconduct, diverting attention from substantive policy discussions (Ojebuyi & Salawu, 2020). This distortion can erode trust in political institutions, as citizens may perceive widespread dishonesty and inefficiency.

2. Framing Theory

Framing theory, developed by Entman (1993), examines how information is presented to influence audience interpretation. Fake news leverages framing by constructing narratives that align with existing biases or stereotypes. In Nigeria, fake news often exploits ethno-religious tensions by framing events in ways that fuel division. For instance, false reports of religiously motivated violence can escalate mistrust among communities, further diminishing confidence in the government's ability to ensure peace and justice (Idris, 2022).

3. Trust and Mistrust Theory

Trust and mistrust theory focuses on the conditions under which individuals place confidence in institutions or withdraw it due to perceived failures. Hardin (2002) explains that trust is built on the expectation of competence, fairness, and alignment of interests. Conversely, repeated exposure to fake news that highlights government failures, whether factual or not, fosters cynicism and erodes trust.

In Nigeria, this erosion is compounded by the country's history of governance challenges, including corruption and poor service delivery. Fake news amplifies these existing grievances, creating a feedback loop where citizens' mistrust makes them more susceptible to believing negative narratives about political actors and institutions (Owolabi & Olabode, 2021).

The Role of Technology and Media Ecology in Spreading Fake News

The proliferation of digital media has transformed the information landscape, creating a media ecology where fake news thrives. McLuhan's (1964) concept of the "global village" highlights how digital platforms connect diverse populations, but it also underscores their potential to disseminate misinformation rapidly. Social media algorithms, which prioritise engagement over accuracy, amplify sensational or polarising content, making fake news more visible and impactful. In Nigeria, platforms such as WhatsApp are particularly influential, as they allow for the rapid, unregulated dissemination of information within close-knit groups (Okoro & Adibe, 2020). This technological environment not only facilitates the spread of fake news but also hinders the public's ability to distinguish between credible and non-credible sources, further undermining political trust.

The theoretical insights provided by media effects theories, trust and mistrust theory, and the concept of media ecology establish a comprehensive framework for analysing how fake news affects political trust in Nigeria. These theories also underscore the urgent need for interventions targeting the structural and systemic factors enabling the proliferation of fake news.

Fake News in Nigeria: A Conceptual and Historical Context

Fake news is not a novel concept in Nigeria. While the term itself has only gained prominence in recent years, misinformation and propaganda have long been tools of manipulation in the Nigerian political landscape. Historically, during Nigeria's colonial and early post-independence years, the state-controlled media served as a primary instrument for promoting political ideologies and suppressing dissent. During the military regimes, especially between the 1970s and 1990s, the government heavily controlled media narratives, and disinformation was used to maintain authority and discredit opposition movements. These media practices, though more overt, laid the groundwork for the manipulation of public opinion through false information (Aderinoye, 2020). However, the dynamics surrounding fake news began to shift dramatically with the advent of digital media and the internet. In the 2000s, the rise of the internet and mobile phones opened up new avenues for information dissemination, allowing a wider range of voices to be heard but also creating opportunities for the spread of misinformation. Social media platforms, which became widely used in Nigeria in the 2010s, have amplified the scale and speed of fake news, as they provide an easy means to share content without significant editorial oversight (Nwabueze & Akinmoladun, 2021).

The 2015 and 2019 Nigerian general elections marked pivotal moments in the escalation of fake news, with both periods witnessing the extensive use of social media platforms to circulate fabricated stories that had political motivations. For instance, the 2015 elections saw fake news stories accusing presidential candidates of illicit activities, which were rapidly shared and amplified across social media, creating an atmosphere of distrust (Okoro & Adibe, 2020). Similarly, in the 2019 elections, false reports about political violence, electoral rigging, and accusations of political corruption were disseminated widely on platforms like WhatsApp and Facebook, exacerbating the lack of trust in the electoral process and government institutions (Ojebuyi & Salawu, 2020). More recently, the COVID-19 pandemic revealed another dimension of the fake news problem. False claims about the virus's origin, treatment methods, and government responses spread rapidly, undermining public health efforts and creating confusion among the public. During this period, misinformation was not limited to political matters but also affected public safety, demonstrating the far-reaching impact of fake news on Nigerian society (Owolabi & Olabode, 2021).

In summary, while the concept of fake news in Nigeria may have evolved with digital technology, its roots trace back to the colonial and military eras, where media manipulation was a common tool of statecraft. The digital age, however, has provided an environment where fake news can spread unchecked, having profound implications for political trust and public order.

Socio-Political Catalysts of Fake News in Nigeria

1. Ethno-Religious Diversity: Nigeria's ethnic and religious pluralism, while a strength in its cultural richness, has also created fault lines that fake news often exploits. Politically motivated actors frequently generate or amplify fake news to deepen existing divisions, rallying support from their in-group while vilifying opponents. For instance, false narratives during electoral campaigns often target specific ethnic groups, portraying them as threats to national unity or prosperity (Ojebuyi & Salawu, 2020).

2. Political Partisanship and Propaganda: The competitive and often adversarial nature of Nigerian politics incentivises the use of fake news as a propaganda tool. Political actors and their allies utilise fake news to discredit opponents, manipulate voter perceptions, and sway electoral outcomes. This was evident in the 2019 general

elections, where fabricated stories about candidates' personal lives and alleged scandals were widely circulated (Idris & Olaniyan, 2020).

3. Weak Media Regulation: Nigeria's regulatory framework for media is inadequate to address the challenges posed by fake news. The National Broadcasting Commission (NBC) focuses primarily on traditional media, leaving digital platforms largely unregulated. This regulatory gap allows for the unchecked proliferation of fake news, particularly on social media. Efforts to introduce stricter controls, such as the controversial "Social Media Bill," have faced backlash for potentially infringing on freedom of speech (Okoro & Adibe, 2020).

4. Lack of Media Literacy: Low levels of media literacy among the Nigerian populace exacerbate the spread of fake news. Many citizens lack the critical thinking skills or tools to verify the authenticity of information before sharing it. This is especially concerning in rural areas where reliance on forwarded messages via WhatsApp or SMS is common, making misinformation pervasive (Idris, 2022).

Implications of Fake News on Political Trust

The pervasive influence of fake news poses significant threats to political trust, particularly in fragile democracies like Nigeria. By distorting perceptions of political actors, institutions, and processes, fake news exacerbates mistrust and deepens societal divisions. This section examines the mechanisms through which fake news undermines political trust and the broader democratic consequences within the Nigerian context.

Mechanisms of Distrust

1. Erosion of Institutional Credibility: Repeated exposure to fake news erodes public confidence in key political institutions, including the judiciary, electoral commissions, and legislative bodies. For instance, during the 2019 Nigerian general elections, fake news narratives accusing the Independent National Electoral Commission (INEC) of bias in favour of certain political parties gained traction on social media. These allegations, though unfounded, contributed to widespread scepticism about the legitimacy of election results (Idris & Olaniyan, 2020).

2. Amplification of Polarisation: Fake news often exploits existing ethnic, religious, and political divides, creating an "us versus them" dynamic that exacerbates mistrust between groups. In Nigeria, fabricated stories portraying one ethnic or religious group as aggressors and another as victims are frequently disseminated, particularly during politically charged periods. For example, during the #EndSARS protests of 2020, false reports about protesters' motives and government responses heightened tensions and mistrust on all sides (Iwuoha, 2021).

3. Perception of Governance Failure: By amplifying narratives of corruption, inefficiency, and incompetence, fake news shapes public perceptions of governance. Even when such narratives are untrue, their prevalence undermines trust in leaders and institutions. For instance, a widely circulated fake news story in 2022 alleged that billions of naira allocated for COVID-19 relief were embezzled, leading many citizens to distrust government-led pandemic responses (Okoro & Adibe, 2022).

Democratic Consequences

1. Decline in Voter Participation: When fake news fosters distrust in electoral integrity, it discourages citizens from participating in democratic processes. Voter apathy becomes a significant issue, as individuals perceive their votes to be inconsequential in a corrupt system. Reports of alleged rigging and vote-buying, whether true or fabricated, have contributed to declining voter turnout in Nigeria's recent elections (Owolabi & Olabode, 2021).

2. Weakening of Governance Legitimacy: Governance legitimacy depends on public trust in the authorities' ability to govern fairly and effectively. Fake news undermines this trust by creating a pervasive sense of betrayal and

incompetence. In Nigeria, instances where fake news portrays government actions as deliberately harmful or oppressive fuel mass discontent, reducing citizens' willingness to cooperate with public policies (Idris, 2022).

3. Social Unrest and Instability: Beyond political trust, the destabilising effects of fake news manifest in physical conflicts and social unrest. For example, in 2018, false reports about ethnic clashes in Plateau State led to retaliatory attacks, resulting in fatalities and the destruction of property. These incidents highlight the dangerous potential of fake news to escalate tensions and disrupt societal harmony (Iwuoha, 2021).

Addressing the Nigerian Predicament

Addressing the complex issue of fake news and its detrimental effect on political trust in Nigeria requires multi-faceted strategies. These strategies need to engage with both the structural factors that facilitate the spread of misinformation and the behavioural patterns that make citizens susceptible to believing and sharing false information. This section explores various approaches to tackling the fake news phenomenon in Nigeria, focusing on media regulation, public awareness, digital literacy, and the role of technology in mitigating misinformation.

Media Regulation and Policy Intervention

One of the central challenges in addressing fake news in Nigeria is the country's weak media regulatory environment. While traditional media in Nigeria is regulated by bodies like the National Broadcasting Commission (NBC), the rapid growth of digital platforms has outpaced these regulatory mechanisms. This regulatory gap enables the unchecked spread of fake news, particularly on social media platforms such as WhatsApp, Facebook, and Twitter, which are largely unmonitored. Efforts to address this issue have seen mixed results. For example, the Nigerian government's introduction of the "Social Media Bill" and the "Hate Speech Bill" aimed to curb the spread of fake news and hate speech online. However, these proposals have faced significant backlash from civil society groups and critics who argue that such measures could infringe on freedom of speech and be used as tools of political repression (Idris, 2022). A more balanced approach is needed—one that involves collaboration between the government, media organisations, and civil society to establish clear guidelines and policies for online content regulation without overstepping democratic freedoms. The role of fact-checking organisations, such as Africa Check and The Cable, is also critical in holding both traditional and digital media accountable by exposing fake news and disinformation.

Public Awareness and Education

Given that many Nigerians consume news via social media without verifying its credibility, raising public awareness is key to combating the spread of fake news. Media literacy programs can equip the public with the skills needed to critically assess information sources and identify false or misleading content. In this context, educational initiatives that focus on digital literacy are crucial. These initiatives should aim not only at schoolchildren but also at adults, particularly in rural areas where access to formal education and media literacy is limited. For instance, the National Orientation Agency (NOA) has undertaken campaigns to educate the public on the dangers of misinformation, but more can be done to create a broader and more sustained media literacy curriculum across the country (Owolabi & Olabode, 2021). Media literacy programs should teach people how to cross-check news, understand the significance of credible sources, and evaluate the intentions behind information that circulates on social media platforms. Moreover, engaging community leaders, religious figures, and local influencers in educating the masses can enhance the effectiveness of these campaigns. Their influence can be pivotal in promoting fact-based information, reducing the impact of fake news, and fostering a culture of truthfulness and accountability.

Role of Technology and Social Media Platforms in Addressing Fake News Crisis

Technology plays a dual role in both facilitating and addressing the fake news crisis. On one hand, platforms like WhatsApp, Twitter, and Facebook have been instrumental in spreading fake news in Nigeria, due to their wide accessibility and low barriers to entry for content dissemination. On the other hand, technological tools can also be used to curb the spread of misinformation.

Algorithmic Solutions and Content Moderation: Social media platforms themselves must take responsibility for curbing the spread of fake news. Algorithmic modifications can be implemented to flag or downrank content that is false or misleading, while content moderation teams can work more proactively to remove such content in real time. International tech companies like Facebook and Twitter have increasingly faced pressure to improve their content moderation practices, especially in light of fake news' impact on elections and political processes. In Nigeria, such interventions could significantly reduce the spread of harmful content, provided they are implemented in collaboration with local fact-checking bodies and are sensitive to local contexts and nuances (Okoro & Adibe, 2020).

Fact-Checking Initiatives: Platforms like Twitter have taken steps to add fact-checking labels to tweets that contain potentially misleading or disputed information. However, more localised and robust efforts are needed. Nigerian organisations like FactCheck.ng and Africa Check are leading the charge in independently verifying information and providing the public with accurate, evidence-based news. These platforms should be supported through public-private partnerships, increasing their accessibility and expanding their reach. Furthermore, encouraging social media users to report fake news or misleading posts could help create a self-regulating environment. This would involve users taking responsibility for the content they share and contributing to a more informed society.

Strengthening Trust in Political Institutions: Finally, addressing the Nigerian dilemma requires building trust in political institutions, which fake news has significantly undermined. Strengthening the transparency and accountability of government actions can reduce the fertile ground on which fake news thrives. For example, establishing independent watchdogs to oversee government activities, enhancing the quality of electoral processes, and improving the responsiveness of political leaders can help rebuild public trust. In addition, citizens must see tangible improvements in governance—such as better infrastructure, education, healthcare, and job creation—in order to regain confidence in political institutions. When people perceive their government as effective and responsive, they are less likely to fall for or spread fake news.

Multi-Stakeholder Approach: Ultimately, addressing the problem of fake news and its impact on political trust in Nigeria requires a multi-stakeholder approach. Government bodies, media organisations, fact-checking agencies, social media platforms, and civil society groups must work together to create a robust framework for combating misinformation. The aim should be not only to curb the spread of false information but also to restore the public's faith in political institutions and processes. By combining effective regulation, media literacy, technological solutions, and institutional reforms, Nigeria can move towards a more informed and politically stable future, where citizens can engage with information critically and trust their political system to deliver on its promises.

Conclusion

Fake news in Nigeria has become a formidable obstacle to democratic engagement, public trust, and governance. The historical trajectory of media manipulation, combined with contemporary digital media challenges, has created an environment where misinformation thrives. From electoral misinformation to health-related hoaxes, the effects of fake news are far-reaching, impacting everything from political participation to social cohesion. The inability of both the government and media systems to effectively regulate or counter misinformation exacerbates this crisis, leaving the public vulnerable to manipulated narratives.

As fake news continues to undermine political trust, the consequences for Nigerian democracy are severe. When citizens lose faith in the accuracy of the information they receive, they become disengaged, disillusioned, and less likely to actively participate in the political process. The erosion of trust in political institutions, electoral processes, and governance structures threatens the very foundations of democratic life in Nigeria.

Recommendations

Strengthening Media Literacy Programmes: To combat the spread of fake news, it is crucial to enhance media literacy among Nigerians, particularly in rural areas. Educational initiatives should equip citizens with the skills to critically assess information, distinguish between credible and unreliable sources, and understand the role of media in shaping public opinion. Schools, universities, and community centres should be central to these campaigns, alongside media outreach by organisations like the National Orientation Agency (NOA). Furthermore, training journalists and content creators to prioritise ethical reporting and fact-checking is essential in fostering a more responsible media ecosystem.

Government and Institutional Collaboration for Effective Regulation: The Nigerian government must collaborate with key stakeholders, including media organisations, civil society groups, and tech companies, to create clear and fair regulations governing digital platforms. Policies should ensure that platforms like Facebook, Twitter, and WhatsApp are held accountable for the content shared on their networks, while respecting freedom of expression. Regulatory bodies such as the National Broadcasting Commission (NBC) could extend their mandate to include the monitoring of online platforms and coordinate with fact-checking organisations to identify and combat the spread of fake news.

Enhanced Role of Fact-Checking Organisations: Fact-checking organisations such as Africa Check and FactCheck.ng should be supported through both public and private partnerships to improve the credibility and accessibility of their services. These organisations play a critical role in verifying claims, debunking myths, and providing the public with reliable information. Furthermore, the government should create frameworks to ensure that these fact-checking platforms are integrated into public health, political, and electoral communications, especially during critical times like elections or crises.

Social Media Platform Accountability: Social media companies need to take greater responsibility in curbing the spread of misinformation. In addition to improving content moderation policies and using AI tools to identify fake news, social media platforms must work with local fact-checking agencies to promote accurate information. Public awareness campaigns on these platforms can also alert users to the risks of sharing unverified content, encouraging them to be more discerning about the information they post or forward.

Promoting Transparency and Accountability in Governance: Restoring political trust requires greater transparency and accountability from Nigerian political institutions. Strengthening the independence of the Independent National Electoral Commission (INEC), ensuring free and fair elections, and implementing measures to hold politicians accountable for their actions will help restore confidence in the political system. When citizens see that their leaders are committed to integrity and fairness, they are less likely to believe and spread false information that undermines trust in governance.

Encouraging Civic Engagement and Public Discourse: Public participation and discourse must be promoted through community-driven initiatives. Citizens should be encouraged to engage in informed discussions about political issues, using reliable sources of information. This can be facilitated through town hall meetings, debates, and discussions on both traditional and digital platforms, where the emphasis is placed on evidence-based arguments. When people are actively involved in democratic processes and have access to truthful information, the appeal of fake news is diminished.

By adopting these recommendations, Nigeria can begin to address the fake news dilemma and work towards rebuilding trust in its political system. While challenges remain, the coordinated efforts of government bodies, media, technology companies, and civil society can foster a more informed and politically engaged populace. In doing so, Nigeria can safeguard its democracy and strengthen the foundation for a more stable and prosperous future.

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PHYSIOLOGICAL RESPONSE AND SERUM BIOCHEMICAL METABOLITES OF WEST AFRICAN DWARF GOATS GIVEN DIETARY HERBAL SUPPLEMENTS UNDER TROPICAL CLIMATE

BY

Olayinka Abosede. Ojo¹, James Ola Daramola², Dupe Olufunke Ogunbosoye¹, Isaac Ade Afe³, Felicia Moturayo Olooto⁴ & Bolakale A. Jimoh¹

¹Department of Animal Production, Kwara State University, Malete, Nigeria

²Department of Animal Production, Federal University of Agriculture, Abeokuta, Nigeria

³Department of Crop Production, Kwara State University, Malete, Nigeria

⁴Department of Agricultural Economics and Extension, Kwara State University, Malete, Nigeria

Email: ykmelodya1@yahoo.com

Abstract

The study was conducted to investigate the physiological responses and serum biochemical metabolites of West African Dwarf (WAD) goats fed *Solanum lycopersicum* (SL) fruit and *Cissus polpunea* (CP) stem powders as dietary herbal supplements. 20 WAD female goats with an average age of 10 ± 1 months and an initial average weight of 7.42kg were used for this experiment. Four experimental diets were formulated and designated as Treatment 1 (T1)- No experimental additive (Control), Treatment 2 (T2)- 10g of CP /300g + basal diet, Treatment 3 (T) -10g of SL /300 g of control diet and Treatment 4 (T4)- 5g of CP and 5g of SL /300 g of diet control). Heat stress significantly elevated the average rectal temperature, while herbal supplementation linearly reduced the heart rate and rectal temperature. ALP and AST were significantly ($p < 0.05$) elevated by heat stress, as revealed before herbal administration. However, TP and CP supplementation decreased both values linearly across all treatments. Combined addition of SL and CP in T4 significantly ($p < 0.05$) elevated the Urea level, while values across other treatments existed within the normal range. Dietary supplementation of SL and CP reduced the evaluated physiological indicators and serum metabolites. Further study should be conducted to test other levels of inclusion.

Keywords: Goat, herbs, tomatoes, heat stress, serum, physiological response

Introduction

Goats have been rated as one of the earliest domesticated animals retaining a close association with humans for several decades (Monteiro *et al.*, 2018). This is due to their adaptability to varying environments and climatic conditions, resulting in their re-distribution all over the world (Mahmoud, 2010). Goats are among the most beneficial animals in the world, supplying meat, milk, fiber, organic fertilizer, and draft power (Arafath *et al.*, 2024). The relatively portable size of goats has made their management possible on a small scale. Goats are capable of existing and breeding under various unfavorable conditions, making them an ideal species for resource-poor farmers. Goats' meat is an excellent source of protein; their meat and milk pose little or no religious taboos among the multi-populated humans (Gawat *et al.*, 2023). It is low in fat and cholesterol and high in vitamins and minerals. Goat milk is rich, widely relished, and seemingly easier to digest, with profound nutritional qualities. Generally, in developing countries, the contribution of goats cannot be overemphasized and plays an important role in boosting poor households' economy (Khowa *et al.*, 2023).

Unfortunately, goats are often exposed to a range of stressors, including nutritional, physical, mental, chemical, and thermal stress. Thermal stress is one of the most outstanding challenges experienced within the tropical, subtropical, and semi-arid regions, notably due to the changing climate (Govindasamy et al., 2022). The tropical environment has been marked for elevated temperature and humidity, which synergistically align with the high metabolic heat generated in livestock, causing heat stress (Oke et al., 2021). Heat stress is an undeniable discomfort that occurs when an animal is exposed to an extremely hot environment. Stress is a harmful impression initiated by several factors influencing the health and performance of animals. It can also be attributed to the degree of superfluous influences that displace an animal's normal condition (Silanikove et al., 2013). Heat stress resulted in increased serum osmolality and lower white blood cells in animals. It also causes reduced feed intake, weight gain, and high feed conversion ratio, which negatively impacts serum biochemical markers and innate immune balance in livestock (Ahmad et al., 2023). The exponentially increased reactive oxygen species (ROS) emanate in response to thermal stress, making affected animals liable to cellular apoptosis. According to Martemucci et al. (2022), herbal feed supplements have recently been regarded as an adequate solution to the problem of inadequate nutrition, health disequilibrium, and a mitigator of stress effects through their innate potential of improving the ROS-scavenging activities of antioxidant enzymes in affected animals. This is possible due to the presence of certain bioactive compounds such as flavonoids, anthraquinone, and carotenoid (lycopene) present in *Cissus polpunea* (CP) and *Solanum lycopersicum* powder (SL), respectively.

Flavonoids have been observed to improve the nutritional intake and physiological resilience in livestock (Zahra et al., 2024). Joseph and Ayo (2024) recorded the modulatory effect of lycopene sourced from SL on Red Sokoto goats exposed to cold-dry induced stress, resulting in an increased rectal temperature value. Aletan et al. (2024) observed a non-significant difference in the serum biochemical indices of Wistar albino rats dosed with aqueous stem extract of CP at varying concentrations. In tandem with this finding, Ojekale et al. (2006) observed that CP did not negatively disrupt the normal concentration and activities of the serum metabolites (serum AST, ALT, alkaline phosphatase, creatinine, bilirubin, and triglycerides) in normal rabbits after administration in comparison with those of the control group. Aholou et al. (2017), contrarily, recorded an increased biochemical index in rabbits when a comparison was made between the effect of *Cissus populnea* and *Synedrella nodiflora* at a 10% dietary inclusion level. According to Mizael et al. (2020), the inclusion of tomato powder into the goat's diet modified the metabolic representation of goat meat, seminal plasma, and physiology, with a positive difference in amino acids, nucleotides, and their biochemical outcomes like creatinine, glutathione, and nicotinic acid. To achieve better production performance, there is a need to source additional feed supplements, mainly ethnobotanical, which are cheap, readily available, and contain bioactive elements with highly beneficial effects to improve the overall performance of animals exposed to unfavorable climatic conditions. There is a dearth of information on the combined effect of CP and SL on the physiological response and serum biochemical indices of WAD goats reared under tropical conditions.

Materials and Methods

Experimental area and study duration

The study was carried out at the small ruminant unit of the Teaching and Research Farm, Kwara State University, Malete, Kwara State, with a Latitude of 8.70°N and a Longitude of 4.46667°E, with an average daily relative humidity of 79% and a temperature of 30 °C.

Preparation of feed Supplements (CP and SL)

The fresh *Solanum lycopersicum* fruits were purchased from the Mandate market, Ilorin. After which, the fruits were washed under running water to remove the debris and dirt. The fruits were chopped into smaller pieces. *Cissus polpunea* (CP) was likewise obtained from the Ilara-Mokin area in Ondo state. The adhering dirt was washed off thoroughly under running water. The two freshly cut herbal materials were dried using different compartments of a parabolic-shaped Solar dryer at Nigerian Stored Products Research Institute (NSPRI) headquarters, situated along Asa Dam, Ilorin metropolis, for 8 days to reduce the moisture content. Their powders were ground into a fine texture, sieved to remove lumps, and to achieve texture uniformity. The fine powders of CL and SL were packed into separate airtight containers for subsequent use.

Experimental Housing and Biosecurity Measures

Indoor pens with short walls were partitioned into standard sizes to house each female. Fumigation was done using Morigad, Lysol, and Jik combined with ten liters of water at a ratio of 2:1:2. The pen area was allowed to dry for two weeks before housing the goats.

Sourcing of Experimental Animals and Management

20 grower female West African Dwarf (WAD) females with an average age of 6.9 ± 1.1 months were sourced from Share, Kambi, and Ajase Markets within Kwara State with an initial average weight of 7.42kg. The experimental animals were quarantined for 60 days during which they were injected with oxytetracycline (LA 20%), V-Multivor (Multi-vitamin), Lvainor (Ivermectin injection), and dewormed using intramuscularly injected Albendazole. Vaccination was achieved using pestes de petit vaccine intramuscularly after 30 days after the commencement of quarantine. Other medications administered included sulfadimidine and antibiotics. After the 60-day quarantine, experimental diet administration commenced.

Table 1: Locally sourced ingredients used in experimental feed composition

Ingredients	Quantity
Cassava peel	40kg
Wheat offal	20kg
Rice bran	10kg
PKC	18.5kg
GNC	5kg
Bone meal	3kg
Oyster shell	2kg
Salt	1kg
Premix	0.1kg
Total	100kg

Experimental Design

Twenty female West African Dwarf Goats were randomly allocated into four treatment groups, with five replicates each:

Treatment 1- Feed containing experimental additive (Control)
Treatment 2- Feed containing 10g of CP / 300 g of control diet
Treatment 3 -Feed containing 10g of SL / 300 g of control diet
Treatment 4- Feed containing 5g of CP and 5g of SL / 300 g of diet control

Data Collection

Initial body weight (g): This was first observed on the first day of purchase by placing the goats on an electronic digital scale with the brand name Camry Ek4150 (China).

Meteorological Data

Environmental Temperature

Ambient temperature ($^{\circ}\text{C}$) was recorded daily inside the brooding pen using an HTC-1 digital electronic alarm clock hygrometer, which was manufactured by Jianda and was made in China. (El-Desoky *et al.*, 2021).

Relative Humidity

The daily relative humidity (RH% %) was recorded daily using an HTC-1 digital electronic alarm clock hygrometer, which was manufactured by Jianda and was made in China (El-Desoky *et al.*, 2021).

Temperature Humidity Index

The Temperature-Humidity Index (THI) is a measure of the combined effect of temperature and humidity on animal comfort calculated using the following formula:

$$\text{THI} = 0.8 \times (\text{Temperature}) \times (\text{Humidity} / 100) \times (\text{Temperature} - 14.4) + 46.4$$

Where:

- Temperature is degrees Celsius($^{\circ}\text{C}$)
- Humidity is in percentage (%)

The values for temperature and humidity were plugged into this formula to calculate the THI. The resulting THI value can help assess the comfort level or stress caused by the temperature and humidity conditions.

Physiological Data

Rectal Temperature

Rectal temperature of each animal was individually measured daily in the morning using a D-Notec digital thermometer that was manufactured by Haiden Technology (India). It was gently introduced into the rectum, and a peeping sound signaled attainment of the highest rectal temperature for the animal under evaluation, which was then recorded appropriately.

Heart Rate

The heart rate was measured by counting the number of beats per minute using a dual-head stethoscope (Greater Goods, Japan), placed on the left side of the heart.

Respiration Rate

The respiration rate was measured by counting the number of flank movements during the complete inhalation–exhalation cycle (breath) per minute (Dißmann et al., 2022).

Blood collection

Blood collection was done twice within the period of the experiment; the initial collection was done after quarantine and before commencement of herbal supplementation, while the second blood collection was done at the termination of the experiment. At each collection, 5 mls blood samples were withdrawn from the jugular vein of each animal into plain sample bottles in the early hours of the morning before sunrise and taken to reputable research laboratories for biochemical analyses biochemical analysis. The serum metabolites evaluated include total protein, albumin, globulin, high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglycerides (TRIG), total cholesterol, creatinine, alkaline phosphatase (ALP), alanine aminotransferase (AST), alkaline transaminase (ALT), glucose, and urea.

Data Analysis

Data collected were subjected to statistical analysis using a statistical software program (SPSS) for Windows, version 16.0, SPSS Inc., Chicago, IL. Duncan's *post hoc* test determined the level of significance between the groups. A linearity test was done, and means were separated using the Duncan Multiple Range Test (DMRT). The data were presented as the mean $\pm$ standard error of mean (SEM) with level of significance tested at $P < 0.05$.

Results and Discussion

Table 2 shows the physiological response of female WAD goats before and after administration of dietary herbal supplements. The average heart rate, respiratory rate, and rectal temperature were assessed after a 60-day acclimatization period to the experimental area and continuously till the end of herbal administration (70-day herbal administration). It was discerned that the average heart rate and respiratory rate were increased before the administration began. However, an insignificant decline in the values was observed at the end of the herbal administration of SL fruit and CP stem powders. In contrast to the above, the rectal temperature was noted to be significantly ($p < 0.05$) affected by the tropical thermal assault as reflected by elevated values in the goats across treatments 1-3 designated with values 39.11 ± 0.14 , 39.21 ± 0.14 , and 39.22 ± 0.10 , respectively. A significant decrease was observed in T4 goats (38.42 ± 0.99).

Table 2: Physiological response of female WAD goats before and after administration of dietary herbal supplements

Parameters	T1	T2	T3	T4	P value
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Av heart rate (Before herbal Administration)	57.31±1.50	56.82±1.64	59.44±2.27	58.13 ±1.69	0.75
Av heart rate (After herbal Administration)	45.33 ±6.57	54.00 ±3.06	57.33 ±0.67	57.50 ±0.3	0.14
Av resp rate (Before herbal Administration)	21.49±0.60	21.04±0.46	21.04±0.53	21.22±0.25	0.90
Av. resp rate (After herbal Administration)	19.67 ±0.88	19.33 ±0.67	16.33 ±1.67	17.50 ±0.96	0.19
Av rect temp (Before herbal Administration)	39.11±0.14 ^a	39.21±0.14 ^a	39.22±0.10 ^a	38.42±0.99 ^b	0.00
Av rect temp (Before herbal Administration)	37.17 ± 2.2	39.10 ±0.53	39.50 ±0.30	39.40 ± 0.32	0.43

Table 3 expresses the serum biochemical indices of experimental goats before administration of herbal supplements. The parameters evaluated include total protein, albumin, high-density, low-density lipoprotein, triglycerides, total cholesterol, creatinine, alanine aminotransferase (ALT), alkaline phosphatase (ALP), alkaline amino transferase (AST), glucose, and Urea. It was discerned that the liver enzymes were significantly ($p<0.05$) affected by the tropical climatic conditions of the experimental animals. The ALP values were significantly increased. in T4 goats (57.95 ± 0.59) with an opposing significantly ($p<0.05$) depressed values under T1, T2 and T3 (49.69 ± 0.76 , 52.83 ± 1.19 and 56.65 ± 0.39) respectively. The values of AST showed a significant elevation under T1 (28.64 ± 2.7) and T2 (32.32 ± 3.05), while a significant decrease was noted in T3 (15.96 ± 2.73) and T4 (19.45 ± 6.39), respectively.

Table 3: Serum Biochemical indices of experimental goats prior to administration of dietary supplementations

Parameters	T1	T2	T3	T4	P value
Total Protein (g/dl)	5.63±0.63	5.43±0.48	5.36±0.56	4.42±0.27	0.13
Albumin (mmol/l)	3.48±0.24	3.88±0.47	3.82±0.28	3.78±0.4	0.48
Globulin (mmol/l)	2.15±0.21	1.55±0.11	1.54±0.1	0.64±0.03	0.34

HDL (mmol/l)	1.03±0.75	1.13±0.07	1.24±0.05	1.02±0.38	0.07
LDL (mmol/l)	1.36±0.19	1.54±0.28	1.88±0.29	1.11±0.19	0.05
TRIG (mmol/l)	1.19±0.32	1.48±0.28	1.40±0.16	1.19±0.16	0.4
Total Cholesterol (mmol/l)	2.63±0.29	2.96±0.36	3.40±0.28	2.37±0.24	0.12
Creatinine (Umol/l)	35.50±4.13	53.58±8.48	48.80±1.31	32.99±10.79	0.19
ALP(U/L)	49.69±0.76 ^c	52.83±1.19 ^b	56.65±0.39 ^{ab}	57.95±0.59 ^a	0.00
AST(U/L)	28.64±2.7 ^{ab}	32.21±3.05 ^a	15.96±2.73 ^c	19.45±6.39 ^{bc}	0.03
ALT(U/L)	26.39±6.69	33.48±3.59	31.61±6.36	40.94±7.82	0.15
Glucose (mmol/l))	1.23±0.06	1.22±0.37	1.37±1.31	1.23±0.05	0.24
Urea(mg/dl)	24.15±4.8	28.46±3.96	28.46±4.14	24.92±5.26	0.55

Table 4 shows the serum biochemical indices of WAD goats after herbal administration of experimental supplements, with exactly similar parameters evaluated in Table 3. Among all evaluated parameters, only HDL and Urea were significantly ($p<0.05$) affected by the herbal supplement. The HDL values were significantly ($p<0.05$) elevated in the control and treatment 1, while being depressed under T3 and T4, respectively. The urea values were significantly ($p<0.05$) hiked under treatment 4 and significantly ($p<0.05$) reduced across other treatment groups.

Table 4: Serum Biochemical indices of experimental goats after administration of dietary supplements

Parameters	T1	T2	T3	T4	Pvalue
Total Protein (g/dl)	6.78±0.75	5.32±1.07	7.14±0.47	7.45±0.55	0.22
Albumin (g/dl)	2.17±0.19	2.59±0.44	3.09±0.14	2.51 ± 0.40	0.35
Globulin (g/dl)	4.61±0.45	2.64±0.41	4.05±0.24	4.94± 0.19	0.25
HDL (mmol/l)	0.83±0.01 ^a	0.83±0.01 ^a	0.78±0.01 ^b	0.81±0.03 ^{ab}	0.01
LDL (mmol/l)	1.64±0.16	1.36±0.15	1.13±0.11	1.73±0.18	0.10
TRIG (mmol/l)	0.81±0.03	0.83±0.06	0.89±0.06	0.92±0.04	0.57
Total Cholesterol (mmol/l)	2.51±0.08	3.02±0.38	2.80±1.29	2.94±0.19	0.43
Creatinine (Umol/l)	88.50±13.54	234.01±117.8	62.91±22.47	132.07±18.09	0.23
ALP (U/L)	28.54±5.05	23.56±4.42	30.29±14.99	27.99±12.37	0.98
AST(U/L)	14.86±1.99	14.33±2.56	9.65±1.09	8.72±2.15	0.12
ALT(U/L)	16.91±3.20	21.76±3.76	17.81±3.27	17.36±3.35	0.75
Glucose(mmol/l))	2.85±0.04	2.86±0.19	3.32±0.28	3.22±0.22	0.30
Urea(mg/dl)	13.46±3.59 ^{ab}	16.83±1.21 ^b	15.38±3.24 ^b	40.77±4.36 ^a	0.00

Discussion

Physiological indices evoke a quick expression of thermal stress and the magnitude of the animal's internal calmness or unrest, which the animal is exposed to. As reiterated by Danso *et al.* (2024), the key factors of thermal stress in

goats include increased body temperature, heart rate, and respiration rate. The sudden elevation of these homeostasis indicators could disrupt the oxidative stability, electrolyte-endocrine balance, and overall performance of the goats. The linear decrease in the average heart rate after dietary herbal supplementation could have been due to the presence of strong antioxidant and bioactive components in the CP and SL, comprising lycopene, polyphenols, flavonoids, and carotenoids. This array of bioactive compounds could have been responsible for mitigating the negative impacts of heat stress in the goats. This result corroborates the report of Sahin *et al.* (2008), who fed quails with 2.5 or 5% of tomato powder in their study.

Although the values recorded were all below the normal range of 70-90 beats per minute in goats. Heat stress was observed to increase the average respiratory rate as reflected in the high values recorded before administration; however, administration of SL and CP might have still enhanced its alignment within the normal range of 12-30 breaths per minute as documented by Bello (2016) while still linearly reducing the values. The increased average rectal temperature in the experimental goats revealed that they were stressed by the environmental factors. The high values obtained for the metabolic rate indicators reflected an incidence of stress in the experimental goat due to the adverse environmental condition coupled with confinement stress, as supported by Bello *et al* (2016). This corroborates the findings of Joseph and Ayo (2024), who recorded an increased rectal temperature value in red Sokoto goats after their exposure to cold-dry stress. The duo of scientists further unveiled the reversal effect of lycopene obtained from SL on the goats with reduced rectal temperature value. The recorded rectal temperature in this study did not follow a particular pattern before or after herbal supplementation, although a slightly lower value was noticed in the control group at the post-herbal administration stage, while all other values existed within the normal rectal temperature range of 38.50 - 39.70 as documented by Robertshaw (2004).

Heat stress remarkably affects goat health and productivity, affecting various enzymatic activities, specifically alkaline phosphatase (ALP). Studies have shown that heat stress increases ALP levels in goats, specifying a definite correlation between heat stress and serum ALP levels. The values recorded for ALP and Aspartate Aminotransferase (AST) fall within the normal range reported by Daramola *et al* (2005) and Danso *et al* (2024) for healthy goats. The improved serum level of HDL was noticeable in goats under the control and CP treatments, which could have been possible through the enhancing influence of CP on the HDL; all values recorded exist within the normal range of 0.75 to 1.65 mmol/L. This is in conjunction with the claims of Geidam *et al.* (2015), who observed an elevated HDL and triglyceride level in normal and alloxan-induced diabetic albino rats, following an intragastric administration of 100 mg/kg body weight of aqueous stem bark extract of *Cissus populnea*.

On the contrary, Matawalli (2015) reported a reduction in the HDL, triglycerides, and LDL values in Wistar rats, after which CP intubation caused a decreased serum level of total cholesterol. This also connects with the research conclusions of a closely related species of CP known as *Cissus sicyoides*, probably due to phyto-constituents such as tannins, flavonoids, anthraquinones, and arginine present in CP. The reduced HDL observable in SL-supplemented diet could also be due to the hypoglycemic, antilipemic reaction and anti-inflammation nature of Lycopene, which could have been responsible for this outcome. This is in line with the findings of Khalil *et al.* (2022), who recorded a depression in the HDL values of diabetic rats given tomato juice. This might be due to the presence of steroidal glycoalkaloid tomatine, which binds strongly with the insoluble complexes of cholesterol *in vitro*, which might have resulted in the depreciation. Urea is noted as a major nitrogen-containing by-product resulting from the breakdown of protein. The synergistic combination of SL and CP could have prompted the elevated serum urea level as observed in T4, potentially through an elevated protein ingestion or modified rumen fermentation, as supported by

Wójtowski *et al.* (2025). The formation of urea following the conversion of ammonia from protein metabolism perhaps result in a higher urea concentration beyond the normal range of 1.8-20 mg/dl, known as hyperuremia. SL and CP supplementation did not pose any ill health conditions in the experimental goats; an improved homeostatic balance was achieved in line with the lowered physiological indicators. Most of the serum metabolites exist within the normal range. Dietary supplementation of SL and CP either singly or in synergy is therefore recommended. Further research using graded levels is therefore recommended.

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