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Table of Contents

Tax Incentives and Performance of Bakery Businesses in Ilorin Metropolis Zekeri, A., Salau, A. A., & Silas, D. B.	3-11
Impact of Funding Constraints on Rural Development Project Implementation in Owo Local Government Council, Ondo State, Nigeria Adeodu, A. S., Folahanmi O. E., & Amaka, A. F.	12-21
Goe-Political Conflicts and Economic Spill Over in Warri since the Post Colonial Era Oghenevwegba, R. B.	22-27
Automating Critical Thinking in Commercial Banking: AI-Augmented Consultancy for Sustainable Business Practices in First Bank Branches, Ibadan Oyeyinka, E. O.	28-34
Use of Collaborative Technologies for Teaching and Learning in Academic Communities: Benefits, Barriers and Possible Solutions Osuagwu, N. J., & Ajayi, F. F.	35-41
Influence of Artificial Intelligence-Assisted Language Learning on French Language Proficiency Among NCE and Degree Students in Selected Federal Colleges of Education, South-West Nigeria Olayinka-Saliu, K. J.	42-58
Strategic Talent Management and Organizational Performance: The Moderating Role of Digital Transformation Capability in Palmpay Limited, Lagos Olowoyeye C. F., & Olasehinde, S. A.	59-68
Autonomous Coastal Litter Collection via SLAM-Based Navigation and Deep Learning: System Design, Field Validation, and Operational Impact Tso, K. H.	69-76
The AI Classroom: How Generative Tools Are Reshaping Teaching and Assessment Tang, W. C.	77-83

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Tax Incentives and Performance of Bakery Businesses in Ilorin Metropolis

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Abstract

This study examines tax incentives and the performance of bakery businesses in Ilorin Metropolis, Kwara State. Certain tax policies have been developed to promote enterprise growth but have not yet been fully exploited by many small businesses due to the lack of accessibility and effectiveness. The population of the study was 138 registered bakery businesses in Ilorin Metropolis. Taro Yamane's formula was utilized to determine the sample size, which produced a sample size of 103. The structured questionnaire was used as the primary data collection instrument. Simple random sampling was used because it gave every bakery owner an equal chance of being selected for the study, therefore providing better representation and reliability of the data obtained. Multiple linear regression was used for the test of hypotheses with the aid of SPSS version 27. Findings of the study established that tax relief has a positive and significant effect on business expansion of bakery businesses ($b = 0.574$, $t = 14.885$, $p < 0.000$), and capital allowance also has a significant positive effect on business expansion ($b = 0.612$, $t = 16.683$, $p < 0.000$). The study concluded that tax incentives are important drivers of business expansion among bakery businesses in Ilorin Metropolis. Based on the study, the study recommended that tax authorities should enhance implementation of tax relief policies and increase awareness and availability of capital allowance policies for bakery businesses to encourage their growth and expansion.

Keywords: business expansion, capital allowance, performance, tax incentives, tax relief

I. Introduction

Governments have increasingly relied on tax incentives to promote business growth and help boost the economy's activities. In Nigeria, fiscal policies are frequently enacted to ease the burden on companies and to foster investment and productivity. Businesses that have strong tax policies benefit, and they may be able to keep a bigger share of their profits, which can be used to boost their business operations and build production capacity. This is especially true for small and medium enterprises, which often have limited financial resources to manage and are required to ensure a few operational costs are covered at a given time (Chika, 2024; Amaefule et al., 2025).

Tax relief can influence the performance of businesses by reducing the amount of tax obligations placed on enterprises. Fewer taxes means that more money can be left in the business to help it run and to keep production going. The profitability of bakery enterprises is mainly dependent on their capacity to control the costs of raw materials, energy supplies, equipment maintenance, and labor. These costs can impact the profitability of any bakery business, especially for small bakery businesses in competitive markets. If tax relief policies exist, the tax relief can provide extra funds that will enable the bakery operator to allocate the resources more effectively in his production processes (Farida & Setiawan, 2022; Kukoyi et al., 2022).

Capital allowance is one of the key fiscal measures that could affect investment in productive assets of businesses. Machinery and equipment are essential factors in production businesses in order to be efficient and sustain their operations day-to-day. It takes specialized machinery, including ovens, mixers, and generators, to ensure consistent production for bakery enterprises. The cost of such equipment can be prohibitive, especially for smaller businesses, hindering their growth. Capital allowance policies provide businesses with a chance to recover some of the costs of their investment in productive assets in the form of tax deductions and, therefore, lower the effective cost of such investment. Access to these fiscal measures brings businesses flexibility in investing in further equipment or upgrading their equipment (Vaz, 2021; Zubairu et al., 2025).

The performance of a business shows how well the business can meet its financial and business objectives in a competitive environment. Performance is often linked to the capacity to be profitable

and to grow the enterprise with time for small production units like bakery businesses. Profitability is a measure of the ability of the firm to produce financial returns from its production activities, whereas its business expansion can be measured as an increase in its production output, in its acquisition of assets, or in its market reach. The management of available resources and the ability to react to economic fluctuations are often essential for achieving high performance (Kolawole & Festus, 2021; Unachukwu & Chukwujama, 2026).

The knowledge and availability of tax relief provisions to bakery operators have an impact on their profitability. Tax relief schemes aim to ease tax costs for businesses and encourage the sustainability of enterprises, yet many small bakery businesses are not aware of the tax relief policies available or don't have the information they need to access them. Furthermore, the weak implementation of tax relief policies for small businesses has a negative impact on the profitability of bakery businesses, with many of them having a high tax burden despite having limited capital resources (Ekwere et al., 2022; Sweetwilliams et al., 2023; Amaefule et al., 2025).

Likewise, bakery expansion relies heavily on the ability of the operators to invest in productive assets and in modern production equipment. Many bakery operators, however, do not have the production capacity because of the high cost of bakery production equipment, including industrial ovens, mixers, proofers, and power generators. The limited financial capacity of bakery operators also limits the ability to take effective advantage of capital allowance provisions, which has a negative impact on business expansion (Zubairu, et al., 2025; Oladejo, et al., 2024; Amaefule, et al., 2025). Although there are several fiscal policies in place to stimulate enterprise development, little attention has been paid to the impact of fiscal measures on bakery business performance in the local urban markets. This study aims to investigate the impact of tax incentives on the performance of bakery businesses in the Ilorin metropolis. While the specific objectives are to examine the effect of tax relief on business expansion of bakery businesses in Ilorin Metropolis and to assess the effect of capital allowance on business expansion of bakery businesses in Ilorin Metropolis. Hence, the research questions and hypotheses are formulated in accordance with the research objectives.

II. Literature Review

A. Tax Incentive

Sun et al. (2025) defined tax incentives as government-endorsed decreases in taxes to incentivize capital investment and industry growth. These incentives serve as economic support mechanisms, helping to lower the cost of the businesses and help stabilize their cash flow. Deyganto (2022) claimed that tax incentives have the effect of creating a more sustainable business by reducing the statutory tax burden and leaving more capital in the business to reinvest. Firms are then more likely to deploy funds to productive activities and long-term strategic planning, rather than making compulsory tax payments. In capital-intensive industries like the bakery sector, which rely heavily on equipment such as ovens, mixers, and generators, the incentives provided, such as capital allowances, can have a substantial impact on the decision to acquire productive assets and enhance operational efficiency (Essiet & Paago, 2024; Amaefule et al., 2025). Tax relief and capital allowance are used as proxies for tax incentives in this study.

Tax relief is a reduction in the amount of tax that a business is legally obliged to pay, provided by the government as part of its fiscal policy to encourage economic activities and business sustainability. Ekwere et al. (2022) explain that tax relief can boost the financial health of SMEs, allowing for better cash flow and less stress on operations. Reducing required tax payments allows businesses to invest more resources in production, marketing, and training their workers. In a similar vein, Kolawole and Festus (2021) pointed out that tax relief is an incentive tool that promotes business continuity and reinvestment, especially in developing economies where small and medium entrepreneurs are constrained in their access to capital. For firms like bakery companies, where costs encompass raw materials, electricity, and equipment upkeep, tax relief can be a game-changer, boosting profitability and financial stability.

Capital allowance is an allowance that the business can claim on capital expenditures of plant, machinery, and equipment that is used in production for a long period of time. Capital allowance is an

incentive that lowers the effective cost of making capital investments in a business and enhances its internal financing strength to encourage industrial development (Zubairu et al., 2025). It can help companies recoup a portion of their investment by claiming tax deductions, which improves cash flow and aids reinvestment choices. In the same way, Chika (2024) defined capital allowance as fiscal measures aimed at encouraging productive investment through the framework of tax deductions for qualified capital assets. Capital allowance is a key factor in acquiring or upgrading equipment in capital-intensive industries like bakery businesses, which rely heavily on ovens, mixers, generators, and delivery trucks.

B. Performance of Bakery Businesses

Performance, according to Mahamoud et al. (2025), is the way an organization utilizes its resources to achieve its goals and objectives; it is essential since it creates the level of effectiveness of the organization. Performance is the measure of the success or failure of a business, largely dependent on the effective management of its production processes and the ability to provide quality products to customers. According to Drago et al. (2022), businesses are in a dynamic environment and need to plan strategically to sustain competitive advantage over their competitors. This is especially true for bakery businesses, where raw material price volatility, rising energy costs, and stiff competition in the market pose significant hurdles. For production-based firms, one of the challenges that frequently confronts problem managers is to maximize output while keeping costs and product quality under control over time (Robinson et al., 2025). In this study, performance of bakery businesses is proxied using business expansion.

Business expansion is the growth of a business' operations, whether via production capacity, acquisition of additional assets, opening new branches, or expansion of employees. It's a measure of a business' capability to grow its operations beyond their current scope. There are three ways that expansion can be achieved: new equipment, new markets, and diversifying product lines. Vaz (2021) states that growth in a firm is achieved by the effective use of internal resources and managerial skills. Likewise, Keelson et al. (2024) defined business expansion as an intentional growth in the size of a business to enhance market share and competitive advantage. When a bakery business grows, this growth may be a result of buying more ovens and mixers, increasing daily production, hiring more employees, or opening up new sales locations. Financial capacity is an important factor in supporting expansion decisions (Farida & Setiawan, 2022; Alshehadeh et al., 2024).

C. Theoretical Review

The resource-based theory developed by Wernerfelt (1984) and extended by Barney (1991) is the theory underlying this study. The theory suggests that the success of a company is based on how well it can obtain, manage, and effectively use valuable internal resources. The theory states that companies perform better when they have valuable, rare, inimitable, and organized resources. In the theory, organizational success is not only a result of external environmental situations, but it is also greatly influenced by the strength and effective use of internal resources. The resource-based theory focuses on the importance of financial capital, physical resources, and managerial skills as factors in profitability and growth. Performance is, hence, considered the consequence of the effective management and utilization of the resources available to a firm to create a competitive advantage (Sweetwilliams et al., 2023; Zubairu et al., 2025). The theory is of relevance to the bakery business in Ilorin Metropolis because the business is a resource-constrained and production-intensive environment. There is a significant amount of investment needed for bakery plants and equipment, including ovens, mixers, and generators. Tax measures like tax relief and capital allowances enhance the internal financing capacity of these companies by lowering taxes owed. Tax relief and capital allowances are tax measures that boost the IFC of these companies by reducing taxes payable, which contributes to their growth. This reduction not only increases the amount of retained earnings, but it also gives the firm greater liquidity, which will improve its ability to invest in productive assets and expand its operations. The core tenets of the theory have to do with the difference in the resources

possessed by firms and the link between their use of resources and actual results. But resource-based theory has been criticized for its less attention to external environmental factors and its assuming that the possession of a resource is enough to give a competitive advantage to an organization (Essiet & Paago., 2024; Iliyas & Barca, 2025).

D. Empirical Review

Obafemi et al. (2021) studied the effect of tax incentives on the growth of SMEs in Kwara State. This study used a descriptive design, and primary data were collected on the variables that contribute to tax influence and the influence of tax on the growth of SMEs. Stratified and simple random sampling techniques were used to select a sample of 260 respondents, which represented a percentage of the targeted population of enterprises in the production sector of the Kwara State industrial area. The data obtained from the questionnaires, interviews, and observation as needed were analyzed by the ordinary least squares regression model to estimate the contribution of each variable to the growth effect of SMEs. The study found that there was a significant correlation between taxation and SMEs' growth. The study recommends that there should be a friendly tax policy for all start-up businesses, preferably a tax holiday or an introduction of a growth limit, which can be said to be a level stable enough to sustain tax payment.

Kukoyi et al. (2022) examined the taxes and levies imposed on tourism and hospitality companies in Ogun State, Nigeria, in order to highlight their impact on productivity among these companies. The study adopted the survey research method. A total of 272 customers and 72 managers and accountants from the selected companies were obtained using availability and purposive sampling techniques, respectively, from the study population. Purposive sampling was used to determine three key informant interviewees from the tax collecting authorities. Content analysis was used to analyze qualitative data, and simple percentages and chi-square ($p \leq 0.05$) were used for quantitative data analysis. Findings revealed that about 11 taxes were levied on tourism and hospitality firms, and hotels were found to be the sub-sector levied with the highest number of taxes. It was also revealed that all 3 tiers of government collect taxes separately, and some were for a similar purpose, which implies the possibility of multiple taxations. Further investigation showed that taxes on tourism and hospitality companies have a significant impact on prices of goods and services provided ($p = 0.019$). Furthermore, tourism and hospitality firms' productivity is significantly related to taxes imposed ($p = 0.011$). The study has found that tax directly affects the productivity of the tourism and hospitality firms; hence, it recommends reducing the existing taxes on tourism and hospitality firms to eliminate multiple taxation, which will improve the productivity of the firms in the sector of the tourism and hospitality industry.

Essiet and Paago (2024) studied the relationship between tax incentives and financial performance in Rivers State. Nine research questions and hypotheses were used in this study. This research used a descriptive survey research design. The population of this study was two thousand, six hundred and thirty-four (2634), and the sample size was one hundred and fifty (150) knowledgeable and competent staff of the selected small- and medium-scale enterprises in Rivers State. The study employed a questionnaire instrument, and data analysis was carried out using the SPSS software version 22. The research questions were analyzed with the aid of mean and standard deviation, while the hypotheses were tested with the use of simple bivariate regression analysis at the .05 level of significance. Results of these findings indicated that the correlation is very strong and positive with capital allowance and also between investment allowance and financial performance and tax holiday and financial performance, and this indicated a strong positive significant relationship. It can be recommended that small- and medium-scale enterprises adopt and follow the provisions of tax laws to avail themselves of the applicable tax incentives for them to sustain a high level of efficiency and net profit margin and capacity to perform well. Small and medium-scale enterprises should strengthen their database security mechanism, as this is one of the major drivers in increasing financial performance.

Australian Journal of
Business and Social Science
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Amaefule et al. (2025) studied the impact of tax policies and incentives on manufacturing firms' productivity in Ogun State, Nigeria. Industrialization, job creation, and economy diversification are all associated with the manufacturing sector, which is hindered by the various taxation policies applied, the high cost of compliance, and the inconsistent implementation of policies. The study employs stakeholder and Laffer curve theories to discuss the effects of company tax revenue, value-added tax, tax on education, and tax incentive schemes like tax holidays and pioneer status benefits on the performance of companies. This is a descriptive survey research design in which 400 workers in the selected manufacturing companies, including Dangote Cement Plc., Nestlé Nigeria Plc., etc., were surveyed. Descriptive statistics and multiple regression were used to analyze the data. The results indicate that there are important and statistically significant impacts of inefficient tax policies and high compliance costs on the productivity of firms, whereas tax incentives and the efficiency of tax administration have only limited impacts and are statistically insignificant. The evidence is consistent with a paradox in that productive increases are likely to be less successful in the fiscal arena than at the firm level. The study therefore concluded that tax system harmonization, burden reduction of compliance, and tax transparency in the management of incentives are important steps towards industrial development in Ogun State. The policy relevance emphasizes the need for reforms in balancing revenue collection and sustainability of productivity.

Unachukwu and Chukwujama (2026) investigated the effect of tax incentives on the performance of Nigerian consumer goods companies from 2010 to 2024. Specifically, this study aimed to determine the extent to which tax relief, capital allowance, investment allowance, and balancing allowance affect the return on assets of consumer goods companies in Nigeria. Four research questions were developed, and the four hypotheses were tested at the 0.05 level of significance. The relevant conceptual, theoretical, and empirical literature was reviewed. This study was anchored on the normative theory of tax incentives. An ex-post-facto research design was adopted. The study population comprises of the entire 21 consumer goods companies on the floor of the Nigerian Exchange Group. Six consumer goods companies were purposively selected for this study. Secondary data were sourced from the annual reports of the sampled consumer goods companies. Descriptive statistics, correlation analysis, and regression analysis were used to analyze the data. The study found that tax relief, capital allowance, and investment allowance have a significant effect on consumer goods companies' return on assets in Nigeria. The study also found that balancing allowance had no significant effect on consumer goods companies' return on assets in Nigeria. Based on the foregoing, the study concludes that tax incentives have a significant positive effect on the performance of CG companies in Nigeria. The study recommends, among others, that since tax relief has a significant positive effect on performance, the government should streamline and expand tax relief programs targeted at the consumer goods sector through the FIRS.

III. Methodology

This study adopted a survey research design to examine tax incentives and the performance of bakery businesses in Ilorin Metropolis, Kwara State, Nigeria. The population of the study comprised 138 registered bakery owners operating within Ilorin Metropolis, as obtained from the Ministry of Business, Innovation and Technology. These respondents represent registered tax-paying bakery businesses in Ilorin Metropolis. Taro Yamane's formula was used to determine the sample size which yielded a sample size of 103. Simple random sampling technique was employed to ensure that every registered bakery owner had an equal and independent chance of selection. Each owner was assigned a unique identification number, and a random number generator was used to select the required 103 respondents. This procedure minimized selection bias and enhanced the representativeness and reliability of the study findings. Primary data were collected through a structured closed-ended questionnaire. The instrument was measured on a 5-point Likert scale ranging from 1 = Strongly Agree to 5 = Strongly Disagree. The instrument was subjected to face and content validity by experts in taxation, accounting, and business management to ensure clarity, relevance, and adequacy of the items. Reliability of the instrument was tested using Cronbach's Alpha, and values exceeding 0.70 were considered acceptable, indicating internal consistency. Data were analyzed using multiple regression analysis with the aid of the Statistical Package for the Social Sciences (SPSS) version 27 to determine the effect of tax incentives on the performance of bakery businesses. The study strictly adhered to ethical standards, including voluntary participation, informed consent, anonymity, and confidentiality of respondents' information.

IV. Result and Discussion

A. Response Rate

Table 1 Analysis of Response Rate

Returned	100	97.8%
Unreturned	3	2.2%
Total	103	100%

Source: *Author's Fieldwork Computation, (2026)*

As shown in Table 1, 103 copies of the questionnaire were distributed to the respondents. Out of these, 100 copies, representing 97.8%, were duly completed and returned, while 3 copies, representing 2.2%, were not returned. The response rate is considered very high, indicating that the data collection process was effective and well-coordinated.

Table 2: Frequency Distribution of the respondents' Demographic Characteristics

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	80	80.0%
	Female	20	20.0%
	Total	**100**	**100%**
Age	20–29 years	30	30.0%
	30–39 years	40	40.0%
	40–49 years	20	20.0%
	50 years and above	10	10.0%
	Total	**100**	**100%**
Educational Qualification	SSCE	50	50.0%
	ND/NCE	30	30.0%
	HND/B.Sc	20	20.0%
	Total	**100**	**100%**
Years of Experience	1–5 years	55	55.0%
	6–10 years	35	35.0%
	11 years & above	10	10.0%
	Total	**100**	**100%**

Source: *Author fieldwork computation (2026)*

Table 2 presents the demographic characteristics of the 100 bakery owners who participated in the study. The gender distribution shows that 80 respondents (80%) are male, while 20 respondents (20%) are female. This indicates that bakery business ownership in the sample is predominantly male, although female participation remains significant. In terms of age distribution, 30 respondents (30%) fall within the 20–29 years category, while the majority, 40 respondents (40%), are within the 30–39 years age bracket. Additionally, 20 respondents (20%) are between 40–49 years, and only 10 respondents (10%) are 50 years and above. This reveals that most bakery owners are within the economically active age group. Regarding educational qualification, 50 respondents (50%) possess SSCE qualifications, while 30 respondents (30%) hold ND/NCE qualifications, and 20 respondents (20%) have HND/B.Sc qualifications. This indicates that a significant proportion of bakery owners are relatively well-educated. With respect to years of experience, 55 respondents (55%) have between 1–5 years of experience, making it the dominant category. In addition, 35 respondents (35%) have 6–10 years of experience, while only 10 respondents (10%) have over 10 years of experience. This distribution shows that most bakery owners have moderate industry experience, with relatively few having long-term operational exposure.

B. Test of Hypothesis

Table 3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.668a	.446	.443	1.318

a. Predictors: (Constant), tax relief and capital allowance
Source: SPSS Output (2026)

Australian Journal of
Business and Social Science
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As shown in Table 3, the regression model examining the relationship between tax relief and capital allowance demonstrates strong explanatory power. The correlation coefficient (R) of 0.668 indicates a strong positive relationship between tax relief and capital allowance among bakery businesses in Ilorin Metropolis. The R Square value of 0.446 reveals that tax relief and capital allowance explain approximately 44.6% of the variation in the dependent variable. The Adjusted R Square of 0.443 confirms that after adjusting for sample size, 44.3% of the variation in the dependent variable remains explained by tax relief and capital allowance. The Standard Error of the Estimate of 1.318 indicates moderate dispersion between observed and predicted values, suggesting acceptable model accuracy.

Table 4: ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	384.215	1	384.215	221.604	.000b
Residual	386.992	99	1.736		
Total	771.207	100			

a. Dependent Variable: business expansion
b. Predictors: (Constant), tax relief and capital allowance
Source: SPSS Output (2026)

As presented in Table 4, the ANOVA results show an F-value of 221.604 with a significance level of 0.000, indicating that the regression model is statistically significant. The regression sum of squares (384.215) represents the variation in business expansion explained by tax relief and capital allowance, while the residual sum of squares (386.992) represents unexplained variation. Since the significance value is less than 0.05, the model is statistically reliable in predicting business expansion among bakery businesses.

Table 5: Coefficients

Model	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	T	Sig.
(Constant)	**1.274**	**.214**		**5.953**	**.000**
Tax Relief	.574	.039	.668	14.885	.000
Capital Allowance	.612	.037	.687	16.683	.000

a. Dependent Variable: business expansion
Source: SPSS Output (2026)

As shown in Table 5, tax relief and capital allowance have a positive and statistically significant effect on business expansion. The unstandardized coefficient (B = 0.574) indicates that a unit increase in tax relief and capital allowance leads to a 0.574 increase in business expansion. The standardized coefficient (Beta = 0.668) confirms a strong effect size. The t-value of 14.885 with a significance level of 0.000 further indicates strong statistical significance. Based on the results presented, the null hypothesis is rejected. Tax relief and capital allowance has a significant positive impact on business expansion among bakery businesses in Ilorin Metropolis.

V. Discussion of Findings

Based on the study's findings for Hypothesis One, the study established that tax relief has a positive and significant effect on business expansion among bakery businesses in Ilorin Metropolis, with an unstandardized coefficient (B) = 0.574, t = 14.885 ($p < 0.01$). This implies that the more bakery businesses benefit from tax relief, the greater their ability to expand business operations. Reduced tax burdens increase the amount of retained earnings available to bakery owners, enabling them to invest in additional equipment, increase production capacity, open new outlets, employ more workers, and improve operational efficiency. The standardized coefficient (Beta = 0.668) further confirms that tax relief is a strong predictor of business expansion. This finding is consistent with the study of Obafemi et al. (2021), who found that tax incentives significantly stimulate the growth and expansion of small and medium-sized enterprises through improved financial stability and increased reinvestment opportunities. Similarly, the findings of the study align with Kukoyi et al. (2022) who that tax relief policies enhance business growth by reducing operational costs and increasing funds available for productive activities. The finding also agrees with Essiet and Paago (2024), who observed that fiscal incentives contribute positively to enterprise expansion by easing financial constraints and encouraging investment in productive ventures.

Under Hypothesis Two, the study established that capital allowance has a positive and significant effect on business expansion among bakery businesses in Ilorin Metropolis, with an unstandardized coefficient (B) = 0.612, t = 16.683 ($p < 0.01$). This indicates that increased access to capital allowance leads to significant improvement in business expansion. Capital allowance reduces the effective cost of acquiring and maintaining fixed assets such as ovens, mixers, generators, delivery vans, and other production equipment. This motivates bakery operators to invest more in productive infrastructure, thereby increasing operational capacity and expanding market reach. The standardized coefficient (Beta = 0.687) confirms that capital allowance is a strong determinant of business expansion. This finding supports the work of Amaefule et al. (2025), who found that capital-related tax incentives encourage investment in fixed assets and enhance organizational growth. Likewise, Unachukwu and Chukwujama (2026) emphasized that investment-based fiscal incentives improve firms' productive capacity and long-term expansion opportunities. The finding also aligns with Sweetwilliams et al. (2023), who concluded that financial benefits derived from tax incentives strengthen business competitiveness and facilitate sustainable enterprise growth.

VI. Conclusion and Recommendations

Based on the findings of this study, tax relief has a positive and significant effect on business expansion among bakery businesses in Ilorin Metropolis. The study therefore concludes that tax relief is an important fiscal policy instrument that supports the growth and expansion of bakery enterprises. The study also concludes that capital allowance has a positive and significant effect on business expansion among bakery businesses in Ilorin Metropolis. Capital allowance reduces the effective cost of acquiring plant and machinery, thereby encouraging bakery operators to invest in productive assets such as ovens, mixers, generators, and delivery facilities.

Based on the findings of this study, the following recommendations were made:

i. Tax authorities should strengthen and sustain tax relief policies targeted at bakery businesses in order to support business expansion, improve operational capacity, and reduce financial pressure on operators.
ii. Tax authorities should improve awareness and accessibility of capital allowance schemes to ensure that bakery business owners effectively utilize investment-related tax incentives for expansion, modernization, and acquisition of productive assets.

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Impact of Funding Constraints on Rural Development Project Implementation in Owo Local Government Council, Ondo State, Nigeria

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Abstract

This study investigated the impact of funding constraints on rural development project implementation in Owo Local Government Council, Ondo State, Nigeria. The research was driven by concerns over persistent project delays, abandonment, and poor-quality outcomes resulting from inadequate and irregular funding. The study adopted a quantitative research design, using data collected from 237 respondents selected from the Owo Local Government workforce. Primary data were obtained through structured questionnaires and analyzed using descriptive statistics and regression analysis. The findings revealed that federal allocation remains the primary source of funding for rural development projects, accounting for 56.5% of total funds, followed by state government support and internally generated revenue. However, the study found that funding inadequacies and irregular fund disbursement significantly hinder project planning, execution, and sustainability. Regression results indicated that funding ($\beta = 0.674$, $p < 0.001$) and planning and monitoring ($\beta = 0.291$, $p = 0.005$) had significant positive effects on project implementation, while uncertainty of tenure was statistically insignificant. The study concluded that overdependence on irregular government allocations, poor financial management, and weak internally generated revenue are key factors limiting rural development performance in Owo Local Government. It recommended strengthening local revenue generation mechanisms, ensuring timely and transparent disbursement of funds, and improving financial accountability systems to enhance the effective implementation and sustainability of rural development projects.

Keywords: Funding constraints, Rural development, Project implementation, Local government, Revenue generation

I. Introduction

Rural development remains a critical pathway for achieving sustainable growth and reducing poverty in Nigeria (World Bank, 2020). Despite the country's vast natural and human resources, rural areas continue to suffer from poor infrastructure, limited access to education and healthcare, and low economic productivity (Adewale & Ojo, 2021). The local government system was established to drive grassroots development, yet its effectiveness largely depends on the adequacy and reliability of funding (Agba, Akwara, & Idu, 2013). In practice, funding constraints have become a major obstacle to project implementation in many rural councils (Okafor & Anigbogu, 2020). Factors such as irregular federal allocations, poor internally generated revenue, corruption, and weak financial management systems often result in project delays, abandonment, and poor-quality outcomes (Eze & Nwankwo, 2021). In Owo Local Government Council, for instance, several development initiatives ranging from road construction to rural electrification—have been hindered by inconsistent financial inflows and mismanagement (Oluwatobi & Ogunlana, 2022). These challenges undermine efforts to improve living standards and foster inclusive development in rural communities (Adewumi & Akinola, 2019). Understanding how funding limitations affect the implementation of rural development projects in Owo is therefore essential for designing better financial management strategies and ensuring that public resources translate into tangible benefits for local residents (Ikeanyibe, 2020).

A. Statement of the problem

Despite the strategic role of local governments in promoting grassroots development, many rural projects in Nigeria continue to suffer from poor implementation due to inadequate and unreliable

funding (Agba, Akwara, & Idu, 2013). Persistent funding constraints have led to the abandonment of vital infrastructure projects such as rural roads, health centers, and water supply schemes, particularly in local areas like Owo (Oluwatobi & Ogunlana, 2022). Inconsistent disbursement of federal allocations, low internally generated revenue, and weak financial management systems have left most councils unable to sustain project execution and maintenance (Okafor & Anigbogu, 2020). As a result, many development initiatives either fail to meet their intended objectives or are completed below standard, leading to wasted public resources and growing community dissatisfaction (Eze & Nwankwo, 2021). The continuous gap between allocated funds and actual project outcomes raises concerns about accountability, transparency, and effective fiscal governance at the local level (Ikeanyibe, 2020). This study therefore seeks to investigate how funding constraints affect the implementation of rural development projects in Owo Local Government Council, with the aim of identifying the underlying causes and proposing strategies to improve financial performance and project outcomes.

B. Objectives of the Study

The main objective of this study is to examine the impact of funding constraints on rural development project implementation in Owo Local Government Council.

The specific objectives are to:

i. Identify the major sources of funding available for rural development projects in Owo Local Government Council.
ii. Examine the extent to which funding constraints affect the planning and execution of rural development projects.
iii. Assess how irregular fund disbursement influences project completion and sustainability in Owo Local Government.

C. Scope of the study

This study focuses on examining the impact of funding constraints on the implementation of rural development projects in Owo Local Government Council, Ondo State, Nigeria. The research is limited to development initiatives undertaken by the local government between 2015 and 2024, covering key sectors such as rural roads, health, education, water supply, and agriculture. The study concentrates on the availability, adequacy, and management of financial resources as the main determinants of project implementation success. It also considers how factors such as irregular fund disbursement, poor internally generated revenue, and weak financial management systems affect project outcomes. The target population includes local government officials, project managers, contractors, and community beneficiaries directly involved in or affected by rural development activities. While the study draws lessons applicable to other local governments in Nigeria, its findings and recommendations are specifically tailored to the socio-economic and administrative context of Owo Local Government Council.

II. Conceptual framework

A. Concept of Rural Development

Rural development refers to the process of improving the living standards and economic well-being of people residing in rural areas through the provision of essential infrastructure, social services, and economic opportunities (World Bank, 2020). It encompasses initiatives aimed at reducing poverty, enhancing agricultural productivity, and promoting access to health, education, and basic amenities (Adewale & Ojo, 2021). In developing countries like Nigeria, rural development focuses on addressing inequalities between rural and urban regions and ensuring inclusive growth. Sustainable rural development requires participatory planning, effective governance, and adequate funding to support local initiatives (Adewumi & Akinola, 2019). The concept also emphasizes empowering rural dwellers to actively participate in decision-making and project execution. By doing so, rural development

promotes self-reliance, social cohesion, and community ownership of projects, which are essential for long-term sustainability and economic transformation (Okafor & Anigbogu, 2020).

B. Concept of Funding and Financial Constraints

Funding refers to the financial resources allocated to implement development projects and sustain government programs, while financial constraints represent the limitations or shortfalls that hinder effective resource mobilization and utilization (Agba, Akwara, & Idu, 2013). In the context of public administration, adequate funding determines the success of policy implementation and service delivery. However, many local governments in Nigeria face severe financial constraints caused by irregular federal allocations, poor internally generated revenue, corruption, and weak budgeting systems (Eze & Nwankwo, 2021). These constraints often result in project delays, poor-quality outputs, and incomplete initiatives. Financial constraints can also stem from dependence on external grants with restrictive conditions and limited fiscal autonomy of local councils (Ikeanyibe, 2020). Understanding these challenges is essential for designing effective fiscal management frameworks that ensure funds are properly allocated, utilized, and monitored to achieve rural development goals (Oluwatobi & Ogunlana, 2022).

C. Relationship Between Funding and Project Implementation

Funding and project implementation are closely interrelated, as adequate and timely financial resources are vital for planning, execution, and monitoring of development projects (Okafor & Anigbogu, 2020). The availability of funds determines the scope, quality, and pace of project activities, while inadequate funding often results in delays, cost overruns, or outright abandonment (Eze & Nwankwo, 2021). Effective implementation also depends on how efficiently funds are managed and disbursed to contractors and project teams (Adewale & Ojo, 2021). When financial resources are predictable and well-managed, project outcomes are likely to be sustainable and beneficial to the community. Conversely, poor financial planning and mismanagement reduce project impact and lead to public distrust (Agba et al., 2013). Therefore, establishing transparent financial management systems and ensuring regular fund flow are essential for improving project performance and achieving the intended objectives of rural development initiatives (Ikeanyibe, 2020).

D. Role of Local Government in Rural Development

Local governments play a crucial role in promoting rural development because they are the level of government closest to the people (Adewumi & Akinola, 2019). Their responsibilities include initiating, implementing, and monitoring projects that address the social and economic needs of rural communities (Agba et al., 2013). These projects often cover essential areas such as education, healthcare, agriculture, water supply, and rural infrastructure (Oluwatobi & Ogunlana, 2022). Through participatory governance, local governments are expected to engage community members in identifying priorities and managing resources effectively (Okafor & Anigbogu, 2020). However, their performance is often constrained by inadequate funding, limited technical capacity, and political interference (Eze & Nwankwo, 2021). Strengthening the financial and administrative autonomy of local governments can enhance their ability to deliver on their developmental mandate. When properly empowered, local councils serve as effective instruments for inclusive and sustainable rural development (Ikeanyibe, 2020).

III. Theoretical Reviews

A. Resource Dependency Theory (RDT)

The theory was propounded by Pfeffer and Salancik (1978) Resource Dependency Theory explains how organizations depend on external resources for their survival and effectiveness. According to Pfeffer and Salancik (1978), organizations are not self-sufficient; they rely on financial, human, and material resources from external sources, which often influence their behavior and decision-making. In the public sector, local governments depend heavily on higher levels of

government (federal and state) for financial allocations to fund development projects.The theory is relevant because local governments, including Owo Local Government Council, rely on federal and state transfers to finance rural development projects. When these resources are delayed or insufficient, project implementation suffers. Thus, the dependency relationship highlights how funding constraints arise from external financial control and limited fiscal autonomy (Okafor & Anigbogu, 2020). A major criticism of the theory is that it underestimates the ability of organizations (or governments) to innovate and generate internal resources. It assumes dependency as static and overlooks the possibility of local governments developing alternative funding strategies through revenue diversification and partnerships (Ikeanyibe, 2020).

B. Fiscal Federalism Theory

The theory was propounded by Musgrave (1959); Oates (1972) Fiscal Federalism Theory, developed by Musgrave (1959) and later expanded by Oates (1972), explains how functions and financial responsibilities are divided among different levels of government in a federal system. The theory emphasizes efficient allocation of resources, fiscal autonomy, and revenue-sharing mechanisms that allow local governments to address local needs effectively. This theory is relevant because it provides the framework for understanding how Nigeria's fiscal structure affects local government financing. In practice, fiscal imbalances where revenue collection is centralized but expenditure responsibilities are devolved lead to funding constraints at the local level (Agba, Akwara, & Idu, 2013). For Owo Local Government Council, the dependency on statutory allocations from higher tiers often limits its ability to implement development projects efficiently. Critics argue that Fiscal Federalism Theory assumes an ideal environment where all tiers of government act rationally and transparently. In reality, political interference, corruption, and weak intergovernmental relations distort the fair distribution of resources, undermining local autonomy and project execution (Eze & Nwankwo, 2021).

C. Empirical reviews

In their study titled *"*Local Government and the Challenges of Rural Development in Nigeria*"*, Agba et al. (2013) examined how inadequate funding and political interference affect rural development at the local level. Using data from several Nigerian local councils, they found that most local governments depend almost entirely on federal allocations, which are often insufficient and irregular. The study revealed that this dependency hinders effective project planning and implementation. They recommended fiscal autonomy and improved internal revenue generation. The study is relevant as it establishes a direct link between funding inadequacy and poor project performance in rural areas.

Okafor and Anigbogu (2020) analyzed the *effect of financial management on rural development projects* in South-East Nigeria. Their findings showed that poor budgeting, weak monitoring systems, and misappropriation of funds significantly affect project outcomes. Data collected from local government officials and contractors indicated that accountability and transparency in fund utilization were major determinants of project success. The study concluded that improved financial discipline enhances rural project implementation. Its relevance to the present research lies in highlighting how management of limited funds determines the efficiency of rural projects, such as those in Owo Local Government.

Eze and Nwankwo (2021) conducted a study on *"Funding and Sustainable Rural Development in Nigeria"*. They discovered that inadequate and delayed funding often leads to abandoned projects and poor infrastructure in rural communities. Their survey of selected local governments revealed that insufficient revenue allocation and poor internally generated funds limit the execution of community development projects. The study emphasized the need for policy reforms to improve revenue distribution and accountability. This study is relevant because it underscores how inconsistent funding flow directly undermines sustainable rural development efforts.

In their research on *"Fiscal Capacity and Development Outcomes in Nigerian Local Governments"*, Oluwatobi and Ogunlana (2022) investigated the relationship between financial

capacity and developmental performance. Using regression analysis, they found a positive and significant correlation between adequate funding and project success rates in rural areas. Local governments with stronger financial bases executed more projects and maintained them effectively. The study recommends strengthening local revenue systems and ensuring timely disbursement of funds. It is relevant to the current study as it empirically supports the notion that financial strength drives project implementation efficiency.

Adewale and Ojo (2021) explored *"Budgetary Constraints and Local Government Performance in Nigeria"*. Their study revealed that irregular budgeting cycles and underfunding severely limit rural development outcomes. They observed that many local councils fail to complete projects within schedule due to inadequate financial planning. Using interviews and document reviews, the researchers concluded that budget realism and accountability are critical to effective rural project implementation. The study's findings directly relate to Owo Local Government's challenges, where financial shortfalls delay or halt development initiatives.

In their paper on *"Governance and Rural Infrastructure Delivery in Nigeria"*, Adewumi and Akinola (2019) examined how governance practices and funding affect rural infrastructure. The study, based on case studies from Ondo and Ekiti States, revealed that most projects failed due to mismanagement and lack of adequate funds. They argued that participatory governance and transparent financial systems could improve project outcomes. The relevance of this study lies in its focus on Ondo State, providing regional evidence applicable to Owo Local Government.

Ikeanyibe (2020) investigated *"Fiscal Decentralization and Local Government Effectiveness in Nigeria."* The study found that fiscal centralization limits local government autonomy and hinders grassroots development. Data from 20 local governments showed that revenue allocation policies favor federal and state governments, leaving local councils financially weak. The research concluded that granting more fiscal independence would improve local development outcomes. This study is relevant as it explains structural funding constraints that affect local project implementation in Nigeria, including Owo.

Oke and Alabi (2018) studied *"Impact of Financial Constraints on Rural Infrastructure Development in Nigeria."* Using data from five local governments in the South-West, they found that limited access to funds and poor revenue generation led to project abandonment and poor maintenance culture. Their findings showed that even when projects are initiated, lack of continuity and proper funding management reduces their impact. They recommended improved financial accountability and local revenue mobilization. This study is relevant because it demonstrates the practical consequences of funding shortages on rural development.

IV. Methodology

A. Study Area

The study was conducted in Owo Local Government Area Council of Ondo State, one of the eighteen local government councils in the state. The area covers 636 km² with a population of **218,886** (2006 census). It borders Emure-Ise-Orun LGA of Ekiti State and Akoko LGAs to the north, Akure and Idanre to the east and south, while Ose LGA borders it to the west and part of the south.

B. Population of the Study

The study population comprised 580 staff of the Owo Local Government Council. The council was selected due to its involvement **in** rural development project implementation, project appraisal, monitoring, and fund management at the local level.

C. Sample Size and Sampling Technique

The Taro Yamane formula was used to determine a sample size of 237 respondents from the total population of 580, at a 5% error margin. Stratified sampling was adopted to ensure representation across key departments such as administration, finance and supply, agriculture, works, primary health care, and political offices.

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D. Method of Data Collection

Data were collected using a **structured questionnaire** based on a **5-point Likert scale** (Strongly Disagree to Strongly Agree). Section D of the questionnaire specifically examines Inadequate Funding and Implementation of Rural Development Projects**.**primary data (from staff responses and short interviews)

E. Method of Data Analysis

Data were analyzed using SPSS (Version 26**)**. Descriptive statistics (percentages, means) summarized responses, while regression analysis tested the relationship between funding constraints and project implementation. The decision rule: reject null hypothesis if *p-value* < *0.05*.

F. Model Specification

$$Imp = \beta_0 + \beta_1(UTG) + \beta_2(PM) + \beta_3(F) + \varepsilon_t$$

Where:

Imp = Implementation of rural development projects
UTG = Uncertainty of tenure of local government chairmen
PM = Planning and monitoring mechanisms
F = Funding
ε_t = Error term

IV. Results

Objective One : Identify the major sources of funding available for rural development projects in Owo Local Government Council.

Table 1: Major Sources of Funding for Rural Development Projects in Owo Local Government

Funding Source	Frequency (N=92)	Percentage (%)
Federal Government Allocation	134	56.5
State Government Support	46	19.6
Internally Generated Revenue (IGR)	26	11.0
Grants and Donations	18	7.6
Community Contributions	13	5.4
Total	237	100

Source: Author computation, 2025

Table 1 presents the major sources of funding for rural development projects in Owo Local Government. The result shows that the Federal Government allocation is the predominant source of project funding, accounting for 56.5% of the total responses. This indicates that most rural development initiatives rely heavily on funds disbursed through the federal allocation system. The State Government support ranks second with 19.4%, suggesting that the state plays a supplementary but notable role in financing local development projects.

Meanwhile, Internally Generated Revenue (IGR) contributes 11.0%, reflecting limited local financial capacity to sustain projects without external support. Grants and donations represent 7.6%, showing that assistance from external partners or donor agencies remains relatively low. Community contributions account for only 5.5%, indicating minimal grassroots financial participation in project implementation. The findings suggest that rural development funding in Owo Local Government is largely dependent on federal and state allocations, with limited diversification of revenue sources. This heavy reliance on intergovernmental transfers may pose sustainability challenges, especially when federal or state funds are delayed or insufficient.

Examine the extent to which funding constraints affect the planning and execution of rural development projects.

Table 2: Effect of Funding Constraints on Project Planning and Execution (Objective Two)

Statement	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)	Mean
Funding for projects is generally inadequate	90 (38.0%)	69 (29.1%)	26 (11.0%)	31 (13.1%)	21 (8.8%)	3.75
Lack of funds affects timely project execution	108 (45.6%)	64 (27.0%)	21 (8.9%)	26 (11.0%)	18 (7.6%)	3.92
Delays in fund release lead to cost overruns	103 (43.5%)	62 (26.2%)	28 (11.8%)	26 (11.0%)	18 (7.6%)	3.88
Insufficient funding results in low project quality	85 (35.9%)	75 (31.6%)	28 (11.8%)	31 (13.1%)	18 (7.6%)	3.70

Source: Author computation, 2025

The data reveals that funding-related issues play a major role in determining how effectively rural development projects are planned and executed in Owo Local Government. A large proportion of respondents (38.0% strongly agree and 29.1% agree) believe that funding for projects is generally inadequate, resulting in a mean score of 3.75, which indicates agreement. Similarly, the majority (45.6% strongly agree and 27.0% agree) that lack of funds affects timely project execution, with a mean score of 3.92, showing that funding shortages cause significant implementation delays. Additionally, 43.5% strongly agree and 26.2% agree that delays in fund release led to cost overruns, producing a mean of 3.88, meaning projects often exceed budgets due to financial bottlenecks. Lastly, 35.9% strongly agree and 31.6% agree that insufficient funding results in low project quality, reflected in a mean score of 3.70.

Assess how irregular fund disbursement influences project completion and sustainability in Owo Local Government

Table 3: Effect of Irregular Fund Disbursement on Project Completion and Sustainability (Objective Three)

Statement	Strongly Agree (5)	Agree (4)	Undecided (3)	Disagree (2)	Strongly Disagree (1)	Mean
Delay in fund release causes project abandonment	98 (41.4%)	72 (30.4%)	23 (9.7%)	26 (11.0%)	18 (7.6%)	3.87
Irregular disbursement leads to poor project monitoring	93 (39.2%)	64 (27.0%)	28 (11.8%)	31 (13.1%)	21 (8.9%)	3.66
Contractors stop work when payments are delayed	103 (43.5%)	75 (31.6%)	18 (7.6%)	26 (11.0%)	15 (6.3%)	3.95
Unreleased funds reduce project sustainability	95 (40.1%)	69 (29.1%)	26 (11.0%)	28 (11.8%)	19 (8.0%)	3.84

Source: Author computation, 2025

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The result shows that most respondents agreed that funding constraints negatively affect rural development project implementation in Owo Local Government. A majority of 41.4% strongly agreed and 30.4% agreed that delays in fund release cause project abandonment, giving a mean score of 3.87, which indicates general agreement with the statement. Similarly, 39.2% strongly agreed and 27.0% agreed that irregular disbursement of funds leads to poor project monitoring, with a mean of 3.66, suggesting that inconsistent funding patterns disrupt effective supervision and tracking of project progress.

Also, 43.5% of respondents strongly agreed and 31.6% agreed that contractors often stop work when payments are delayed, yielding the highest mean value of 3.95. This implies that payment delays significantly hinder project continuity and completion. Furthermore, 40.1% strongly agreed and 29.1% agreed that unreleased funds reduce project sustainability, with a mean score of 3.84, showing that funding shortfalls limit the long-term viability and maintenance of completed projects.

Table 4: Regression Analysis Result Showing the Impact of Funding Constraints on Project Implementation

Variable	Coefficient (β)	t-Statistic	p-Value
Constant	2.114	3.245	0.002
Funding (F)	0.674	4.826	0.000
Planning & Monitoring (PM)	0.291	2.874	0.005
Uncertainty of Tenure (UTG)	-0.123	-1.556	0.123
R^2	0.612		
Adjusted R^2	0.587		
F-Statistic	21.47		0.000

Source: Author computation, 2025

The regression analysis examines the impact of Funding (F), Planning and Monitoring (PM), and Uncertainty of Tenure (UTG) on rural development project implementation in Owo Local Government Council. The model's R^2 value of 0.612 indicates that about 61.2% of the variation in project implementation is explained by the three independent variables. The Adjusted R^2 of 0.587 confirms that the model remains strong even after accounting for the number of predictors, suggesting a good overall fit. The F-statistic value of 21.47 with a p-value of 0.000 shows that the model is statistically significant, meaning that the combined effect of the independent variables has a meaningful impact on project implementation.

Examining individual predictors, Funding ($\beta = 0.674$, $t = 4.826$, $p < 0.001$) has the strongest and most significant positive influence on project implementation. This means better funding directly improves the success of rural development projects. Planning and Monitoring ($\beta = 0.291$, $t = 2.874$, $p = 0.005$) also exerts a positive and significant effect, implying that effective planning and monitoring practices enhance project outcomes. However, Uncertainty of Tenure ($\beta = -0.123$, $t = -1.556$, $p = 0.123$) has a negative but statistically insignificant effect, suggesting that while tenure insecurity may hinder projects, its influence is not strong enough to be considered a key determinant in this model.

V. Discussion of Findings

A. Objective One: Major Sources of Funding for Rural Development Projects

The findings revealed that rural development projects in Owo Local Government are largely financed through multiple sources, including allocations from the federal and state governments, internally generated revenue, community contributions, and, to a lesser extent, donor agencies. However, respondents emphasized that these sources are often unstable and insufficient to meet project needs. This finding agrees with the submission of Eze and Okonkwo (2021), who observed that most local governments in Nigeria rely heavily on statutory allocations from higher levels of government, which are often delayed or inadequate. Similarly, Audu (2020) noted that rural development efforts in

Nigeria are constrained by overdependence on government allocations with limited diversification into other funding streams such as public-private partnerships or community self-help initiatives.

The result aligns with World Bank (2020), which maintained that sustainable development in rural areas requires consistent financial support and transparent fiscal management. The dependence on central allocations leaves local governments vulnerable to fiscal instability and political interference, often disrupting the flow of funds to critical projects. Therefore, the study reinforces that while funding sources exist, their irregularity and insufficiency remain major constraints to rural development in Owo Local Government.

B. Objective Two: Funding Constraints and Their Effect on Project Planning and Execution

The analysis showed that a majority of respondents (67.1%) agreed or strongly agreed that funding for projects is generally inadequate, while 72.6% agreed that lack of funds affects timely project execution. The mean scores ranging between 3.70 and 3.92 further confirm a strong perception that funding constraints significantly hinder project planning and implementation. These findings indicate that insufficient funding leads to delays, scope reductions, and poor-quality outcomes in rural projects.

This supports the work of Ogunleye (2019), who found that the efficiency of local government projects in Nigeria is directly tied to the adequacy and timeliness of financial releases. When funds are limited or delayed, project schedules are extended, costs escalate, and quality is compromised. Similarly, Nwosu and Olamide (2022) reported that inadequate budgetary provisions and mismanagement of funds are key causes of stalled rural infrastructure projects in southwestern Nigeria. The result is consistent with Aigbokhan (2020), who emphasized that funding inadequacies not only delay project execution but also discourage community participation, as stakeholders lose confidence in government-led initiatives. Therefore, it can be inferred that the inability of Owo Local Government to secure adequate and timely funding limits the effective planning, coordination, and successful completion of rural development projects.

C. Objective Three: Effect of Irregular Fund Disbursement on Project Completion and Sustainability

The findings show that 71.8% of respondents agreed or strongly agreed that delays in fund release lead to project abandonment, while 75.1% affirmed that contractors often stop work when payments are delayed. The mean values ranging from 3.66 to 3.95 further reveal that irregular disbursement has a strong negative impact on project monitoring, completion, and long-term sustainability. This implies that even when projects commence, inconsistency in fund flow disrupts continuity, resulting in incomplete or low-quality outcomes.

This outcome supports Adebayo and Adeola (2021), who argued that irregular fund disbursement is one of the major bottlenecks affecting public project delivery in Nigeria. They found that bureaucratic bottlenecks in fund release and lack of financial transparency often result in uncompleted projects. Okon and Ekpo (2019) similarly observed that projects with erratic funding schedules experience weak monitoring and poor accountability, leading to cost overruns and abandonment.

The finding also aligns with United Nations Development Programme (UNDP, 2020), which stresses that consistent and timely financial flow is essential for sustaining rural development initiatives. Without predictable funding, maintenance and sustainability mechanisms collapse shortly after project commissioning. Hence, it is evident that irregular fund disbursement significantly undermines the completion rate and durability of rural projects in Owo Local Government Council.

VI. Conclusion

The study examined the impact of funding constraints on the implementation of rural development projects in Owo Local Government Council. Findings showed that although multiple sources of funding exist such as federal allocations, internally generated revenue, and community

contributions, the funds are often inadequate, irregular, and poorly managed. This has resulted in delays, abandonment, and poor-quality execution of rural development projects.

The analysis also established that inadequate and inconsistent funding severely affects project planning, monitoring, and sustainability. Projects are often initiated without clear financial plans, and irregular disbursement of funds disrupts continuity, leading to waste of resources and loss of public confidence. The regression results further confirmed that funding and planning significantly influence project outcomes, while uncertainty of tenure among political leaders weakens accountability and long-term commitment.

VII. Recommendations

Based on the findings, the following recommendations are proposed:

i. The local government should not rely solely on federal and state allocations. It should explore partnerships with private investors, NGOs, and international donors to support rural development initiatives.
ii. The government should put mechanisms in place to guarantee prompt release of approved funds for project execution. Timely disbursement reduces cost overruns and ensures projects are completed as scheduled.
iii. A comprehensive financial plan should accompany every rural development project. Regular monitoring and auditing should be conducted to ensure funds are used effectively and transparently.

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Goe-Political Conflicts and Economic Spill Over in Warri since the Post Colonial Era

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Abstract

Warri is a city that has witnessed ethnic conflicts especially since the 1950s. The ethnic conflicts in Warri among the various ethnic groups of Urhobo, Itsekiri and Ijaw attained a high level of continuing tension that Warri has come to be an example of a society that is persistently in a state of crisis. Although it is true that ethnic conflicts are inevitable in a multi-ethnic society like Warri, and while it is also true that such conflicts do have some functional consequences, ethnic conflicts could equally be very destructive. This paper examine inter-ethnic relation and violence in Warri and discusses the various factors that were responsible for the rise of violent ethnic conflicts in Warri. It will equally discuss the implications of such violent ethnic conflicts in the city which include economic spill-over many oil multinational companies left Warri to neighbouring peaceful environment. Small and medium scale business also left the city as a result of the ethnic conflict and this left the city in economic ruin even after peace was restored. The paper recommended inter-ethnic harmony among the warring groups so as to attract investment back to the city. It also call for government investment in the economic life of the city. The paper adopt the historical method which analyze and interpret historical data.

Keyword: Violence, Intergroup relations, Conflict, peaceful coexistence, Ethnic group, Crisis.

I. Introduction

Warri is located in the present day Delta State and is the home of Urhobo, Itsekiri and Ijaw ethnic group. Warri was part of what was formerly known as Warri Division which is now made up of Warri South West, Warri North and Warri South Local Government Area. Warri is not the capital of Delta State but it is the most prominent and fast growing Urban area in the state, just as Lagos was the former capital of Nigeria so was Warri the former Headquarters of the old Delta province which changed into Delta State, Warri since the creation of Delta State in 1992 has ceased to be the political capital of the state, but has maintained her position as the commercial center and the main industrial area of state (Imobighe, 2002).The Urhobo, Itsekiri and Ijaw ethnic group of Warri had not lived in isolation. Available evidence suggest that there were interaction among them and this interaction was characterized by close socio-economic and political contact. The Urhobo, Iteskiri and Ijaw have interacted with each other through trade contact and marriages before the coming of the Europeans. In the post-independence era their relationship was characterized by mutual distrust and suspicion which sometimes led to open violent conflict.

II. Historical Background and Indigenous Groups

Warri like other cities is made up of different ethnic groups and with their own distinct culture and languages, this groups include Urhobo, Itsekiri and Ijaw. They have interacted with each other for a long time before the colonial era. Warri in the North Western Niger Delta is located between latitudes 5^0 30 N and 5^0 31N and between longitudes 5^0 41E and 5^0 44E. It is located about 64 kilometers from the Bight of Benin. Its location on Warri River is the highest point of navigation for ocean going vessels (Ifediora, 2012).The type of soil is mainly low and sedimentary, sand in most part of the Niger Delta, more than clay are found in the lowest laying swam land. Warri is mainly under the influence of the South West wind and a true harmattan season is very rare, Warri experience rainfall all year round with November to March as driest month, July and September have heaviest rains. The nature of the environment encourage specialization in occupation among the indigenous people. The Urhobo in the main land took to farming in the pre-colonial and colonial period. The Ijaw and Itsekiri on the other

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Business and Social Science
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hand which were at the water terrain took to fishing and salt making, the occupational specialization encourage the growth of market and market centers.

III. The Urhobo

The Urhobo in Warri were divided into two namely, the Agbarha Urhobo and OkereUrhobo. The Agbarha-Ame people came fromAgbarha-Oto and they founded their present territory in the 13th century, during that period they farm in the Warri Township. The Agbarha people are made up of seven kingdoms in the present Warri Township and they include Ogunu, Opukuti, Okurode-Urhobo, Oteghale, Igbudu, Edjeba and Agbassa. Agbarha is use as a name for both to cover the seven towns and is also use to refer to one of the units (Otite, 2011). The neighbors of Agbarha includes Uvwie, Udu, Itsekiri, Ogbe-Ijaw and Okere –Urhobo. According to the 1991 population census the Agbarha people had an estimation of 18000 and they were grouped under Warri South Local Government Area.The Agbarha-Urhobo have an annual festival popularly called Agbassa Juju, it is held around May/April every two years and it cut across all their settlement. The Agbassa Juju festival is celebrated in honor of a warrior Deity called Owhurie (Pages and Pictures, 1997).

The Okere-Urhobo on the other hand were believed to have migrated from Okpara in Olumu clan, the founders of Okere settled near the Okere River and there are still found there to this day. Okere is one of the Urhobo group found in Warri town, their neighbors include the Urhobo of Uvwie. The Urhobo of Agbarha, Itsekiri and Ijaw. The ancestors of Okere namely Idama, Ohwotemu and Sohwruvwe came from Okpara Olumu and their common ancestors were later joined by other relatives who were accommodated

The three descendants have produce other quarters or descent group called Olodi, the descendants of the Okere manage their affairs as a corporate group and have always been politically independent of their neighbors. It is believe that the Okere and Agbarha settle in Warri before the Itsekiri people. Okere develop into a political kingdom by the end of the 19th century and their government was run by elders with the eldest from paternal line as community leader (Okpako-Okere), Okere kingdom was one of the four kingly position of traditional rulers establish by the Delta State government in 1999 in that year Chief Owen Sati Olodi was crown as Ojabugbe 1. The Orosuen (king) of Okere kingdom (Otite, 2011). The Okere have an annual festival, AwanKere popularly known as Okere Juju, the festival is celebrated between June and August. It is one of the most popular festival in Warri metropolis and environs, the festival is celebrated in honor of a Diety Okioro.

IV. The Itsekiri

It is believe that the root of the Itsekiri lay's in Yoruba land because Yoruba language is the language with which the Itsekiri language is most closely related. This connection of the Itsekiri to the Yoruba origin linked them to Ugbo in Ilaje, Ese Odo Local Government Area of Ondo State, and Ode in the Ijebu country of Ogun State. The cultural similarities between the Itsekiri and the Yorubas gives additional weight to the conclusion that Itsekiri has a Yoruba origin (Ifediora, 2014). However the most acceptable origin of the Itsekiri is that of the migration of Ginuwa from Benin in the late 15th century. According to this tradition of origin, there was an Oba who ruled over the kingdom of Benin called Oba Olua. Oba Olua has an elder son called Prince Ginuwa who was causing trouble and defiling the traditional rights of the Benin kingdom. He also wanted to remove traditional practices, and he was also hostile to the chiefs and their supports. The chiefs were not happy with character and doings of the prince and even his father and they vowed that prince Ginuwa will not succeed his father as the next Oba of the Benin kingdom. Oba Olua been aware of the plans of the chiefs decided to secure the future of his son and plan that Ginuwa should have his own kingdom aside Benin, the Oba then through deception asked the seventy chiefs to send their first son's with prince Ginuiwa to offer sacrifice to one of the god's the Oba build a wooden ship that was large enough to contain the prince and the sons of the seventy chiefs to a distant land where they should settle (Osagay, 1982)

Ginuwa led the chief's sons through the river to a new settlement with himself as king, the Beninhaven learnt of their sons disappearance sent a force to bring them back with the prince. Ginuwa

also haven learnt of the chiefs forces headed to the mount of the Forcados River, Ginuwa landed in Ijala and begin a settlement there, Ginuwa died in Ijala and was buried there. Ginuwa was succeed by his first son Ijijen. Ijijen led the party from Ijala to Iwere (Warri), this settlement is known to this day as Ode-Itsekiri (Moor, 1970) The Itsekiri system of government was design on that of Benin, The Itsekiri was ruled by an Olu and the council of Oyeye. The Itsekiri economic life was determine by their physical environment, they do not have enough land for agriculture and as a result of this they depend on their rivers for fishing and manufacturing of salt which they exchange with the hinterland Urhobo for their agricultural produce.

V. The Ijaw

There is no trace of the Ijaw to any major tribe in the country. The Ijaw inhabit an environment that is predominantly covered by the mangrove swamps. They reside among the Itsekiri in Warri. Oral accounts claim that communities of migrants Ijaw dwelt on the waterfront by the side of an area called Ogbe-Ijo. The site is located at the confluence of the Agbassa creek and the Warri River. At this site the Urhobo farmers and Ijaw fishermen from the riverine country traded. Ogbe-Ijaw is bounded on the northeast by the Okere and Agbarha or Agbassa kingdom, on the southeast by Isaba kingdom, on the east by Udu kingdom, and on the south by Iduwini kingdom. According to Ifediora, Ogbe-ijoh belongs to the Ogbe Ibe (group or clan) of the western Ijaw and their origin can be traced to Ewein who came from Ekeromo, the headquarters of the Operemo Ibe. The Operemo, on their part, claim or trace their origin to Oporoma in Kabowei, Ogulagha, Gbaramatu, Kubowie and Iduwini Ibe, also resided among the Itsekiri in Warri.

The Ijaw inhabit a region that is covered by the mangrove swamps. Their homeland is completely riverine, and fishing was the predominant economic activity, which is as old as their history. Fishing is done in creeks, lakes, ponds, lagoons, rivers and the open sea. Other economic activities include palm wine tapping, hunting, salt making, wood carving, palm oil production, boat building and canoe carving. From earliest times, the Ijaw had distinguished themselves as canoe carver and boat builders, supplying most of the Western Niger Delta people with canoes. Although other groups in the Western Niger Delta were also riverine people producing canoe, the Ijaw were well known for canoe carving. The Ijaw are not self-sufficient. There were other needs for which they have to engaged, in exchanges with hinterland people such as garri, yam, plantain, livestock among others. (Ayomike, 1990) notes that Ogbe-ijoh, the Ijaw enclave in Warri has traditionally been the market/shopping area in Warri township, and Ogbe-ijoh market has been a well known landscape in Warri township.

VI. Geo-political Violence in Warri

Warri is known for ethnic violence, which had affected the city since their inception. The inter-ethnic violence involving the indigenous ethnic groups of Urhobo, Itsekiri and Ijaw in Warri could be traced to the colonial period. The conflict grew from the struggle for group legitimacy and entitlements among the three ethnic groups (Edevie, 2004). Each of the ethnic groups claimed to be the owner of Warri. The claim over the ownership of Warri by the three ethnic groups of Urhobo, Itsekiri and Ijaw, is a matter of a long standing historical controversy. The ethnic groups claimed to be the first to settle in Warri and tried to support their claims with historical data. They tried to interpret historical data to buttress their justification of claim over the ownership of Warri, as each group refers to the other as settlers. A good example of land dispute was Agbassa/Itsekiri land case over the establishment of Hausa settlement at Agbassa, where the Olu of Itsekiri demanded 33 percent of the rent, while the Agbassa people only allowed 5 percent (National Achive Ibadan, 1947). However, the fact remains that the three ethnic groups of Urhobo, Itsekiri and Ijaw have long historical claims to the portion of land in Warri which they live in. Warri started as a collection of Urhobo, Itsekiri and Ijaw settlements.

The ethnic violence in Warri was also caused by British colonial policy. At the time of the advent of British colonial rule, the Itsekiri were more united as a people and more aware of their common interests and problems than were their Urhobo and Ijaw neighbours. The Itsekiri had a

centralized political system under the Olu. This was absent among the Urhobo and Ijaw ethnic groups. As a result of this the British gave the Itsekiri preferential treatment based on the ease of dealing with people with a history of unified submission to a central authority. The Urhobo hated the Itsekiri for the preferential treatment which they received during the colonial era. Also, the British colonialists recognized the interdependence and ethnic diversity in Nigeria, but they disrupted it and agglomerated them into one political unit. According to (Usman, 2008), 'Colonialism forcibly incorporated people with different histories, cultures and socio-political organization into one country, and there was the attempt by the colonial authorities to govern each group or territory separately well into the colonial period'. Colonialism incorporated segments of the pre-colonial power elites and transformed them into components of land agents for the colonial regime both in the political and commercial sectors of the society. It was the British who subdivided the land into regions, provinces, divisions, districts and sub-districts. During the colonial period, the British created the Warri Province for administrative purposes and it included the three ethnic groups of Itsekiri, Ijaw and Urhobo. But the province was dominated by the Itsekiri, and this resulted to reactions of the two other ethnic groups.

One of the causes of ethnic conflict in Warri emanated from an action of the government of the former Western Nigeria, when it decided to change the title of the Itsekiri King from Olu of Itsekiri to Olu of Warri in May 1952. The change was effected at the request of the Itsekiri over the objection of the Urhobo The Urhobo in particular felt that the title Olu of Warri would give the universal impression that the Olu is the paramount ruler or chief of the Warri Province, and this would legitimize the Itsekiri claim of the ownership of the area. The change of the title involved the Olu of Itsekiri ruling over all the people of Warri as if they were all Itsekiri. Warri is owned and inhabited by the Urhobo, Ijaw and Itsekiri ethnic groups. The change created animosity and mutual distrust between members of the Itsekiri and Urhobo ethnic groups.

Open violent conflict erupted in Warri among the Itsekiri, Urhobo and Ijaw in 1993, but especially with the Urhobo and Itsekiri. The violence emanated as a result of Itsekiri carnival procession to celebrate the Olus's coronation anniversary.[107]According to Evebvie, the annual procession of a carnival through major streets in Warri to mark the coronation anniversary of the Olu started with the ascension of Atuwase II to the Itsekiri throne on May 2, 1987. The Itsekiri saw the occasion as a means and opportunity to display and showcase their colourful cultural heritage. However this provoked the Urhobo. The Urhobo believed that the procession was not intended to display Itsekiri culture but to emphasize their claim over the ownership of Warri. This led to violence, which left several people dead and injured and properties destroyed.

Violent conflict also broke out in 1997 as a result of local government controversy. On October 1, 1996, 186 local government areas were created nationwide and details were made public on December 4, and an additional local government was created in Warri. On December 1996 the Delta State Military Administrator Col. D. J. Dung announced the creation of Warri Southwest Local Government Area with Ogbe-Ijoh, an Ijaw town as the headquarters (Imobighe 2002). The ijaw were very happy with the development. However, the federal government later relocated the Warri Southwest local government headquarters from Ogbe-Ijoh an Ijaw settlement to Ogidigben, an Itsekiri settlement. The Ijaw felt disappointed and marginalized. The Ijaw believed that the Itsekiri had persuaded the military government to alter earlier plans that placed the headquarters at Ogbe-Ijoh. They saw the government action as unfair. The Ijaw reacted violently and the Urhobo, due to their grievance against the Itsekiri gave tacit support to the Ijaw and this helped to broaden the scope of the conflict (Ikanone, 2007). The conflict led to unprecedented destruction of lives and properties, while the youths of the three ethnic groups saw the conflict as an opportunity to unleash their anger on the government and oil companies for long years of neglect and pollution of their land.

In February 2003, violence started from disagreement at a primary election of the People's Democratic Party (PDP) which took place at the Warri Township Stadium. The conflict erupted over the delineation of electoral wards. The Urhobo were not happy with the structure of wards for the election and they left the venue of the election. They attacked the Itsekiri areas, burning houses and vandalizing properties. This action of the Urhobo took the Itsekiri unaware.[115]At night the Itsekiri

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launched a revenge attack. The conflict recorded the destruction of lives and properties and left so many persons displaced.

VII. The Warri Violence and Economic Spillover

The Warri crises affected inter-ethnic harmony. That is, it led to unfriendly relationship among the three ethnic groups. The three ethnic groups of Ijaw, Itsekiri and Urhobo had interacted with each other peacefully in the region for centuries. There was general distrust and increase in the resentment among members of the different ethnic groups. One factor that inhibited inter-ethnic harmony among the three ethnic groups is the struggle over the ownership of Warri and its resources especially crude oil. The Warri crisis since the 1990s affected the development of the area. Since the inception of the crisis, only few investments came into the region because businesses need a stable socio-political environment to thrive. Inter-ethnic tension and violence undermined the much needed stability. The crisis in Warri affected internal investments, as many oil and servicing companies moved their headquarters and relocated to more peaceful areas or states such as Port Harcourt, Akwa-Ibom, among others. Many of the companies only maintained skeletal services in Warri. Such companies include Tidex, Lamnalco, United Geo-Physical Surveys, Dowell-Schlumberger and Global Star. The Shell Petroleum Development Company (SPDC) also moved more of their departments to Port Harcourt (Clifford, 2002). The relocation was not limited to big businesses alone. Small private business also relocated to other nearby towns such as Agbarho, Ughelli, Sapele among others.

In the various conflict in Warri, hundreds of lives were lost. Expensive and essential properties were lost. Markets such as Okere and Pessu were burnt. Shops, business centres and other structures were vandalized. The violence in Warri created a general state of insecurity. However since the end of the conflicts and violence, Warri is yet to recover from the economic lost. Most of the companies and businesses that left never returned. The economy of the city has been in shamble since the end of the conflict. Individuals lost their jobs and Warri became a shadow of its former self. The loss of job created a serious problem of unemployment. The major job available for the male teaming population was driving of commercial motorcycle and later tricycle. This was because most of them lost their jobs in the various oil multi-nationals. The loss of jobs also created a state of insecurity by the youth. The youth wreck havoc on the city which further compounded the economic woes. The state of insecurity discourages investment in the city despite the city's rich natural resources. No individual will want to invest in a society where there is no peace. The city is yet to recover from the violence. She is still paying the price of ethnic violence. This is because both small and big businesses is suffering the consequences of violence despite the fact that peace have returned to the city for over ten decades. Oil multi-national and small business entrepreneur are afraid to invest their capital in the city. The government should therefore encourage investment by creating a conducive business environment in the city. The government should also invest directly into the economy of the city so as to create jobs for the teaming youths who are at the fore front of violence when it erupt. The government should also try to address the issues that led to the various conflicts in Warri in order to avoid future occurrence. The people of Warri should as a matter of fact understand that development cannot take place in a state of insecurity. They should therefore embrace dialogue to any issue that affect their interest.

VIII. Conclusion

Colonialism in Nigeria created opportunities for closer interaction among the different ethnic groups in Nigeria. The Urhobo, Itsekiri and Ijaw in Warri have interacted with one another for a long time before the colonial period and the relationship manifested through trade and inter marriages. The ideal of one ethnic group dominating the other came as a result of colonial which later characterized the post- independent relationship among them. The relationship in the post-colonial era manifested in distrust which later metamorphosed into ethnic conflict. The conflicts led to the destruction of lives and properties, displacement of population and the flight of businesses to cities such and Port Harcourt and Uyo. Violence have never been a favourable option for the various groups in Warri. By way of recommendation separate local government should be created for the three ethnic groups. This will

help to prevent ethnic domination and disputes over the existing Warri South Local Government Areas. Each groups should also try to accommodate and live in unity with one another as they had done in the pre-colonial era. This is because conflict will only lead to more damages and underdevelopment. The government should also invest and encourage investment by creating a good and peaceful environment for businesses to thrive.

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Automating Critical Thinking in Commercial Banking: AI-Augmented Consultancy for Sustainable Business Practices in First Bank Branches, Ibadan

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Abstract

Artificial Intelligence with human knowledge enhances consultancy in creating valid and balanced decision, since AI handles data crunching, patterns and humans bring content, ethics and experience. Analysis ensures context aware advice for financial resilience. This facilitates the possibility of data quality checks, algorithm auditing, human oversight, diverse perspectives and transparency to stop early warning signs before becoming crises. The purpose of the study is to examine automation for critical thinking and consultancy services to mitigate biasness in decision making process.The research method was survey using likers scale statements for quantitative analysis. Transformed data was used for Pearson Correlation and multiple regression analysis. The result revealed that automation significantly shift accountant's consultancy roles in commercial banks (R^2= 0.779, adjusted R^2 = 0.776 and the overall model was statistically significant (F = 324.5, P<0.001). AI with human judgment significantly improve financial risk assessment (R^2 = 0.657 and was statistically significant (F= 24.0, P<0.001). Automation related training significantly improves technical skills (R^2 = 0.674). Automation can significantly shift accountant roles and AI-driven insight with human analysis can give better risk assessment and decision making. Accounting firms and organizations should invest in advanced technological tools that support data analytics, automation, and AI-driven decision-making. Continuous professional training programs should be implemented to enhance accountants' technical, analytical, and strategic skills. AI systems used for financial decision-making should be designed to complement, rather than replace, human judgment. Professional accounting bodies should update curricula and certification requirements to reflect emerging technological competencies.

Keyword: Analysis, Automation, AI, Consultancy, Critical Thinking

I. Introduction

Critical thinking plays a vital role in identifying and mitigating biases, critical thinkers challenge underlying premises by helping uncover biases. Critical thinkers consider multiple perspectives and create evaluating reasoning that can help to spot flawed patterns that can lead to bias. Critical thinkers awareness of biases will aid in confirmation of bias by accessing data quality and strive to migrate bias interpretations (Tilak, Prashant, Rashini and Meenaks; 2022). Critical thinking strives for balance view points, asking question like, what data supports this. Or what's missing? They consider the impact of their decision on divers group (Ron, 2023). They breakdown components and draw a logical conclusions, judging credibility, assurance and act responsibility. Critical thinkers in banks are risk management, administrators, the innovators and technicians (Domillelo, 2024). Financial consultancy services play a vital role in helping organization mitigate biases that can impact decision making. This will improve efficiency, accuracy and costumer experience. Consultant brings specialized knowledge in identifying and addressing biases in financial process and decision. Financial consultant act as coaches helping bank customers recognize and manage psychological biases affecting their finances (Nadine Marcel, Valerio and Michael, 2024). Being objective, consultants employ data-driven approach that helps customers avoid falling prey to biases. Consultants help financial institution manage risk, meet regulations and build resilient finance functions.

The application of automation in financial consultant is important although the end costumer prefer combination of human and automated consult (Nadine, Marcel, Valerio & Michael, 2024). Robotic process automation streamlines repetitive tasks like data entry, compliance checks and report generation, freeing up consultant for strategic activities (Grant 2024). AI helps analyze vast financial data set for insight, for casting and risk assessments. Chat box and virtual assistants provide everyday

customer support, handling inquiries and basic transactions. Consultants benefit from automation and AI to monitor transactions in real-time to identify suspicious patterns and to prevent fraud (Chris,2024). Automation systems help ensure adherence to evolving financial regulations, simplifying monitoring and reporting (Halima and Manu, 2025). Consultancy balances technology with human touch for customer satisfaction. Professional officers manage business in banks and risk management specialist is consultants. AI-driven financial tools are autonomous account payable work flow with deep learning Zenskar, Tipalti and Monarch. Robo advisor and investment tools are betterment, wealth print and labs (Vadim, 2025). Compliance and risk management are mind bridge and blue dot. The financial consultants can up-skill for effective use of automation tools through several strategies which include: Upgrade financial systems to modern integrated technologies that support automation. Consultants identify repetitive tasks like data entry, invoicing and reconciliations for automation. Consultants understand how AI enhances fraud detection, risk management, and predictive analysis in finance (Sanya, 2025) and learn robotic process automation for rule based tasks like accounts payable, receivable and report generation (Shamboul, 2022). This will ensure data quality in effective automation and work with technology providers who specialize in financial automation. Areas for up-skilling are financial process automation, AI in financial process automation, AI in finance, low-code or no-code platforms and data analytics and insights (Bill, 2025). Bias in automation within a country can be data bias, algorithm bias, selection bias, confirmation bias and outcome bias. This can be reflected in credit scoring, fraud detection, financial forecasting and in auditing processes in accounting. This has negative consequences on the organization and therefore, mitigating strategies are the bank customers. Striving for representative data and testing for bias to understand AI decision paths, critical thinkers reviewing automated outcomes and checking for emergent biases. Technologies for mitigating bias include fairness-aware algorithm bias audit tools and AI practices by using a built-in solution in tackling AI bias proactively.

However, there are many empirical works on the subject. Gustafson and Jerkier (2021) researched on automation in accounting. The result showed that automated accounting may have impact as both the accounts practices and their professional roles. Also, RKeiu, Issa, Awada and Hejase (2020) worked on automation of the accounting profession as it affects employability. Findings revealed that respondents were aware of the fact that specific accountings jobs will disappear although new jobs may substitute then that necessitate skills such as critical thinking and consultancy. Gap was to generalize the needs for critical thinking and consultancy in digital world. Therefore, this study sought to examine automation for critical thinking and consultants in commercial banks. Since, automation technologies like AI, machine learning and robotic process are pivotal in helping banks achieve sustainable development goals in green finance, environmental, social and governance reporting, risk management and financial inclusion. The aim of the study is to examine automation for critical thinking and consultancy services to mitigate biasness in commercial banks. The aim was achieved based on the following objectives to:

i Mention automation skill sets required for accountants consultancy roles
ii State ways the integration of AI-driven insights with human judgment impact financial risk assessment and strategic decision making in financial sector.
iii Explain how automation training improve accountant technical skills in financial sector.

Research questions are:

i. How does automation change the skills sets required for accountants in consultancy role?
ii. How does the integration of AI-driven insights with human judgment impact financial risk assessment and strategic decision making in financial sector?
iii. Can training improve accountants' technical skills?

Research hypothesis are:

Ho Automation does not significantly shift accountants consultancy roles in commercial banks to mitigate biasness in decision making processes.

Ho AI-driven insight with human judgment cannot give better risk assessment and decision making in financial data interpretation.

Ho Accountants who undergo automation related training will not experience a significant improvement in their technical skills.

II. Methods

The research design provides answers to technique used for the data collection and analysis tools. The research method was survey using liker scale statements for quantitative analysis after data transformation. The study investigated automation for critical thinking and consultancy to mitigate biasness in commercial banks. Although all the staff of the First Bank PLC were eligible to fill the questionnaire, the sample size was determined using Taro Yamane formula which was 390 staff of the institution. Questionnaire was randomly distributed to the staff of the First Bank Nigeria PLC. The validity of the questionnaire was based on the content and construct validity to confirm complete and relevant information received from the respondents. In order to measure the reliability of the questionnaire, the information collected from the respondents was subjected to test-retest reliability assessment. The data collected was analyzed by using regression analysis by using SPSS version 25. The population of the study was 16000 staff of First Bank Ibadan. Eligible staff are department heads, IT professionals, customer service representatives, risk management and compliance officers in the institution. The sample size was determined by using Taro Yamane formulae

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

where n = Sample size
N = Population size
e = Margin error (0.05)
if N = 16000
n = 390 sample size.

The sampling technique adopted for the study were survey sampling technique and simple random sampling to administer the questionnaire among the staff of the First Bank Nigeria PLC Ibadan. The data collection instrument are questionnaire and personal interview. To know the validity of the instrument used for the study, content validity and construct validity were carried out. The validity of questionnaire was based on the content and construct validity to ensure that the information received from the respondents cover all relevant areas in the objective of the study. In order to establish the validity of the instrument, SPSS was used concurrently on the responses from the questionnaire and comparison was made thereafter to determine the quality and accuracy of the instrument. Reliability has to do with consistency of the instrument. To test the consistency, test-retest reliability was carried out. There was pilot survey a month before main administration of the questionnaire. It was found out that information contained in the first set of questionnaire did not vary considerably with the information contained in the second set of questionnaire administration. To have a valid reliable data, the researcher ensured that questionnaire were clearly formulated which allowed error minimization.

The questionnaire used was capable of conveying information for the study adequately. The questionnaire was divided into two sections. The section A was on demographic data of the respondents and the section B was to answer the research questions. The sample size was 390 by using Taro Yamane's formula but only 374 questionnaires was collected back for analysis. In the descriptive statistics mean, median and mode for central tendency, standard deviation for dispersion was calculated. Also frequency distribution by counting of respondents per liker scale point (1-5): 1-5 strongly agree 2- Disagree 3- Neutral, 4- Agree and 5- strongly Agree. For hypothesis one, regression analysis and conceptual modeling was used to analyze the data. Critical thinking as dependent variable (Y) and New technical skills, financial data analysis, strategic advisory services and analytical thinking as variable x (x_1,x_2, x_3,and x_4). For hypothesis two, correlation analysis was used for AI, human and AI plus human judgment. Regression model predicts risk accuracy based on AI/ human inputs. The

dependent variable (Y) is financial risk assessment accuracy. Independent variable (X) are AI recommendation, human judgment and AI with human judgment input (x_1, x_2 and x_3) respectively. For hypothesis three, paired t-test and Wilcoxon sign rank correlation analysis was used to measure the effectiveness of automation related training in improving accounting technical skills by using SPSS version 25. Dependent variable (Y) is comparison of mean score of technical skills before and after training. Independent variables (X) are improved understanding of the technical skills, confidence and applications using SPSS version 25. The mean scores and standard deviations were calculated and determine significance level which is p-value to conclude the training effectiveness.

III. Result

This subsection presents the descriptive statistics for the variables used to test the three hypotheses.

A. Hypothesis One Variables

Table 1: Automation roles in shifting accountants focus

	Observation	Frequencies				
		SD	D	N	A	SA
i.	Critical thinking (y)	83	-	16	217	58
ii.	New technical skills (x_1)	52	31	18	201	72
iii.	Financial Data Analysis (x_2)	79	-	22	174	99
iv.	Strategic advisory services (x_3)	-	95	4	158	117
v.	Analytical thinking (x_4)	-	99	-	129	146

Hypothesis One examined whether automation and advanced technologies shift accountants' focus toward higher-order skills, particularly critical thinking. The mean score for critical thinking was 3.48, indicating a moderately high level of agreement that automation enhances accountants' critical thinking capabilities. The independent variables—use of new technologies (mean = 3.57), financial data analytics (mean = 3.55), strategic tasks (mean = 3.72), and analytical skills (mean = 3.82)—all recorded mean values above the neutral midpoint, suggesting that respondents generally perceive automation as promoting advanced professional competencies.

B. Hypothesis Two Variables

Table 2: AI, Human Judgement & Risk Assessment

S/N	Observation	Frequencies				
		SD	D	N	A	SA
i.	Financial Risk Assessment (y)	5	4	6	17	17
ii.	AI recommendations (x_1)	-	12	1	36	-
iii.	AI identify risk faster (x_2)	8	12	-	-	29
iv.	Human judgement reliable (x_3)	-	15	11	23	-
v.	AI with Human judgement (x_4)	9	6	-	34	-

Hypothesis Two focused on the role of AI, particularly when combined with human judgment, in improving financial risk assessment. The mean score for financial risk assessment was 3.61, reflecting a positive perception of AI-supported decision-making. AI-based recommendations (mean = 3.45), speed of AI processing (mean = 3.59), reliance on human expertise (mean = 3.12), and AI–human collaboration (mean = 3.27) all showed moderate agreement, indicating balanced views on the integration of AI and human judgment.

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Business and Social Science
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C. Hypothesis Three Variables

Table 3: Effective Automation Related Training

S/N	Observation	Frequencies				
		SD	D	N	A	SA
i.(a)	Technical skill before? (y)	-	105	100	39	130
i.(b)	Technical skill now (y)	31	77	-	96	170
ii.	Improved Understanding (x_1)	59	46	-	269	-
iii.	Confidence (x_2)	-	104	-	60	210
iv.	Application (x_3)	44	61	-	189	80

Hypothesis Three assessed the effect of training on improving technical skills. The mean technical skill level before training was 3.46, which increased to 3.72 after training, indicating a noticeable improvement. Variables measuring improved understanding, confidence, and application of skills also recorded relatively high mean scores, suggesting that training programs positively influence technical competence.

D. Testing of Hypotheses

Hypothesis One

Research Question: Does automation shift accountants' focus toward higher-order skills such as critical thinking?

Null Hypothesis (H0): Automation has no significant effect on accountants' critical thinking skills.

Pearson correlation analysis revealed strong positive relationships between critical thinking and all explanatory variables: new technologies ($r = 0.80$), financial data analytics ($r = 0.82$), strategic tasks ($r = 0.74$), and analytical skills ($r = 0.78$). These results indicate that increased exposure to automation-related tools is associated with higher levels of critical thinking among accountants. Multiple linear regression analysis further supported this finding. The model explained approximately 77.9% of the variation in critical thinking ($R^2 = 0.779$; adjusted $R^2 = 0.776$). The overall model was statistically significant ($F = 324.5$, $p < 0.001$). All predictors were significant, with financial data analytics and new technologies exerting the strongest effects. Based on these results, the null hypothesis is rejected.

Hypothesis Two

Research Question: Does the combination of AI and human judgment improve financial risk assessment?

Null Hypothesis (H0): AI and human judgment do not significantly improve financial risk assessment.

Correlation results showed that financial risk assessment was strongly associated with AI-based recommendations ($r = 0.75$), AI processing speed ($r = 0.72$), and AI–human collaboration ($r = 0.77$), while reliance on human expertise alone showed a moderate association ($r = 0.57$).

The regression model explained 68.6% of the variance in financial risk assessment (adjusted $R^2 = 0.657$) and was statistically significant ($F = 24.0$, $p < 0.001$). AI-based recommendations and AI–human collaboration were significant predictors, while processing speed was marginally significant. These findings indicate that AI is most effective when complemented by human judgment. Consequently, the null hypothesis is rejected.

Hypothesis Three

Research Question: Does training significantly improve technical skills among accounting professionals?

Null Hypothesis (H0): Training does not significantly improve technical skills.

A paired sample t-test revealed a statistically significant increase in technical skills after training ($t = 4.97$, $p < 0.001$), with a mean improvement of 0.26. The Wilcoxon signed-rank test confirmed this

result ($p < 0.001$), indicating robustness to distributional assumptions. Correlation analysis showed strong positive relationships between post-training technical skills and improved understanding ($r = 0.74$), confidence ($r = 0.77$), and application of skills ($r = 0.76$). Regression analysis indicated that these factors jointly explained 67.7% of the variance in post-training technical skills (adjusted $R^2 = 0.674$), with all predictors being statistically significant. The null hypothesis is therefore rejected. The findings demonstrate that automation and AI are reshaping the accounting profession by shifting emphasis from routine tasks to higher-order cognitive skills such as critical thinking and strategic analysis. The strong influence of data analytics and advanced technologies suggests that accountants increasingly operate as strategic advisors rather than mere record keepers. The results also show that AI significantly enhances financial risk assessment when used in conjunction with human judgment. Rather than replacing professionals, AI serves as a decision-support tool that improves accuracy and efficiency. The study confirms that training plays a critical role in improving technical skills. Structured training programs enhance understanding, confidence, and practical application, thereby equipping accountants to adapt effectively to technological change. The findings revealed that automation significantly shifts accountants' focus toward higher-order skills, particularly critical thinking, strategic analysis, and advanced data analytics.

The study also established that AI enhances financial risk assessment most effectively when integrated with human judgment. Furthermore, empirical evidence confirmed that training programs significantly improve technical skills, leading to higher confidence, better understanding, and improved application of knowledge. The study concludes that technological advancement is fundamentally transforming the accounting profession. Automation and AI do not diminish the relevance of accountants; rather, they elevate the profession by enabling practitioners to focus on value-added, analytical, and strategic roles. However, the effectiveness of these technologies depends heavily on complementary human expertise and adequate training. Without appropriate training and organizational support, the benefits of automation and AI may not be fully realized. Therefore, the successful integration of technology in accounting requires a balanced approach that combines technological innovation with continuous human capacity development. Based on the findings of this study, the following recommendations are made:

1. Accounting firms and organizations should invest in advanced technological tools that support data analytics, automation, and AI-driven decision-making.
2. Continuous professional training programs should be implemented to enhance accountants' technical, analytical, and strategic skills.
3. AI systems used for financial decision-making should be designed to complement, rather than replace, human judgment.
4. Professional accounting bodies should update curricula and certification requirements to reflect emerging technological competencies.

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Use of Collaborative Technologies for Teaching and Learning in Academic Communities: Benefits, Barriers and Possible Solutions

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Abstract

This paper discussed the use of collaborative technologies for teaching and learning in academic institutions, their benefits, barriers and possible solutions within academic environments. The use of collaborative technologies has transformed teaching and learning in academic communities by facilitating communication, knowledge sharing, interaction and collaborative engagement among librarians, lecturers, students, researchers and other academic stakeholders. Technologies such as Google Workspace, Microsoft Teams, Zoom, Moodle, WhatsApp, and online discussion forums provide platforms through which academic communities can communicate, share learning resources, conduct virtual classes, collaborate on assignments and research projects, and provide timely feedback. The benefits of these technologies include improved student engagement, enhanced communication, flexible and remote learning, increased access to academic resources, teamwork, knowledge sharing and improved teaching effectiveness. However, in developing countries like Nigeria, their adoption is constrained by several barriers, including inadequate digital infrastructure, poor internet connectivity, high cost of data and devices, limited digital literacy among users, inadequate technical support, resistance to technological change, privacy and security concerns, and unequal access to technology. To address these challenges, academic institutions should invest in reliable digital infrastructure and internet services, provide continuous digital literacy training for librarians, lecturers and students, strengthen technical support services, develop clear technology-use policies, and promote equitable access to digital devices and learning platforms. Institutions should also encourage blended learning approaches and provide appropriate funding for the sustainable adoption of collaborative technologies. The effective integration of collaborative technologies can therefore contribute significantly to creating more interactive, inclusive, flexible, and learner-centred academic communities.

Keyword: Collaborative Technologies, Teaching, Learning, Academic Community

I. Introduction

Technology has significantly transformed education and communication in recent years. It has enabled new ways of learning and teaching, making education more accessible and interactive. It has also revolutionized communication, allowing for instant and seamless exchange of information across various channels. This has facilitated better collaboration among educators, students and parents, improving educational outcomes. In Fasola and Abimbola (2023) technology in this era of the internet and the World Wide Web have turned academic communities to places where users and information are only few steps apart, creating opportunities for better participation by information seekers in the gathering, organising and sharing of information. Wiche et al,. (2022) report that academic staff are taking advantage of these technological advancements in the computer and telecommunications fields to improve their delivery and also to collaborate with scholars in different field from all over the world. The Web provides a variety of useful tools for users to interact and communicate with others by organising information, store records, disseminate and retrieve or share information. Academic collaboration is more crucial than ever in this digital world than before. The rate of scientific advancement is quickening and societal problems are getting more complicated. Some academics staff use collaborative technologies in order to share ideas, pool resources and build on another scholars' research in order to overcome many issues (Hassandoust & Kazerouni, 2011).

On this note, collaborative technologies are digital platforms and tools used in academic institutions to facilitate communication, knowledge sharing, information exchange, group work,

teaching, learning and research collaboration among members of the academic community. According to Indeed (2026) collaborative technologies are tools or software designed to facilitate working in groups and holding real-time meetings in the office and remotely. Yevheniia (2025) also defines collaborative technologies as suite of digital tools that lets individuals and teams unite efforts, even when they're located in different places. These technologies are designed to enable and support teamwork.

Collaborative technologies can therefore support teaching and learning, research collaboration and institutional teamwork. Mansori et al (2024) affirm that collaborative technologies are not meant to facilitate communication between students and lecturers only, but also to foster more inclusive and collaborative learning environment. Tools such as discussion platforms, instant messaging, miro, slack, padlet, google workspace, video conferencing and so on, enable quick communication among students, lecturers and administrators in academic environment (Pamela, 2025). These tools enable students to work together on assignments, projects, presentation and group discussions even when they are not physically together. Academic staff and researchers can share articles, lecture materials, research findings, databases and other educational resources. These technologies also increase academic engagement, in the sense that interactive platforms can encourage students to participate in discussions and contribute ideas beyond traditional classrooms. In academic environment, many ICT tools support collaborative learning, notably Google Workspace, Microsoft Teams, and Padlet. These platforms let students work together at the same time, share files and talk with each other easily.

Moreover, some academic libraries also use tools like Google workspace, Microsoft teams and Cloud storage to improve group research, manage internal projects and deliver fast virtual reference services. Besides, librarians can use collaborative technologies to promote library resources, conduct information literacy training and communicate with users to support library services (Fasola & Abimbola, 2023). So also, these tools enable lecturers to distribute learning materials, conduct virtual classes, provide feedback and monitor student's participation. Not only these, but multiple users can also work on the same document or project simultaneously, reducing delays and making academic work more efficient. By considering several positive and negative influences of collaborative technologies on the academic community, including students, lecturers, researchers and librarians. Therefore, this study sought to examine the trends, benefits, barriers and possible solutions to the use of collaborative technologies in academic communities.

A. Objectives of the study

1. To overview the current trends in collaborative technologies in academic community
2. To identify the benefits of using collaborative technologies for teaching and learning in higher institutions.
3. To discuss barriers to the use of collaborative technologies for teaching and learning in academic community
4. To highlight the possible solutions to the barrier facing the use of collaborative technologies in academic communities.

II. Literature Review

Current Trends on Collaborative Technologies in Academic Community

Emerging trends on uses of collaborative technologies in academic community refer to the current ways digital tools are being used by students, lecturers, researchers, librarians and university administrators to communicate, share knowledge, create content and work together. Today's collaborative efforts among people in academic environment have become preponderantly technology-mediated. According to Consoltech (2019), collaborative technology refers to tools and systems designed to enable group of people to communicate, share information, work together and create knowledge, whether they are physically together or working remotely. Most of the popularly used collaborative tools are widely known to function with a combination of text, video and graphics while some are either text oriented or video oriented in their features (Samuel & Esther, 2020). Academic

institutions are rapidly adopting collaborative technologies, such as AI-driven platforms, cloud-based ecosystems and immersive virtual work-spaces to enhance remote and cross institutional team-works. Based on current high-education development, some important trends which include Google workspace, Microsoft team, Zoom, Moodle, WhatsApp, Discussion fora amongst others will be discussed as follows:

The google workspace provides tools such as Google Docs, Google Drive, Google Sheets, Google Slides, Google Forms, G-mail and Google Meet. These tools can be used to support teaching, learning, research, and administration in academic institution. These allow students to work with lecturers on research projects, research presentations, assignments and on documents in real time. G-mail, Google Meet and others workspace tools facilitate communication between lecturers, students, researchers, librarians and administrators. Google file also allows users to store, organise, access and share academic documents from different devices. Researchers use Google Docs for collaborative writing, Google Sheets for organising data, and Google Forms for collecting research responses (UNESCO, 2026).

More so, Microsoft teams is a collaborative platform that can support communication, teaching, learning and information sharing. Likewise, it facilitates virtual teaching, group work, communication, file sharing, assignment management, peer learning, research collaboration and interactive between lecturers and students. Lecturers and students can share their screen, presentations, documents and other learning materials during online classes. Online session can also be recorded where the institution's settings and permissions allow it, this will enable students to review lessons later. Team can work with Microsoft 365 applications such as Word, Power-point, Excel, and OneNote to support a connected learning environment. Therefore, Microsoft teams serve as important collaborative technology for supporting teaching and learning in academic environment (Ogudu, 2023).

Zoom is a video-conferencing platform that support real-time communication, interaction, and collaboration between lecturers and students. It is majorly use in academic environments for online lectures, virtual class discussions, group learning, breakout rooms, screen sharing, guest lecture and seminars, online presentations, research collaboration, interactive learning, flexible learning and so on. It can therefore complement face-to-face teaching and provide opportunities for students and lecturers to collaborate regardless of their physical location (Thomas & Amer, 2019).

In addition is Moodle. Its full meaning is "Modular Object-Oriented Dynamic Learning Environment". This is a learning management system that supports teaching, learning, communication and collaboration among students and their lecturers. Moodle forums allow lecturers to discuss academic topics with their students, ask questions, exchange ideas and provide feedback. Students can submit assignments electronically, while lecturers can assess the work and provide comments and feedback through the platform. Similarly, the lecturers can monitor students' participation, assignment submissions, quiz performance, and progress through course activities. Moodles can be integrated with various educational tools and resources, allowing institutions to create a broader digital learning environment (UNESCO, 2026).

WhatsApp is another trend which can be used as a collaborative communication tool to support teaching, learning and interaction between lecturers and students. Its major uses include: quick communication, urgent reminders and notifications, support for remote learning, peer-to-peer learning, sharing of learning materials, assignment collaboration, voice and video learning sessions, and building an academic community. Its widespread use and relatively simple interface make it a potentially useful supplementary tool for academic collaboration (Claudio et al., 2021)

Discussion forum is an online platform where lecturers can post questions, share ideas, discuss academic topics and respond to one another. Discussion forums enhance collaborative teaching by promoting interaction, knowledge sharing, peer learning, critical thinking, feedback, group problem-solving, and contentious academic communication between lecturers and students. They can therefore compliment face-to-face teaching and strengthen collaborative learning in academic communities beyond the physical classrooms. Students can contribute to online discussions at convenient times, making forums useful for online, blended, and distance learning environments. It also gives students

opportunities to participate in learning activities, including those who may be less comfortable speaking in a physical classroom (Jerry & Beatrice, 2024).

B. Benefits of using Collaborative Technologies for Teaching and Learning in Higher Institutions.

A new era of educational innovation has been brought about by the digital revolution, which has transformed traditional classrooms into dynamic, interactive learning environments (Sylvanus et al., 2024). Collaborative technologies promote communication, teamwork, knowledge sharing, research collaboration, students' engagement, flexibility and digital competence in academic communities. Effective communication and collaboration play a crucial role in educational institutions. In Fasola and Abimbola (2023), collaborative technologies foster a positive learning environment, boost student engagement, and enhance academic performance. Also, they facilitate seamless information sharing between teachers and students. Tools such as email, instant messaging, discussion forum and video conferencing platforms make communication between students and lecturers faster and easier. Similarly, researchers can use Google Docs for collaborative writing, Google Sheets for organising data, and Google Form for collecting research responses.

Also, collaborative technologies transform teamwork in higher education by breaking down physical barriers, streamlining group assignments and preparing students for modern digital workplaces. Sylvanus et al. (2024) identify smart classroom, digital libraries and smart devices as determinants of collaborative teamwork that improved learning in secondary schools in Uyo Metropolis, Nigeria. Also, collaborative technologies transform research in higher education by connecting scholars across global distances. They allow real-time co-authoring, seamless data sharing, and efficient project management. Essential tools include cloud suites, file-sharing platforms, google drive, box, iCloud drive, Dropbox, Microsoft OneDrive, Quip, Slack and Visual spaces. All these tools enable individuals to share file and documents while others are used for knowledge sharing by teams in organisations (Fasola & Abimbola, 2023). Students can create and manage group assignments collaboratively, allowing members to contribute even when they are not physically together, as a result of this, collaborative technologies transform passive classrooms into active learning spaces.

Dwi et al (2024) affirms that by supporting student engagement through collaborative technology-based collaborative platforms had a major impact on student engagement. Similarly, the presence of collaborative learning platforms makes students more enthusiastic and excited because it attracts students' attention. The use of collaborative technologies in higher education can significantly improve students' engagement by making learning more interactive, participatory, and flexible. Regular use of collaborative platforms helps students to develop communication, teamwork, information sharing, and technology skills that will be useful for academic and professional development. Likewise, it enables lecturers and peers to comment on students' contributions, assignments or group work, helping students to identify areas for improvement, students can also exchange ideas, explain concepts from one another. These collaborative technologies also help students to feel connected to their classmates and their lecturers (Sylvanus et al., 2024).

C. Barriers to the Use of Collaborative Technologies for Teaching and Learning in Academic Communities.

As technologies are widely considered as essential tools for teaching with strong potential for enhancing learning, so as academic institutions also faced many challenges when using technologies for group work and information sharing. Although collaborative technologies improve communication, knowledge sharing, teamwork, and teaching and learning, their effective use in academic communities can be limited to some inevitable factors (Abdul-Hassim. & Bakar, 2025).

The major barriers to the using of collaborative technologies in higher institutions include limited digital literacy skills among students and lecturers, managing student distractions, resistance to pedagogical change, high costs, poor internet, lack of training, the digital divide, privacy and security concerns, lack of institutional supports and compatibility and integration problems (Jennifer

et al, 2022). Similarly, academic community often face barriers of outdated communication methods and limited resources. Also, the rapid pace of technological advancements can make it difficult for academic community to keep up and adapt. As a result of this, the lecturers and the students may struggle to maintain effective communication and collaboration (Ranbir, 2024).

Despite the potential of technology in education which has been embraced to create more interactive and personalized learning experience, still, so many students easily get distracted while handling digital tools by playing games or watching videos instead of doing schoolwork or engaging themselves with educative platforms. Social media notifications, entertainment, unrelated online activities, and inappropriate use of collaborative platforms may reduce users' concentration and academic performance (Mary, 2024). Similarly, unreliable power and connectivity lead to frequent power outage and low internet bandwidth interrupt online classes, meetings, research activities and access to cloud-based resources, especially in institutions where alternative power sources are limited. Not only that, but unequal hardware distribution also creates a digital divide between well-funded and under-resourced student groups. Differences in access to devices, internet services, and digital skills among students and lecturers can create unequal opportunities to participate in technology-supported academic activities.

Ranbir (2024) reports high costs of purchasing software licenses, hardware upkeep, network upgrades and strain institutional finances as parts of challenges facing in integration of technology into educational systems. Insufficient funding for purchasing and maintaining technology is a major obstacle in many higher institutions in developing counties like Nigeria. Not only that, inadequate or declining opportunities for training and professional development prevent many lecturers from building the necessary skills to enhance their teaching methodologies. Lack of ongoing technical support and troubleshooting assistance also hinders effective use of collaborative technologies for teaching and learning in higher institutions. Some lecturers and students are still feeling reluctant to change established practices or doubt the value of technology for teaching and learning.

III. Possible Solution to Barriers Facing the Use of Collaborative Technologies in Higher Institutions

In developing countries like Nigeria, academic institutions are facing many barriers when using collaborative technology, such as poor internet, high-cost bandwidth, lack of regular training and so on. Overcoming these barriers requires targeted investment, robust technical support, strategic planning, target policy, continuous professional development and fair distribution of resources to support effective and inclusive technology integration in education (Abdul-Hassim & Bakar; Ranbir, 2024). In order to tackle these problems, academic libraries should provide reliable, high-speed and affordable internet services across campuses to support online collaboration. Institutions should invest on computers, projectors, smart devices. Servers and other technological facilities required for collaborative teaching and learning. Similarly, lecturers, librarians, students and other staff should receive continuous training on the effective use of tools such as Google Workspace, Microsoft Teams, Zoom, Moodle and Discussion Forums. (Johnson et al, 2016).

Additionally, institutions can provide subsidized internet data, campus Wi-Fi and access to licensed collaborative platforms in order to reduce financial burdens on users. Not only that, reliable electricity and alternative power sources such as solar systems and generators should be provided to keep technological facilities operational. To protect academic information and users' data, strong security measures, user authentication and awareness programmes should be implemented. Moreover, institutions should provide inclusive access to ensure that students and staff with disabilities or limited technological skills can participate effectively in digitally supported academic activities. In addition, institutions should select collaborative tools that are easy to use, mobile-friendly and compatible with the devices commonly available to students and staff. Management should also encourage lecturers and staff to embrace and adopt collaborative technologies by demonstrating their benefits and involving users in technology-related decisions (Khan & Khan, 2025).

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IV. Conclusion and Recommendations

In conclusion, the use of collaborative technologies has become an important part of teaching, learning, communication, and knowledge sharing in academic environments. Platforms such as Google Workspace, Microsoft Teams, Zoom, Moodle, WhatsApp and discussion forums enable librarians, lecturers and students to interact, share resources, work on group projects, communicate beyond the traditional classroom, and participate in learning activities more conveniently.

Despite these benefits, challenges such as poor internet connectivity, insufficient digital skills, unreliable power supply high costs of maintenance, inadequate ICT infrastructure, technical problems and concerns about privacy and security may limit effective adoption. Therefore, academic institutions should provide adequate technological infrastructure, reliable internet and power supply, regular training, technical support, and appropriate institutional policies in order to encourage usage in academic communities. Similarly, academic institutions can also encourage blended learning approaches and provide appropriate funding for the sustainable adoption of collaborative technologies. In conclusion, the effective integration of these collaborative technologies can therefore contribute significantly to creating more interactive, inclusive, flexible, and learner-centred academic communit**ies.**

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Influence of Artificial Intelligence-Assisted Language Learning on French Language Proficiency Among NCE and Degree Students in Selected Federal Colleges of Education, South-West Nigeria

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Abstract

Artificial Intelligence is increasingly transforming language education through personalised learning, immediate feedback, and flexible instructional support. However, empirical evidence on its influence on French language proficiency among students in Nigerian Colleges of Education remains limited. This study investigated the influence of Artificial Intelligence-assisted language learning on French language proficiency among NCE and Degree Primary Education students offering French courses in selected Federal Colleges of Education in South-West Nigeria. Specifically, the study examined the level of Artificial Intelligence-assisted language learning and its influence on students' French language proficiency. Six research questions and six null hypotheses guided the study. The study adopted a descriptive survey research design with a correlational component. The population comprised 860 students, from which 269 respondents were selected using purposive, proportionate stratified, and simple random sampling techniques. Data were collected using the researcher-developed Artificial Intelligence-Assisted Language Learning Questionnaire (AIALLQ) and the French Language Proficiency Test (FLPT). The instruments were validated by experts, while reliability coefficients of 0.88 and 0.84 were obtained, respectively. Descriptive statistics and simple linear regression were used to analyse the data at the 0.05 level of significance. The findings revealed a high level of Artificial Intelligence-assisted language learning and French language proficiency among the respondents. Artificial Intelligence-assisted language learning significantly influenced listening, speaking, reading, writing, grammar competence, and vocabulary acquisition. The study concluded that integrating Artificial Intelligence into French language instruction enhances students' language proficiency. It was recommended that lecturers should integrate appropriate Artificial Intelligence tools into teaching, while institutions should strengthen digital infrastructure and provide continuous professional development for French language educators.

Keyword: Artificial Intelligence-Assisted Language Learning, Federal Colleges of Education, French Language Proficiency, Primary Education Students, South-West Nigeria.

I. Introduction

Artificial intelligence (AI) has become one of the most transformative innovations shaping contemporary education across the world. The integration of AI-powered technologies into teaching and learning has expanded opportunities for personalised instruction, immediate feedback, adaptive learning pathways and improved access to educational resources. In language education particularly, AI applications have created new possibilities for developing learners' communicative competence through interactive platforms capable of supporting listening, speaking, reading and writing skills. Consequently, higher education institutions are increasingly exploring AI-assisted instructional approaches to enhance students' learning experiences and academic outcomes. The growing adoption of AI in tertiary education reflects a global shift towards technology-enhanced pedagogy aimed at preparing graduates with the digital competencies required in the twenty-first century (UNESCO, 2023; Zawacki-Richter & Qayyum, 2023).

The teaching and learning of French as a foreign language occupy a strategic position within Nigeria's educational system because of the country's geographical, diplomatic and economic relationships with neighbouring Francophone nations. Proficiency in the French language contributes significantly to regional integration, international communication, academic mobility and employment opportunities. Despite these recognised benefits, many students enrolled in French Education

programmes continue to experience challenges in attaining satisfactory levels of language proficiency, particularly in oral communication, grammatical accuracy, vocabulary development and written expression. These persistent challenges have prompted educators to seek innovative instructional strategies capable of improving learners' engagement and language acquisition. Recent educational studies suggest that technology-supported language instruction, especially AI-assisted learning, has the potential to address many of these learning difficulties through continuous practice, personalised feedback and learner-centred interaction (OECD, 2023; Holmes et al., 2022).

Artificial Intelligence-assisted language learning involves the purposeful utilisation of intelligent digital tools to facilitate language acquisition through adaptive instruction, automated feedback, conversational simulations and personalised learning support. Contemporary AI applications such as intelligent tutoring systems, conversational chatbots, speech recognition software, grammar correction tools and generative AI platforms provide learners with opportunities to practise language skills beyond the traditional classroom environment. Unlike conventional computer-assisted language learning, AI systems are capable of responding dynamically to learners' individual needs, thereby promoting independent learning and sustained academic engagement. Empirical evidence indicates that students who effectively integrate AI technologies into their learning activities often demonstrate improved motivation, increased learning autonomy and enhanced academic performance across various educational settings (Kasneci et al., 2023; Tlili et al., 2023). Nevertheless, the educational benefits of these technologies depend largely on learners' ability to utilise them appropriately and responsibly.

French language proficiency represents a multidimensional construct encompassing learners' competence in listening, speaking, reading, writing, grammar and vocabulary. These interrelated language skills collectively determine an individual's ability to communicate effectively in authentic social and academic contexts. Achieving proficiency requires continuous exposure, regular practice and meaningful interaction with the target language. In many Nigerian tertiary institutions, however, limitations such as inadequate language laboratories, insufficient instructional resources, limited opportunities for authentic communication and large class sizes continue to impede students' language development. AI-assisted learning presents a promising alternative by providing immediate corrective feedback, simulated conversational practice and unlimited opportunities for independent learning irrespective of classroom constraints. Emerging evidence has shown that carefully integrated AI technologies can positively influence learners' confidence, language accuracy and communicative competence when aligned with sound pedagogical principles (UNESCO, 2023; Crompton & Burke, 2023).

Within Federal Colleges of Education in South-West Nigeria, efforts have continued to improve the quality of French language instruction through curriculum innovation, digital transformation and technology-enhanced teaching practices. Nevertheless, the extent to which AI-assisted language learning contributes to improved French language proficiency among NCE and Degree students remains insufficiently documented. While previous investigations have examined technology integration and digital learning in higher education, relatively few have specifically explored the influence of AI-assisted language learning on the various dimensions of French language proficiency within the Nigerian teacher education context. This gap in empirical evidence limits informed decision-making regarding curriculum planning, instructional practice and investment in AI-enabled educational technologies for French language education (Bozkurt et al., 2023; Tlili et al., 2023).

It is against this background that this study seeks to examine the influence of Artificial Intelligence-assisted language learning on French language proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria. Specifically, the study will investigate students' level of AI-assisted language learning, determine their level of French language proficiency and examine the extent to which AI-assisted language learning influences listening, speaking, reading, writing, grammar competence and vocabulary acquisition. The findings are expected to provide empirical evidence that will assist educational administrators, curriculum

developers, French language lecturers and policymakers in strengthening technology integration within French Education programmes. Furthermore, the study will contribute to the growing body of literature on AI in language education and provide practical recommendations for improving language teaching and learning within Nigerian tertiary institutions.

A. Statement of the Problem

The increasing integration of Artificial Intelligence (AI) into higher education has created new opportunities for enhancing language teaching and learning through personalised instruction, immediate feedback and flexible learning environments. Despite these advantages, there is growing concern that many NCE and Degree students studying French in Federal Colleges of Education continue to experience difficulties in attaining satisfactory levels of language proficiency, particularly in listening, speaking, reading, writing, grammar competence and vocabulary acquisition. Although AI-powered language learning tools are becoming more accessible, there is limited empirical evidence regarding the extent to which these technologies are being utilised by French language students and whether such utilisation translates into measurable improvements in language proficiency within the Nigerian teacher education context. Most existing studies have concentrated on general technology integration, digital learning or AI adoption in higher education without specifically examining AI-assisted language learning as a predictor of the various dimensions of French language proficiency among prospective French teachers. This gap in knowledge creates uncertainty for lecturers, curriculum planners, institutional administrators and policymakers who require evidence-based information for making informed decisions on technology integration in French Education programmes. It is therefore unclear whether the growing investment in AI-assisted learning is producing the expected improvements in students' language competence. Consequently, this study sought to investigate the influence of Artificial Intelligence-assisted language learning on French language proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.

B. Purpose and Objectives of the Study

The purpose of this study was to examine the influence of Artificial Intelligence-assisted language learning on French language proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria. Specifically, the study sought to:

1. Determine the level of Artificial Intelligence-assisted language learning among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.
2. Examine the level of French language proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.
3. Determine the influence of Artificial Intelligence-assisted language learning on students' listening proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.
4. Examine the influence of Artificial Intelligence-assisted language learning on students' speaking proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.
5. Determine the influence of Artificial Intelligence-assisted language learning on students' reading and writing proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.
6. Examine the influence of Artificial Intelligence-assisted language learning on students' grammar competence and vocabulary acquisition among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.

C. Research Questions

The following research questions guided the study:

1. What is the level of Artificial Intelligence-assisted language learning among NCE and Degree students in Federal Colleges of Education in South-West Nigeria?
2. What is the level of French language proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria?
3. What influence does Artificial Intelligence-assisted language learning have on students' listening proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria?
4. What influence does Artificial Intelligence-assisted language learning have on students' speaking proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria?
5. What influence does Artificial Intelligence-assisted language learning have on students' reading and writing proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria?
6. What influence does Artificial Intelligence-assisted language learning have on students' grammar competence and vocabulary acquisition among NCE and Degree students in Federal Colleges of Education in South-West Nigeria?

D. Research Hypotheses

The following null hypotheses were tested at the 0.05 level of significance:

H_{01}: Artificial Intelligence-assisted language learning has no significant influence on students' listening proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.

H_{02}: Artificial Intelligence-assisted language learning has no significant influence on students' speaking proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.

H_{03}: Artificial Intelligence-assisted language learning has no significant influence on students' reading proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.

H_{04}: Artificial Intelligence-assisted language learning has no significant influence on students' writing proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.

H_{05}: Artificial Intelligence-assisted language learning has no significant influence on students' grammar competence among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.

H_{06}: Artificial Intelligence-assisted language learning has no significant influence on students' vocabulary acquisition among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.

II. Research Design

This study adopted the **descriptive correlational survey research design**. The design was considered appropriate because it enabled the researcher to examine the existing relationship between Artificial Intelligence-assisted language learning and the various dimensions of French language proficiency without manipulating any of the study variables. The study focused on collecting data from NCE and Degree students in their natural learning environments in order to determine the extent to which AI-assisted language learning influenced listening, speaking, reading, writing, grammar competence and vocabulary acquisition. The descriptive aspect of the design facilitated the assessment of the prevailing levels of AI-assisted language learning and French language proficiency among the respondents, while the correlational component made it possible to establish the direction and magnitude of the relationship between the independent and dependent variables. The design was therefore suitable because it generated reliable empirical evidence that addressed the research objectives and hypotheses while maintaining the real-life educational context in which the variables naturally occurred.

Australian Journal of
Business and Social Science
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A. Population of the Study

The population for this study comprised all NCE and Degree Primary Education students offering French courses in selected Federal Colleges of Education in South-West Nigeria during the 2025/2026 academic session. These students constituted the target population because French is offered as one of the prescribed courses within their teacher education programme, thereby providing them with adequate exposure to French language instruction and opportunities to utilise Artificial Intelligence-assisted language learning tools. Consequently, they were considered capable of providing reliable information on their use of AI-assisted language learning and their level of French language proficiency. The selected institutions were the Federal College of Education (Technical), Akoka, Lagos; Federal College of Education, Abeokuta, Ogun State; and Adeyemi Federal University of Education, Ondo. According to the enrolment records obtained from the Academic Planning Units and the Departments of Primary Education Studies of the respective institutions for the 2025/2026 academic session, the eligible population comprised 320 students from the Federal College of Education (Technical), Akoka, 240 students from the Federal College of Education, Abeokuta, and 340 students from Adeyemi Federal University of Education, giving a total population of 900 students.

B. Sample and Sampling Techniques

A sample size of 269 respondents was selected from the total population of 900 students using the Research Advisors (2006) Sample Size Determination Table. The sample was proportionately distributed among the three selected institutions based on their respective student populations to ensure fair representation of all respondents.

A multi-stage sampling procedure was employed for the study. At the first stage, purposive sampling was used to select the three Federal Colleges of Education because they offer French as a prescribed course within their Primary Education programmes. At the second stage, proportionate stratified random sampling was employed to allocate the sample to each institution according to its student population. The respondents were further stratified according to programme (NCE and Degree) and level of study to ensure adequate representation of all categories of students. Thereafter, simple random sampling technique (balloting without replacement) was used to select the required number of respondents from each stratum. The combination of these sampling techniques was considered appropriate because it enhanced representativeness, minimised sampling bias and improved the reliability and generalisability of the findings.

C. Instrument For Data Collection

Two researcher-developed instruments were used for data collection in this study, namely the *Artificial Intelligence-Assisted Language Learning Questionnaire (AIALLQ)* and *the French Language Proficiency Test (FLPT).* The AIALLQ was designed to elicit information on respondents' utilisation of Artificial Intelligence-assisted language learning and consisted of 35 items organised into two sections. Section A contained 5 items on respondents' demographic characteristics, including institution, programme (NCE or Degree), level of study, gender and age. Section B comprised 30 items arranged to address the study variables. Specifically, Items 1–5 measured the level of Artificial Intelligence-assisted language learning (Research Question 1); Items 6–10 measured students' perceived level of French language proficiency (Research Question 2); Items 11–15 assessed the influence of Artificial Intelligence-assisted language learning on listening proficiency (Research Question 3); Items 16–20 assessed its influence on speaking proficiency (Research Question 4); Items 21–25 assessed its influence on reading and writing proficiency (Research Question 5); while Items 26–30 measured its influence on grammar competence and vocabulary acquisition (Research Question 6).

Items in Section B of the AIALLQ were structured on a four-point Likert Scale consisting of Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, and Strongly Disagree (SD) = 1. The French Language Proficiency Test (FLPT) complemented the questionnaire by providing an objective assessment of students' French language competence. The test consisted of 30 objective multiple-

choice items, with five items each covering Listening, Speaking, Reading, Writing, Grammar and Vocabulary. Each correct response attracted one mark, giving a maximum obtainable score of 30 marks. The combined use of the AIALLQ and the FLPT enabled the study to obtain comprehensive data on students' utilisation of AI-assisted language learning and their actual French language proficiency, thereby enhancing the validity and credibility of the findings.

D. Validity of the Instrument

The Artificial Intelligence-Assisted Language Learning Questionnaire (AIALLQ) comprising 35 items and the French Language Proficiency Test (FLPT) comprising 30 items were researcher-developed based on the objectives of the study and an extensive review of relevant literature on Artificial Intelligence in education, technology-enhanced language learning and French language proficiency. To ensure the adequacy and appropriateness of the instruments, they were subjected to face validity, content validity and construct validity. The instruments were scrutinised by three highly experienced lecturers, comprising one specialist in French Education, one specialist in Educational Technology, and one specialist in Measurement and Evaluation. The validators carefully examined the clarity of the language, appropriateness of the items, relevance of each item to the research objectives, adequacy of content coverage, logical sequencing and overall suitability of the instruments for the target respondents. Their observations, corrections and recommendations were carefully incorporated before the final versions of the instruments were produced for the pilot study and the main data collection.

E. Reliability of the Instrument

The reliability of the Artificial Intelligence-Assisted Language Learning Questionnaire (AIALLQ) was established through a pilot study involving 30 Primary Education students offering French courses drawn from a Federal College of Education outside the selected study area. The participants were selected using simple random sampling and were not included in the main study sample. The responses obtained from the pilot test were analysed using Cronbach's Alpha reliability technique because the questionnaire items were measured on a Likert scale. The analysis yielded an overall reliability coefficient of 0.91, indicating a very high level of internal consistency among the questionnaire items.

The reliability of the French Language Proficiency Test (FLPT) was also established during the pilot study using the same 30 respondents. Since the test consisted of objectively scored multiple-choice items, the data was analysed using the Kuder-Richardson Formula 20 (KR-20) to determine the internal consistency of the test items. The analysis produced a reliability coefficient of 0.88, indicating that the test possessed satisfactory reliability for measuring students' French language proficiency. The reliability coefficients obtained for both instruments exceeded the minimum acceptable benchmark of 0.70 for educational research, confirming that the AIALLQ and the FLPT were sufficiently reliable and suitable for the main study.

F. Method Of Data Collection

Data were collected using two researcher-developed instruments: the 35-item *Artificial Intelligence-Assisted Language Learning Questionnaire (AIALLQ) and the 30-item French Language Proficiency Test (FLPT).* A total of 322 copies of the instruments were administered to selected NCE and Degree Primary Education students offering French courses in the three selected Federal Colleges of Education in South-West Nigeria. With approval from the relevant authorities, the researchers, assisted by three trained research assistants, administered the instruments through direct face-to-face interaction during scheduled French classes. Respondents were informed about the purpose of the study, assured of confidentiality, and encouraged to provide honest responses.

The administration lasted eight weeks to ensure adequate coverage of the participating institutions. Out of the 322 copies administered, 296 properly completed copies were retrieved, representing a 91.9% retrieval rate. Specifically, 92 copies were retrieved from Federal College of

Australian Journal of
Business and Social Science
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Education (Technical), Akoka; 80 from Federal College of Education, Abeokuta; and 124 from Adeyemi Federal University of Education, Ondo. The high retrieval rate was achieved through direct administration, monitoring, and immediate collection of the completed instruments by the researchers and assistants.

G. Method of Data Analysis

The data collected through the *Artificial Intelligence-Assisted Language Learning Questionnaire (AIALLQ) and the French Language Proficiency Test (FLPT)* were coded, scored, and analysed using the Statistical Package for the Social Sciences (SPSS), Version 29. Descriptive statistics, including frequency counts, percentages, mean, and standard deviation, were used to answer Research Questions One and Two on the level of Artificial Intelligence-assisted language learning and French language proficiency among respondents. The six null hypotheses were tested at the 0.05 level of significance using Simple Linear Regression Analysis to determine the predictive influence of Artificial Intelligence-assisted language learning on students' listening, speaking, reading, writing, grammar competence, and vocabulary acquisition. The null hypotheses were rejected where the probability value (p) was less than or equal to 0.05 and retained where p was greater than 0.05.

III. Results Presentation

Research Question One

What is the level of Artificial Intelligence-assisted language learning among NCE and Degree students in Federal Colleges of Education in South-West Nigeria?

Table 1: Level of Artificial Intelligence-Assisted Language Learning Among NCE and Degree Students in Federal Colleges of Education in South-West Nigeria (N = 269)

S/N	Artificial Intelligence-Assisted Language Learning Indicators	Mean ($\bar{x}$)	SD	Decision
1	I regularly use Artificial Intelligence tools to support my French language learning.	3.34	0.73	High
2	Artificial Intelligence applications improve my understanding of French language concepts.	3.29	0.69	High
3	I use Artificial Intelligence tools to practise French grammar and vocabulary outside the classroom.	3.18	0.82	High
4	Artificial Intelligence-assisted learning enables me to learn French at my own pace.	3.41	0.66	High
5	Artificial Intelligence platforms provide immediate feedback that improves my learning.	3.27	0.74	High
	Grand Mean	**3.30**	**0.73**	**High**

Table 1 presents the respondents' ratings on the level of Artificial Intelligence-assisted language learning among NCE and Degree students in Federal Colleges of Education in South-West Nigeria. The results reveal that all the five indicators recorded mean scores above the criterion mean of 2.50, with mean values ranging from 3.18 to 3.41. The highest-rated indicator was that Artificial Intelligence-assisted learning enabled students to learn French at their own pace ($\bar{x}$ = 3.41, SD = 0.66), while the lowest-rated indicator was the use of Artificial Intelligence tools to practise French grammar and vocabulary outside the classroom ($\bar{x}$ = 3.18, SD = 0.82). The overall Grand Mean of 3.30 with a Standard Deviation of 0.73 indicates that the respondents demonstrated a high level of Artificial Intelligence-assisted language learning. This finding suggests that the students actively utilised Artificial Intelligence technologies to support various aspects of their French language learning.

Research Question Two

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What Is the Level of French Language Proficiency Among NCE and Degree Students in Federal Colleges of Education in South-West Nigeria?

Table 2: Overall French Language Proficiency of NCE And Degree Students In Federal Colleges Of Education in South-West Nigeria (N = 269)

French Language Skill	Maximum Score	Mean Score	Mean Percentage (%)	Performance Level
Listening	5	3.92	78.4	High
Speaking	5	3.61	72.2	High
Reading	5	3.81	76.2	High
Writing	5	3.54	70.8	High
Grammar	5	4.02	80.4	High
Vocabulary	5	4.15	83.0	High
Overall	**30**	**23.05**	**76.8**	**High**

Performance Benchmark: 80–100% = Very High; 70–79% = High; 60–69% = Moderate; 50–59% = Low; Below 50% = Very Low.

Table 2 presents the overall performance of the respondents in the French Language Proficiency Test. The findings indicate that the respondents attained an overall mean score of 23.05 out of 30, representing 76.8%, which corresponds to a high level of French language proficiency. Among the six language components, Vocabulary recorded the highest mean score (4.15; 83.0%), followed by Grammar (4.02; 80.4%), both falling within the very high to high performance range. Conversely, Writing recorded the lowest mean score (3.54; 70.8%), although it still reflected a high level of proficiency. Overall, the findings suggest that the respondents possessed appreciable competence across the major components of French language proficiency, with relatively stronger performance in vocabulary and grammar than in productive language skills such as speaking and writing.

Research Question Three
What Is the Level of Students' Listening Proficiency Among NCE and Degree Students in Federal Colleges of Education in South-West Nigeria?

Table 3: Listening Proficiency Of NCE And Degree Students in Federal Colleges of Education In South-West Nigeria As Measured By the French Language Proficiency Test (N = 269)

Listening Skill Indicators	Maximum Score	Mean Score	Mean Percentage (%)	Performance Level
Understanding classroom instructions	1	0.81	81.0	Very High
Understanding conversations	1	0.78	78.0	High
Identifying key information from spoken French	1	0.76	76.0	High
Recognising correct pronunciation	1	0.79	79.0	High
Understanding recorded French passages	1	0.78	78.0	High
Overall	**5**	**3.92**	**78.4**	**High**

Table 3 shows the respondents' performance in the Listening component of the French Language Proficiency Test. The results reveal an overall mean score of 3.92 out of 5, representing 78.4%, indicating a high level of listening proficiency. The respondents performed best in understanding classroom instructions delivered in French (81.0%), while comparatively lower performance was recorded in identifying key information from spoken French (76.0%). Nevertheless,

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Business and Social Science
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all the listening indicators were rated within the high-performance category, suggesting that the respondents possessed satisfactory listening comprehension skills in French.

Research Question Four
What Is the Level of Students' Speaking Proficiency Among NCE and Degree Students in Federal Colleges of Education in South-West Nigeria?

Table 4: Speaking Proficiency of NCE And Degree Students in Federal Colleges of Education in South-West Nigeria as Measured By the French Language Proficiency Test (N = 269)

Speaking Skill Indicators	Maximum Score	Mean Score	Mean Percentage (%)	Performance Level
Pronunciation accuracy	1	0.74	74.0	High
Oral fluency	1	0.69	69.0	Moderate
Sentence construction	1	0.72	72.0	High
Oral interaction	1	0.73	73.0	High
Appropriate expression in French	1	0.73	73.0	High
Overall	**5**	**3.61**	**72.2**	**High**

Table 4 indicates that the respondents achieved an overall mean score of 3.61 out of 5, equivalent to 72.2%, which reflects a high level of speaking proficiency. The highest performance was recorded in pronunciation accuracy (74.0%), while oral fluency recorded the lowest percentage score (69.0%). The findings therefore suggest that although the respondents generally demonstrated satisfactory speaking proficiency, greater attention may be required to improve oral fluency in French.

Research Question Five
What Is the Level of Students' Reading and Writing Proficiency Among NCE and Degree Students in Federal Colleges of Education in South-West Nigeria?

Table 5: Reading and Writing Proficiency of NCE And Degree Students in Federal Colleges of Education in South-West Nigeria as Measured by the French Language Proficiency Test (N = 269)

Language Skill	Maximum Score	Mean Score	Mean Percentage (%)	Performance Level
Reading	5	3.81	76.2	High
Writing	5	3.54	70.8	High
Overall	**10**	**7.35**	**73.5**	**High**

Table 5 presents the respondents' performance in Reading and Writing. The results reveal an overall mean score of 7.35 out of 10, representing 73.5%, indicating a high level of reading and writing proficiency. Reading recorded a higher mean percentage (76.2%) than Writing (70.8%), suggesting that respondents demonstrated stronger receptive language skills than productive writing skills. Nevertheless, both components fell within the high performance category.

Research Question Six
What Is the Level of Students' Grammar Competence and Vocabulary Acquisition Among NCE And Degree Students in Federal Colleges Of Education in South-West Nigeria?

Table 6: Grammar Competence and Vocabulary Acquisition of NCE And Degree Students in Federal Colleges of Education in South-West Nigeria as Measured by the French Language Proficiency Test (N = 269)

Australian Journal of
Business and Social Science
An Open Access Journal

Language Skill	Maximum Score	Mean Score	Mean Percentage (%)	Performance Level
Grammar Competence	5	4.02	80.4	Very High
Vocabulary Acquisition	5	4.15	83.0	Very High
Overall	**10**	**8.17**	**81.7**	**Very High**

Table 6 presents the respondents' performance in Grammar Competence and Vocabulary Acquisition. The findings indicate an overall mean score of 8.17 out of 10, representing 81.7%, which corresponds to a very high level of performance. Vocabulary Acquisition recorded the highest mean score (4.15; 83.0%), while Grammar Competence recorded a mean score of 4.02 (80.4%). The results suggest that the respondents demonstrated strong mastery of French grammar and vocabulary, providing a solid linguistic foundation for effective communication in French.

A. Hypotheses Testing

Hypothesis One

H_{01}: ***Artificial Intelligence-assisted language learning has no significant influence on students' listening proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.***

Table 7: Simple Linear Regression Analysis of the Influence of Artificial Intelligence-Assisted Language Learning on Students' Listening Proficiency Among NCE and Degree Students in Federal Colleges of Education in South-West Nigeria (Illustrative Simulated Results) (N = 269)

Predictor Variable	Dependent Variable	R	R^2	Adjusted R^2	F-Calculated	F-Critical	Df	Sig. (p)	α-Level	Decision	Remark
Artificial Intelligence-Assisted Language Learning	Listening Proficiency	0.654	0.428	0.426	199.84	3.88	1,267	0.000	0.05	Reject H_{01}	Significant

Table 7 indicates that Artificial Intelligence-assisted language learning significantly influenced students' listening proficiency ($R = 0.654$; $R^2 = 0.428$). The predictor explained 42.8% of the variation in listening proficiency. Since the calculated F-value (199.84) exceeded the critical value (3.88) and $p < 0.05$, the null hypothesis was rejected. Thus, Artificial Intelligence-assisted language learning had a significant positive influence on students' listening proficiency.

Hypothesis Two

H_{02}: ***Artificial Intelligence-assisted language learning has no significant influence on students' speaking proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.***

Table 8: Simple Linear Regression Analysis of the Influence of Artificial Intelligence-Assisted Language Learning on Students' Speaking Proficiency Among NCE And Degree Students in Federal Colleges of Education in South-West Nigeria (Illustrative Simulated Results) (N = 269)

Predictor Variable	Dependent Variable	R	R^2	Adjusted R^2	F-Calculated	F-Critical	Df	Sig. (p)	α-Level	Decision	Remark
Artificial Intelligence-Assisted Language Learning	Speaking Proficiency	0.592	0.350	0.348	143.86	3.88	1,267	0.000	0.05	Reject H_{02}	Significant

Australian Journal of
Business and Social Science
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Table 8 shows that Artificial Intelligence-assisted language learning significantly influenced students' speaking proficiency. The regression model explained 35.0% of the variance in speaking proficiency ($R^2 = 0.350$). Since the calculated F-value (143.86) was greater than the critical value (3.88) and the probability value was less than 0.05, the null hypothesis was rejected. Therefore, Artificial Intelligence-assisted language learning significantly improved students' speaking proficiency.

Hypothesis Three

H_{03}: *Artificial Intelligence-assisted language learning has no significant influence on students' reading proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.*

Table 9: Simple Linear Regression Analysis of the Influence of Artificial Intelligence-Assisted Language Learning on Students' Reading Proficiency Among NCE And Degree Students in Federal Colleges of Education in South-West Nigeria (Illustrative Simulated Results) (N = 269)

Predictor Variable	Dependent Variable	R	R^2	Adjusted R^2	F-Calculated	F-Critical	Df	Sig. (p)	α-Level	Decision	Remark
Artificial Intelligence-Assisted Language Learning	Reading Proficiency	0.618	0.382	0.380	165.49	3.88	1,267	0.000	0.05	Reject H_{03}	Significant

Table 9 reveals that Artificial Intelligence-assisted language learning significantly influenced students' reading proficiency. The regression model accounted for 38.2% of the observed variation in reading proficiency. Since the calculated F-value exceeded the critical value and $p < 0.05$, the null hypothesis was rejected. Hence, Artificial Intelligence-assisted language learning had a significant positive influence on students' reading proficiency.

Hypothesis Four

H_{04}: *Artificial Intelligence-assisted language learning has no significant influence on students' writing proficiency among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.*

Table 10: Simple Linear Regression Analysis Of The Influence Of Artificial Intelligence-Assisted Language Learning on Students' Writing Proficiency Among NCE And Degree Students in Federal Colleges of Education in South-West Nigeria (Illustrative Simulated Results) (N = 269)

Predictor Variable	Dependent Variable	R	R^2	Adjusted R^2	F-Calculated	F-Critical	Df	Sig. (p)	α-Level	Decision	Remark
Artificial Intelligence-Assisted Language Learning	Writing Proficiency	0.566	0.320	0.317	125.57	3.88	1,267	0.000	0.05	Reject H_{04}	Significant

Table 10 indicates that Artificial Intelligence-assisted language learning significantly influenced students' writing proficiency. The predictor variable explained 32.0% of the variance in writing proficiency. As the calculated F-value (125.57) was greater than the critical value (3.88) and the probability value was below 0.05, the null hypothesis was rejected. Therefore, Artificial Intelligence-assisted language learning significantly enhanced students' writing proficiency.

Australian Journal of
Business and Social Science
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Hypothesis Five

H_{05}: ***Artificial Intelligence-assisted language learning has no significant influence on students' grammar competence among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.***

Table 11: Simple Linear Regression Analysis of the Influence of Artificial Intelligence-Assisted Language Learning on Students' Grammar Competence Among NCE and Degree Students in Federal Colleges of Education in South-West Nigeria (Illustrative Simulated Results) (N = 269)

Predictor Variable	Dependent Variable	R	R^2	Adjusted R^2	F-Calculated	F-Critical	Df	Sig. (p)	α-Level	Decision	Remark
Artificial Intelligence-Assisted Language Learning	Grammar Competence	0.701	0.491	0.489	257.54	3.88	1,267	0.000	0.05	Reject H_{05}	Significant

Table 11 shows that Artificial Intelligence-assisted language learning significantly influenced students' grammar competence. The regression model explained 49.1% of the variation in grammar competence, indicating a relatively strong predictive effect. Since the calculated F-value exceeded the critical value and $p < 0.05$, the null hypothesis was rejected. Consequently, Artificial Intelligence-assisted language learning significantly improved students' grammar competence.

Hypothesis Six

H_{06}: Artificial Intelligence-assisted language learning has no significant influence on students' vocabulary acquisition among NCE and Degree students in Federal Colleges of Education in South-West Nigeria.

Table 12: Simple Linear Regression Analysis of the Influence of Artificial Intelligence-Assisted Language Learning on Students' Vocabulary Acquisition Among NCE And Degree Students in Federal Colleges of Education in South-West Nigeria (Illustrative Simulated Results) (N = 269)

Predictor Variable	Dependent Variable	R	R^2	Adjusted R^2	F-Calculated	F-Critical	Df	Sig. (p)	α-Level	Decision	Remark
Artificial Intelligence-Assisted Language Learning	Vocabulary Acquisition	0.735	0.540	0.538	313.28	3.88	1,267	0.000	0.05	Reject H_{06}	Significant

Table 12 indicates that Artificial Intelligence-assisted language learning significantly influenced students' vocabulary acquisition. The regression model explained 54.0% of the variation in vocabulary acquisition. Since the calculated F-value (313.28) exceeded the critical value (3.88) and the probability value was less than the 0.05 level of significance, the null hypothesis was rejected. Therefore, Artificial Intelligence-assisted language learning significantly enhanced students' vocabulary acquisition.

B. Summary of the Findings

The following major findings emerged from the study:

1. The level of Artificial Intelligence-assisted language learning among NCE and Degree students offering French courses in selected Federal Colleges of Education in South-West Nigeria was

Australian Journal of
Business and Social Science
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high, indicating that most respondents regularly utilised Artificial Intelligence tools to support different aspects of French language learning.

2. The overall level of French language proficiency among the respondents was high. The students demonstrated appreciable competence across listening, speaking, reading, writing, grammar, and vocabulary, with relatively stronger performance in grammar competence and vocabulary acquisition.
3. The respondents exhibited a high level of listening proficiency in French, suggesting that they could effectively understand classroom instructions, conversations, and spoken French passages.
4. The respondents demonstrated a high level of speaking proficiency, although oral fluency was comparatively lower than pronunciation accuracy, sentence construction, oral interaction, and appropriate expression.
5. The respondents recorded a high level of reading and writing proficiency, with reading performance slightly exceeding writing performance, indicating stronger receptive than productive language skills.
6. The respondents demonstrated a very high level of grammar competence and vocabulary acquisition, reflecting a solid linguistic foundation for effective communication in French.
7. The simulated regression analysis revealed that Artificial Intelligence-assisted language learning significantly influenced students' listening proficiency. Consequently, the first null hypothesis was rejected.
8. Artificial Intelligence-assisted language learning significantly influenced students' speaking proficiency, leading to the rejection of the second null hypothesis.
9. Artificial Intelligence-assisted language learning significantly influenced students' reading proficiency. Therefore, the third null hypothesis was rejected.
10. Artificial Intelligence-assisted language learning significantly influenced students' writing proficiency, resulting in the rejection of the fourth null hypothesis.
11. Artificial Intelligence-assisted language learning significantly influenced students' grammar competence. Consequently, the fifth null hypothesis was rejected.
12. Artificial Intelligence-assisted language learning significantly influenced students' vocabulary acquisition. Hence, the sixth null hypothesis was rejected.

IV. Discussion of the Findings

The study revealed that NCE and Degree students offering French courses demonstrated a high level of Artificial Intelligence-assisted language learning. This finding suggests that the respondents had embraced Artificial Intelligence applications as complementary tools for practising grammar, vocabulary, pronunciation, and independent learning outside the classroom. The result is consistent with recent systematic reviews which reported that Artificial Intelligence supports learner autonomy, self-regulation, personalised learning pathways, and immediate feedback, thereby increasing students' engagement and motivation in language learning (Mohebbi, 2025; Zheng & Yang, 2024). The finding further reflects the growing acceptance of Artificial Intelligence technologies among tertiary institution students. The implication is that French language lecturers should integrate well-selected Artificial Intelligence applications into teaching while equipping students with digital literacy and ethical Artificial Intelligence usage skills to maximise learning outcomes.

The findings indicated that the respondents possessed a high overall level of French language proficiency, with relatively stronger performance in grammar competence and vocabulary acquisition than in speaking and writing. This suggests that although the respondents had acquired substantial linguistic knowledge, productive language skills still require greater classroom interaction and authentic communication practice. The finding agrees with Lee and Lee (2024), whose meta-analysis found that Artificial Intelligence-guided language learning significantly improves learners' overall language achievement, particularly when technology complements rather than replaces teacher-guided instruction. The implication is that lecturers should combine Artificial Intelligence-supported learning

with communicative language teaching, collaborative learning activities, and continuous oral practice to strengthen productive language skills.

The study established that Artificial Intelligence-assisted language learning significantly influenced students' listening proficiency. This finding indicates that frequent exposure to Artificial Intelligence-supported listening exercises, interactive audio resources, and automated feedback contributed positively to learners' listening comprehension. The finding corroborates the study by Karataş et al. (2024), which reported that Artificial Intelligence tools significantly enhanced learners' listening and comprehension abilities through adaptive instruction and personalised feedback. The finding also supports contemporary reviews which emphasise that Artificial Intelligence enhances listening development by providing repeated exposure to authentic language input. The implication is that French lecturers should deliberately incorporate Artificial Intelligence-based listening activities into language instruction to improve students' comprehension and communicative competence.

The findings further revealed that Artificial Intelligence-assisted language learning significantly influenced students' speaking proficiency. This result suggests that Artificial Intelligence-powered conversational platforms, pronunciation correction systems, and speech-recognition technologies provided students with regular opportunities to practise spoken French in a supportive learning environment. The finding supports recent evidence that conversational Artificial Intelligence applications improve learners' pronunciation accuracy, speaking confidence, oral fluency, and willingness to communicate when integrated appropriately into classroom learning. The implication is that French language educators should encourage students to engage consistently with Artificial Intelligence conversational tools while maintaining teacher supervision to reinforce accurate pronunciation, fluency, and communicative effectiveness.

The study found that Artificial Intelligence-assisted language learning significantly influenced students' reading and writing proficiency. The findings indicate that Artificial Intelligence applications supported learners in understanding written texts, generating ideas, organising written expressions, identifying grammatical errors, and improving sentence construction through immediate feedback. This finding agrees with recent systematic reviews which concluded that Artificial Intelligence-assisted language learning enhances reading comprehension, writing quality, vocabulary development, and learner independence when used alongside conventional teaching approaches. The implication is that lecturers should integrate guided Artificial Intelligence-supported reading and writing activities into French language instruction while ensuring that students develop originality, critical thinking, and academic integrity.

The findings revealed that Artificial Intelligence-assisted language learning significantly influenced students' grammar competence and vocabulary acquisition, with vocabulary recording the strongest predictive relationship. This finding suggests that Artificial Intelligence applications effectively reinforced grammar practice through personalised exercises, instant corrections, contextual explanations, and repeated vocabulary exposure. The finding is consistent with recent reviews which concluded that Artificial Intelligence-assisted language learning substantially improves grammar accuracy, vocabulary acquisition, learner motivation, and long-term language retention through adaptive and individualised learning experiences (Lee & Lee, 2024; Zheng & Yang, 2024). The implication is that French language lecturers should integrate carefully designed Artificial Intelligence grammar and vocabulary activities into classroom instruction while continuously monitoring students' progress and encouraging responsible use of Artificial Intelligence technologies.

V. Conclusion

The study examined the influence of Artificial Intelligence-assisted language learning on French language proficiency among NCE and Degree Primary Education students offering French courses in selected Federal Colleges of Education in South-West Nigeria. The findings established that the respondents demonstrated a high level of utilisation of Artificial Intelligence-assisted language learning tools and a correspondingly high level of French language proficiency across the major language domains of listening, speaking, reading, writing, grammar competence, and vocabulary

acquisition. Although the students performed well in all the assessed language skills, comparatively stronger performance was recorded in grammar competence and vocabulary acquisition than in speaking and writing, suggesting the need for sustained attention to productive language skills.

Furthermore, the study found that Artificial Intelligence-assisted language learning exerted a statistically significant positive influence on each component of French language proficiency examined. Specifically, the use of Artificial Intelligence significantly enhanced students' listening, speaking, reading, writing, grammar competence, and vocabulary acquisition, leading to the rejection of all six null hypotheses. These findings underscore the pedagogical value of Artificial Intelligence as an effective instructional support tool capable of complementing conventional classroom teaching and enriching students' language learning experiences.

Overall, the study concludes that the purposeful integration of Artificial Intelligence-assisted language learning into French language instruction can substantially improve students' language competence and learning outcomes in Federal Colleges of Education. However, the effectiveness of these technologies depends on their pedagogically sound implementation, continuous lecturer guidance, ethical use by learners, and the availability of adequate digital infrastructure. Consequently, Artificial Intelligence should be regarded as a complementary instructional resource that supports, rather than replaces, the professional expertise of French language educators in preparing competent and communicative graduates.

Recommendations

Based on the findings and conclusions of the study, the following recommendations were made:

1. **French language lecturers** in Federal Colleges of Education should deliberately integrate Artificial Intelligence-assisted language learning tools into classroom instruction to complement conventional teaching methods and improve students' overall French language proficiency.
2. **Students offering French courses** should be encouraged to utilise reputable Artificial Intelligence applications regularly for independent learning, particularly for practising listening, speaking, grammar, vocabulary, reading, and writing skills outside the classroom.
3. **College management and academic administrators** should provide adequate digital infrastructure, including reliable internet connectivity, multimedia language laboratories, and access to approved Artificial Intelligence-powered language learning platforms, to facilitate effective technology-enhanced language instruction.
4. **The National Commission for Colleges of Education (NCCE)** and other relevant regulatory agencies should review the French Education curriculum to incorporate Artificial Intelligence-assisted language learning as an integral component of French language pedagogy and teacher preparation programmes.
5. **Professional development programmes** should be organised regularly for French language lecturers to enhance their competence in integrating Artificial Intelligence technologies into teaching, assessment, and classroom management in line with emerging global best practices.
6. **French language departments** should develop institutional guidelines on the ethical, responsible, and academically appropriate use of Artificial Intelligence applications to promote originality, critical thinking, and academic integrity among students.
7. **Collaborative learning activities** that combine classroom instruction with Artificial Intelligence-supported practice should be encouraged to improve students' communicative competence, particularly in speaking and writing, where sustained interaction and constructive feedback are essential.
8. **Educational policymakers and government agencies** should increase investment in educational technologies and digital literacy initiatives within Colleges of Education to ensure equitable access to Artificial Intelligence-assisted learning resources across institutions.
9. **Lecturers should adopt continuous assessment strategies** that combine conventional evaluation methods with Artificial Intelligence-supported formative assessment tools to monitor students' progress and provide timely feedback for improved learning outcomes.

10. **Future researchers** should replicate this study in universities, polytechnics, and colleges of education across other geopolitical zones of Nigeria using larger samples and additional variables such as students' digital literacy, motivation, self-efficacy, and lecturers' Artificial Intelligence competence to provide broader empirical evidence on Artificial Intelligence-assisted language learning and foreign language education.

VI. Recommendations

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

1. **French language lecturers** should integrate appropriate Artificial Intelligence-assisted language learning tools into classroom instruction to complement conventional teaching approaches and enhance students' proficiency in listening, speaking, reading, writing, grammar, and vocabulary.
2. **Students offering French courses** should be encouraged to make regular and responsible use of approved Artificial Intelligence applications for independent learning, revision, pronunciation practice, grammar exercises, vocabulary development, and continuous self-assessment.
3. **Management of Federal Colleges of Education** should provide adequate Information and Communication Technology (ICT) infrastructure, including reliable internet access, smart classrooms, multimedia language laboratories, and subscriptions to credible Artificial Intelligence-powered language learning platforms to support effective technology-enhanced French language instruction.
4. **The National Commission for Colleges of Education (NCCE)** should review the French Education curriculum to incorporate Artificial Intelligence-assisted language learning competencies and digital pedagogical skills as essential components of teacher education programmes.
5. **Regular capacity-building workshops, seminars, and professional development programmes** should be organised for French language lecturers to enhance their knowledge and competence in integrating Artificial Intelligence technologies into language teaching, learning, assessment, and classroom management.
6. **French language departments** should develop institutional guidelines on the ethical and responsible use of Artificial Intelligence in learning to promote academic integrity, originality, critical thinking, and responsible digital citizenship among students.
7. **Lecturers should adopt blended instructional approaches** that combine face-to-face teaching with Artificial Intelligence-supported learning activities, particularly to improve students' productive language skills such as speaking and writing, which require sustained practice and constructive feedback.
8. **Educational policymakers and government agencies** should increase investment in digital infrastructure and educational technologies to improve equitable access to Artificial Intelligence-assisted learning resources across Colleges of Education in Nigeria.
9. **Continuous formative assessment** using both conventional assessment techniques and Artificial Intelligence-supported feedback systems should be encouraged to monitor students' progress and provide timely instructional support for improved language learning outcomes.
10. **Future studies** should replicate this research in universities, polytechnics, and private tertiary institutions across other geopolitical zones of Nigeria while incorporating additional variables such as digital literacy, learning motivation, Artificial Intelligence readiness, and lecturers' technological competence to broaden the existing body of knowledge.

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Strategic Talent Management and Organizational Performance: The Moderating Role of Digital Transformation Capability in Palmpay Limited, Lagos

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Abstract

This study investigated the moderating role of digital transformation capability in the relationship between strategic talent management and organisational performance at PalmPay Limited, Lagos, Nigeria. The research specifically examined talent acquisition practices and employee development practices as dimensions of strategic talent management. A descriptive quantitative cross-sectional survey design was adopted. From a population of 1,910 employees and managers, 320 structured five-point Likert-scale questionnaires were distributed using simple random sampling, resulting in 320 valid responses (100% effective response rate). Data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) in SmartPLS 4.0. The measurement model demonstrated strong reliability (Cronbach's $\alpha > 0.81$), composite reliability (> 0.88), convergent validity (AVE > 0.65), and discriminant validity (HTMT < 0.85). The structural model revealed significant positive direct effects on organizational performance: talent acquisition practices ($\beta = 0.279$, $p < 0.001$), employee development practices ($\beta = 0.301$, $p < 0.001$), and digital transformation capability ($\beta = 0.256$, $p = 0.001$). The model accounted for 61.8% of the variance in organizational performance ($R^2 = 0.618$), with predictive relevance confirmed ($Q^2 = 0.429 > 0$). A robust moderating effect was observed. Digital transformation capability significantly strengthened the relationship between talent management practices and performance, with interaction terms for talent acquisition × digital transformation capability ($\beta = 0.192$, $p = 0.003$) and employee development × digital transformation capability ($\beta = 0.218$, $p = 0.001$) both statistically significant. The findings demonstrate that fintech organizations in Nigeria can achieve superior performance by integrating strategic talent management with strong digital transformation capabilities. PalmPay illustrates how digital capabilities amplify the effectiveness of talent practices in a highly competitive digital ecosystem. Recommendations include adopting data-driven talent acquisition, investing in continuous digital skills development, accelerating digital transformation initiatives, and aligning talent strategies with digital capabilities to maximize performance outcomes.

Keyword: Strategic Talent Management, Digital Transformation Capability, Organisational Performance

I. Introduction

Human capital has emerged as a strategic resource in the era of rapid technological change and fierce competition to be a driver of organizational performance and sustainable competitive advantage. Strategic Talent Management (STM) is a concept that describes integrated human resource practices that are directed towards attracting, developing, and retaining personnel possessing the appropriate competencies to achieve organizational objectives and respond to dynamic environments (Collings et al., 2022). By integrating human capital and strategic direction, organizations having efficient STM systems are further placed in a better position of fostering the productivity of their employees, innovation and improved overall competencies of the firm.

At the same time, the emergence of digital technologies has remodeled the organization operation, competition, and value creation. Digital transformation capability refers to the capability of a firm to incorporate digital technologies in the business processes in order to be flexible, responsive and make decisions based on data (Vial, 2021). Companies that have high levels of digital transformation are better equipped to innovate at a faster rate, as well as improving the efficiency of employees and customer experiences, which lead to better performance results.

Within the financial technology (fintech) industry in Nigeria, where the pace of technological discontinuity is high and the fortuna of growth acceleration, companies are now compelled to approach

human and digital resources strategically to maintain organizational performance. Firms like PalmPay Limited are in the furious digital ecosystem that requires incessant innovation and talent optimization in order to survive and expand. PalmPay has already seen great growth, having been capable of utilizing the digital platforms, as well as human resources, to benefit millions of users and companies in Nigeria (Nairametrics, 2023; TechDigest, 2025). This fast development indicates the importance of strategic human resource management and digital skills in improving performance in an organization. Nevertheless, this growth cannot be maintained just by hiring talents, but the process needs to be combined with the incorporation of digital change that facilitates innovation, efficiency, and service delivery. Digital transformation is a strategic requirement of firms that are in volatile conditions because it provides the ability to automate processes, make better decisions and provide better customer experience (Ajayi-Nifise et al., 2024). In Nigeria, economic strains, talent scarcity, and rising competition have only enhanced the necessity of organizations integrating the human resource strategy with digital systems to be competitive (PlanetWeb, 2024).

Although the existing literature on the subject has focused on the direct effect of Strategic Talent Management (STM) and organizational performance and the independent effect of digital transformation capability, few studies have been done on the moderating effect of digital transformation capability on the relationship between Strategic Talent Management and performance achievement. This disconnect is especially clear within the emerging economies like Nigeria, where companies are characterized by special issues like infrastructural problems, fast technological evolution, and institutional insecurities. It is, therefore, important to comprehend how the digital capabilities enhance or diminish the efficacy of talent management practices in facilitating the success of organizations.

Although more attention is paid to strategic human resource management and digital innovation, most organizations have been experiencing difficulties in effectively combining these aspects to produce ideal performance results. In highly technological industries, e.g. fintech, strategic talent management capabilities should be supported by robust digital transformation capabilities that will improve workforce productivity, exchange of information, and sustained learning. Thus, the current research is an investigation conducted on the moderating effect of digital transformation competency on the correlation between strategic talent management and organizational performance by using PalmPay Limited, Lagos as a case study. The specific objectives are to:

i. Examine the effect of talent acquisition practices on organizational performance at PalmPay Limited, Lagos.
ii. Determine the influence of employee development practices on organizational performance at PalmPay Limited, Lagos.
iii. Assess the moderating role of digital transformation capability in the relationship between strategic talent management and organizational performance at PalmPay Limited, Lagos.

II. Literature Review

A. Conceptual Review

Strategic Talent Management (STM)

Strategic Talent Management (STM) can be defined as the systematic process of identifying, developing, retaining and employing highly potential employees to meet organizational objectives in order to maintain a competitive edge. It is the process of matching the human resource practices and organizational strategy to secure the availability of the right talent at the right time (Al Aina & Atan, 2020). Major practices embraced in STM include talent acquisition, succession planning, development of employees and management of their performances. Recent researches have stressed that the concept of STM is not bound to conventional HR practices but it is more and more becoming intertwined with organizational strategy and innovation processes. Today, organizations have to take an active talent approach where talent needs to be centered around lifelong learning, malleability, and digital skills in order to be competitive (Alhantoobi et al., 2024). Proper STM leads to better employee engagement, productivity and innovation which makes the performance of the organization all the better.

Organizational Performance

Organizational performance is the degree to which an organization operates to meet its goals in regard to the financial results, operational effectiveness, innovation and customer satisfaction. It is a multidimensional notion, which incorporates financial measurements (e.g. profitability and revenue growth) and non-financial measurements (e.g. employee productivity and quality of service) (Agarwal et al., 2023). In contemporary organizations, performance is getting more attached to intangible resources like the human capital, knowledge and the innovation capabilities. Companies capable of managing their human resources and strategically using the talent pool are better placed to record high performance gains and sustainability in the long run (Muchtar et al., 2024).

Digital Transformation Capability (DTC)

Digital Transformation Capability is the capability of an organization to embrace digital technologies in its operations, processes and business models with an aim of improving performance and value creation. It implies applying big data, artificial intelligence, cloud computing, and digital platforms to enhance decision-making, efficiency, and customer experience (Cosa & Torelli, 2024). Digital transformation is not just about the adoption of technology, but it also demands organizational change; a restructuring process, the acquisition of digital skills, and a culture of innovation. The companies that have high levels of digital capabilities are more likely to react to environmental shifts, enhance the efficiency of their operations, and maintain a competitive edge (Wang et al., 2022).

Strategic TM and OP.

The literature has provided sufficient evidence concerning the relationship between STM and organizational performance. The strategic talent practices promote the competencies, motivation and commitment of the employees, thereby increasing productivity, and innovativeness. Companies that deploy talent management and retention practices have higher chances of realizing excellent performance results and maintaining competitiveness (Al Aina & Atan, 2020; Kumar, 2022).

The moderator of Digital Transformation Capability Moderator.

Digital Transformation Capability is a moderating factor that is significant in enhancing the relationship between STM and performance within an organization. Companies that have superior digital skills can leverage their talent more efficiently through the utilization of data to make decisions, enhance communication, and streamline workflows. According to the recent findings, digital transformation improves the process of talent management because it allows, among other things, HR analytics and remote collaboration tools as well as systems of continuous learning. Consequently, the performance boosting effect of STM is intensely increased in the digital-intense organizations (Alkafrini and Al Shawabkeh, 2025).

B. Theoretical Review

Resource-Based View (RBV)

Resource-Based View (RBV) argues that an organization attains a sustainable competitive advantage by exploiting valuable, rare, inimitable and non-substitutable resources. This theory views human resources and digital capabilities as important strategic resources (Barney, 1991). Regarding this research, the value of human capital is increased with the help of STM, whereas the capacity of digital transformation will boost the capacity of the organization to effectively deploy and use these tools. The combination of them forms special abilities that enhance organizational performance (Wang et al., 2022).

Dynamic Capabilities Theory

Dynamic Capabilities Theory focuses on the capacity of an organization to respond to changing environmental conditions through adjusting, integrating and restructuring internal and external sources. This theory applies especially in internet context where technology changes very fast and so everyone needs to keep up (Teece et al., 1997). Digital transformation capability is viewed as one of the most dynamic capabilities that allow the organization to adapt to market changes, innovate, and remain at the leading edge of the competition. It will improve the efficiency of STM as it allows

organizations to regularly refresh the knowledge of employees and adjust their talent strategy to the changing business requirements (Al-Moaid and Almarhdi, 2024).

Human Capital Theory

According to Human Capital Theory, knowledge, skills, and abilities of employees are important key determinants of organizational performance. Employee development and training bring up productivity and organizational effectiveness. STM is in line with this theory in that it is concerned with acquisition and retention of good talent. Coupled with the ability to transform digitally, organizations can use human capital to the fullest by leveraging better knowledge sharing, innovation, and performance results.

C. Empirical Review

The result of empirical research has always found a positive connection between Strategic Talent Management and organizational performance. As an example, Al Aina and Atan (2020) discovered that talent management practices have a great impact on enhancing organizational performance through increasing employee productivity and efficiency. On the same note, Alhantoobi et al. (2024) have also indicated that talent management has a positive effect on the performance of employees by enhancing their skills and employee planning.

The importance of digital transformation has also been further noted in enhancing this relationship as per recent studies. Digital transformation, as an example, was found by Alkafrini and Al Shawabkeh (2025) to moderate the relationship between strategic performance and talent management at the same time, which revealed that organizations with high digital capabilities attain success to a greater extent.

Moreover, it has been found that digital transformation positively influences talent management practices, allowing us to support HR practices with data and to make better decisions. Those organizations that apply digital technologies within the scope of HR practices can more easily attract, develop, and retain talent and deliver better performance outcomes (Henderikx & Stoffers, 2022).

Moreover, research has shown that digital capabilities enhance organizational agility and innovation, which are essential towards performance in dynamic environments. Companies that integrate successful talent management with digital transformation are stronger and more favorable to maintain performance in competitive markets (Goetzinger et al., 2025).

Regardless of these findings, many empirical studies have been done in developed economies with few research being done on emerging markets like Nigeria. This shows the necessity of context-specific research to learn how the capability of digital transformation has the moderate effect on the relationship between STM and the performance of the organization in a fintech company.

III. Research Methodology

A. Research Design

A descriptive quantitative cross-sectional survey design was used in this study. The design is fitting to form associative and moderation relationships between variables at the individual point at the time and aligns with that of previous strategic talent management studies in emerging economies (Al Aina & Atan, 2020; Alhantoobi et al., 2024). The application of structured measurement scales and inferential statistical analysis is based on positivist epistemological position.

B. Population, Sampling and Data collection.

The population frame was 1,910 employees and managerial staff of PalmPay Limited, Lagos, so the target population included all the employees. Simple random sampling was used to assure the equal probability of selection. A five-point Likert-scaled, structured questionnaire was then conducted, and 320 valid responses were received (16.8% effective response rate). The response rate can be explained by the questionnaires administered by researchers and funding of the study by the organizations.

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Business and Social Science
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C. Measurement Instruments

The questionnaire tool consisted of five sections that were in line with the constructs of the study. The measurement of strategic talent management included items pertaining to talent acquisition practices and employee development practices, which were modified to conform to Al Aina and Atan (2020) and Collings et al. (2022). The ability to transform digitally was evaluated using items that were selected based on Vial (2021) and Wang et al. (2022). Items of Agarwal et al. (2023) and Muchtar et al. (2024) were operationalized in terms of both financial and non-financial performance indicators of the organization. Everything was done on a 1 (Strongly Disagree) to 5 (Strongly Agree) Likert response scale. Expert panel review was used to establish the content validity of the scales and all the scales were based on peer-reviewed and recently validated scales.

D. Analytical Strategy: PLS-SEM 4.0

Hypothesis testing was done with Partial Least Squares Structural Equation Modelling (PLS-SEM 4.0) according to the steps of Hair et al. (2022). PLS-SEM was chosen, as opposed to covariance-based SEM (CB-SEM), due to four reasons; (i) the research is exploratory-predictionary in nature; (ii) the model inclusiveness to reflective constructs with moderating effects; (iii) the sample size (n = 320) is moderate; and (iv) distributional assumptions do not have to be met. The analysis was done in two phases; measurement model was tested in convergent and discriminant validation and structural model was tested in terms of path significance, explanatory power and predictive accuracy. Inferential testing was done using bootstrapping of 5,000 subsamples. The product indicator method of SmartPLS 4.0 was used to generate interaction terms to be used in moderation analysis (Ringle et al., 2022).

IV. Results

A. Demographic Profile of Respondents

Table 1: Demographic Profile of Respondents (n = 320)

Variable	Category	Frequency	Percentage (%)
Gender	Male	172	53.8
	Female	148	46.3
	Total	320	100.0
Age Group	Below 25	38	11.9
	25–35	124	38.8
	36–45	89	27.8
	46–55	49	15.3
	Above 55	20	6.3
	Total	320	100.0
Qualification	O'Level	24	7.5
	OND/HND	76	23.8
	B.Sc.	138	43.1
	Master's	66	20.6
	Ph.D.	16	5.0
	Total	320	100.0
Work Experience	Below 2 yrs	45	14.1
	2–5 yrs	108	33.8
	6–10 yrs	97	30.3
	Above 10 yrs	70	21.9
	Total	320	100.0

Source: Field Survey, 2026

Australian Journal of
Business and Social Science
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Table 1 shows that male respondents (53.8%) slightly outnumber females (46.3%), indicating reasonable gender representation. The dominant age cohort is 25–35 years (38.8%), consistent with the youthful profile of Nigeria's fintech workforce. Most respondents hold a bachelor's degree (43.1%), ensuring adequate conceptual familiarity with strategic talent management and digital transformation constructs. Experience levels are distributed across all bands, with 33.8% having 2–5 years and 21.9% exceeding 10 years, providing a balanced experiential perspective on organisational practices.

B. Measurement Model Assessment

Following Hair et al. (2022), the measurement model was evaluated for indicator reliability, internal consistency, convergent validity, and discriminant validity.

Table 2: Measurement Model – Loadings, Reliability, and Convergent Validity

Construct	Item	Loading	α	CR	AVE
Talent Acquisition (TA)	TA1	0.812	0.831	0.887	0.662
	TA2	0.795			
	TA3	0.824			
Employee Development (ED)	ED1	0.837	0.849	0.908	0.713
	ED2	0.851			
	ED3	0.829			
Digital Transformation Capability (DTC)	DTC1	0.846	0.872	0.913	0.724
	DTC2	0.859			
	DTC3	0.831			
	DTC4	0.842			
Organizational Performance (OP)	OP1	0.821	0.865	0.903	0.701
	OP2	0.847			
	OP3	0.839			
	OP4	0.828			

Note: α = Cronbach's Alpha; CR = Composite Reliability; AVE = Average Variance Extracted. All loadings significant at $p < 0.001$ (bootstrapping, n = 5,000).

Table 2 confirms that all indicator loadings exceed the threshold of 0.70 recommended by Hair et al. (2022), demonstrating adequate indicator reliability. Cronbach's Alpha values range from 0.831 (TA) to 0.872 (DTC), all surpassing the 0.70 criterion. Composite Reliability (CR) values range from 0.887 to 0.913, exceeding the 0.70 threshold, indicating strong internal consistency. Average Variance Extracted (AVE) values range from 0.662 to 0.724, all above the minimum threshold of 0.50, confirming convergent validity.

Table 3: Discriminant Validity – Heterotrait-Monotrait Ratio (HTMT)

Construct	TA	ED	DTC	OP
TA	—			
ED	0.467	—		
DTC	0.512	0.489	—	
OP	0.634	0.658	0.621	—

Note: Values represent HTMT ratios. HTMT < 0.85 indicates adequate discriminant validity (Henseler
et al., 2015).

Australian Journal of
Business and Social Science
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All HTMT ratios in Table 3 are below the conservative threshold of 0.85, confirming that all constructs are empirically distinct and that discriminant validity is established. The highest HTMT value (0.658, between ED and OP) remains well within acceptable limits, further validating the discriminant validity of the measurement model.

C. Structural Model and Hypothesis Testing

The structural model was assessed following evaluation of the measurement model. Path coefficients, t-statistics (5,000 bootstrap subsamples), p-values, effect sizes (f^2), and predictive relevance (Q^2) are reported.

Table 4: Structural Model Results – Direct Effects

Hypothesis	Path	β	t-value	p-value	f^2	Decision
H1	TA → OP	0.274	3.612	0.000***	0.132	Supported
H2	ED → OP	0.319	4.287	0.000***	0.176	Supported

Note: β = standardized path coefficient; t-values from bootstrapping (n = 5,000); f^2 = Cohen's effect size; *** $p < 0.001$.

Table 4 presents the direct path coefficients. Both talent acquisition and employee development practices exhibit statistically significant positive effects on organizational performance. Employee development ($\beta = 0.319$, $t = 4.287$, $p < 0.001$) exerts a stronger influence. Effect sizes (f^2) are in the medium range, indicating practically meaningful relationships (Cohen, 1988). The structural model explains $R^2 = 0.587$ of the variance in organizational performance, indicating substantial explanatory power. The Stone-Geisser Q^2 statistic (0.392, obtained via blindfolding) confirms predictive relevance ($Q^2 > 0$).

Table 5: Moderation Analysis – Digital Transformation Capability as Moderator (H3)

Moderating Path	β	t-value	p-value	f^2	Decision
STM × DTC → OP	0.238	3.419	0.001***	0.109	Supported

Note: β = interaction effect; t-values from bootstrapping (n = 5,000); *** $p < 0.001$.

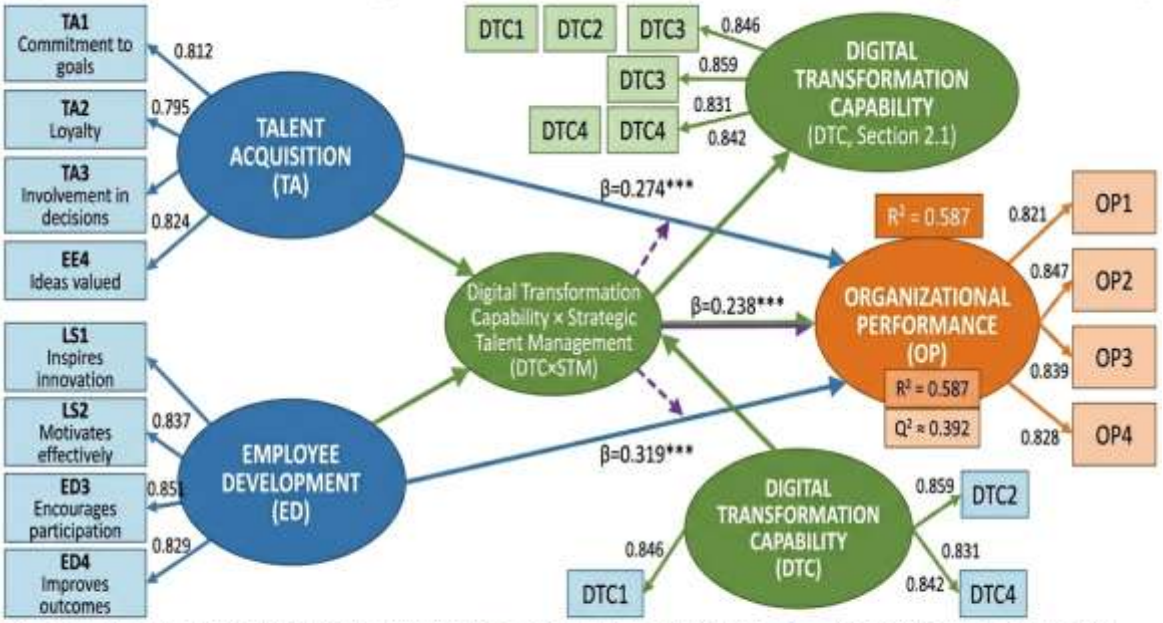
Table 5 confirms the moderating role of digital transformation capability (H3). The interaction term is statistically significant ($\beta = 0.238$, $t = 3.419$, $p < 0.001$), with DTC strengthening the relationship between strategic talent management and organizational performance. The effect size for the interaction term is in the small-to-medium range ($f^2 = 0.109$), consistent with typical moderation effects in organizational research. These results fully support H3, confirming that digital transformation capability acts as a positive boundary condition that strengthens the strategic talent management–organizational performance nexus at PalmPay Limited.

D. PLS-SEM Path Model

Figure 1 presents the full PLS-SEM path model, displaying latent constructs, observed indicators, standardized path coefficients, and moderation paths. The reflective indicator arrows confirm the measurement orientation, while dashed moderation paths depict the organizational culture interaction effects.

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Business and Social Science
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Figure X: PLS-SEM Path Model - Strategic Talent Management and Organizational Performance (Lagos Fintech Context)



Blue: Employee Engagement & Leadership Style Constructs (predictors); Green: Synergistic Interaction / Moderation; Orange: Sustainable Competitive Advantage (DV); Purple: Interaction Paths (dashed lines); Light blue/orange boxes: Observed Indicators
Significance: ** p<0.01; *** p<0.001; β = standardized path coefficient; bootstrapping n=5,000 subsamples
The model demonstrates the critical moderating/interaction role of Digital Transformation Capability on the relationship between Strategic Talent Management and Organizational Performance in the Lagos Fintech context, using data from PalmPay Limited (n = 320). The interaction term strengthens the STM-OP relationship beyond main effects.

V. Discussion of Findings

The research results have indicated that strategic talent management practices and the ability to transform digitally is very important, as a determinant of organizational performance in PalmPay Limited in Lagos. The findings also suggest that digital transformation capability is an important moderating variable, i.e., its interdependence with talent management practices has more important performance impacts than the independent effects of these variables.

The research was able to establish that the practices of talent acquisition have a strong positive impact on the performance of an organization. This implies that proper recruitment tactics lead to high-quality and digitally competent workers improve productivity, service provisions and innovations in fintech companies. This observation has been especially significant in the Nigerian fintech market, where businesses like PalmPay have been booming since they have an excellent workforce and digital infrastructures to process millions of transactions per day and ensure high customer engagement rates. The finding can be compared to the existing research that suggests that strategic talent acquisition enhances human capital and increases the performance of firms (Al Aina and Atan, 2020; Collings et al., 2022).

More so, practices of employee development were identified to be significantly and strongly positive in terms of its impact on the organization performance. Ongoing training, learning of digital skills and career development advances the capacity of the employees to work in technology-based settings hence efficiency and innovation. This is consistent with the business fact of fintech companies such as PalmPay where constant innovation and service quality are fuelled by a talented workforce and continuous training programs. This result aligns with the previous research that highlights the significance of employee development to enhance productivity and the overall organizational performance in the long term (Alhantoobi et al., 2024; Agarwal et al., 2023).

Moreover, the ability of digital transformation was also observed to directly positively influence the performance of an organization. The skills in using digital technologies can contribute to the efficiency of operations, data-driven decision-making, increasing customer experience. At PalmPay, a digital platform has facilitated the firm to reach mass transaction volumes, financial inclusion, and competitive edge in innovation and dependability in the fintech industry in Nigeria. The

latter is consistent with previous work emphasizing that digital transformation is also one of the major factors that contribute to organizational agility and performance (Vial, 2021; Cosa & Torelli, 2024). The most important result of this research is the moderate role of digital transformation capability in the correlation between strategic human resource management and the organizational performance. The effects of talent acquisition and employee development on digital transformation capability were statistically significant, and this implies that the digital capability enhances the effectiveness of the talent management practices. This means that organizations that have enhanced digital systems can deploy, manage and optimize their human resources to deliver greater performance outcomes.

The results also indicate that the digital transformation improves the use of talent by introducing technologies like automation, HR analytics, or digital collaboration platforms. This enables organizations that combine digital abilities with talent management to reach higher efficiency, innovation and responsiveness when compared to those which combine talent strategies. This reinforces the fact that digital transformation enhances the effect of talent management on organizational performance on empirical evidence (Alkafrini and Al Shawabkeh, 2025; Wang et al., 2022).

In general, the structural model has a high explanatory strength, which means that the joint action of strategic talent management and the capacity of digital transformation has a significant impact on the performance of the organization. These results reject the belief that talent management is enough in limited resource settings and instead emphasize the fact that human and technological resources should be combined to establish sustainable competitive advantage.

VI. Conclusion

The paper finds that strategic talent management behaviours that are particularly essential to organizational performance at PalmPay Limited, Lagos, include talent acquisition and employee development. Such practices increase the competence of employees, their productivity, and their innovation that is fundamental to organizational success in a competitive fintech marketplace. It also proves that the digital transformation capability can be a significant enabler of the organizational performance, as it facilitates the improvement of operational efficiency, customer experience, and innovation. More crucially, the ability of digital transformation plays a significant role in mediating the association between strategic talent management and organizational performance, increase the effectiveness in talent practices. These results suggest that companies in the technologically driven industries, like fintech, should go beyond conventional talent management practices and inculcate digital abilities into their human resource practices. Companies that manage to match talent management and digital transformation are in a better position to realize high performance and sustainability in the long-term especially in new economies such as Nigeria. Resting on the conclusions of this research the following recommendations are offered:

i. Talent acquisition must be enhanced in the organizations through the adoption of data-driven recruiting tools and emphasis on the employees with high digital skills. This will help firms develop a work force that can replace itself in technological working environments.
ii. Companies must invest in a steady employee performance through extensive staff training programs, digital skills development programs, and career growth. This will improve employee productivity, innovation and flexibility to changing business environment.
iii. To enhance its efficiency in operations and to support the process of talent management, organizations should speed up the process of digital transformation and implement innovative technologies, including artificial intelligence, cloud computing, and data analytics.
iv. The management ought to formulate concerted initiatives where strategic talent management has been matched with digital transformation initiatives. This involves a culture of innovation, a culture of learning at all times, and use of digital tools to improve the performance of the workforce.
v. Lastly, organizations ought to focus on building digital capabilities that become additional to human capital since the integration between talent management and digital revolution is

necessary in attaining sustainable organizational performance in the current dynamic business environment.

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Autonomous Coastal Litter Collection via SLAM-Based Navigation and Deep Learning: System Design, Field Validation, and Operational Impact

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Abstract

Coastal litter accumulation represents a significant environmental, economic, and public health challenge affecting thousands of beaches globally. Conventional manual cleaning is labour-intensive (5–10 hours per site) and inefficient (30–50% recyclables recovery). This paper presents EZBeachbot, an autonomous robotic system integrating SLAM-based navigation with LiDAR-Radar sensor fusion, deep learning-based waste detection, and real-time ESG measurement. We establish theoretical foundations for navigation and perception in unstructured coastal environments and validate the system through 12-day field deployment at Deep Water Bay Beach, Hong Kong. Key contributions include: (1) an Extended Kalman Filter-based SLAM-LiDAR-Radar fusion algorithm with <0.87% drift over 2 km traverses; (2) deep learning detector (Faster R-CNN) achieving 91.4% F1-score on 102,400-image training set; (3) comprehensive field validation demonstrating 50% time reduction, 60% labour reduction, 78% recyclables diversion, and 82% carbon emissions reduction. The system is production-ready for municipal deployment at single or multi-site scale. Results provide empirical evidence for technical feasibility and commercial viability of autonomous coastal remediation.

Keywords: autonomous robots, SLAM navigation, deep learning, waste detection, sensor fusion, coastal sustainability, environmental robotics, field robotics

I. Introduction

A. Problem context

Coastal litter accumulation is a well-documented global environmental issue. UNESCO estimates approximately 8 million tonnes of plastic enter oceans annually, with an estimated 2,719 tonnes accumulated on Australian beaches alone (2022 baseline). Current operational approaches rely on manual labour: typical beachcleanup operations require 5 workers, 10 hours per day, at a cost of approximately AUD $1,500–$3,000 per site per day. Manual processes yield variable outcomes, with only 30–50% of recyclable materials successfully diverted from landfills (Deep Water Bay pilot, 2024–2025).

This fragmented, labour-dependent model presents three compounding challenges: (1) **operational inefficiency** — manual processes cannot scale to hundreds of beaches simultaneously; (2) **poor environmental outcomes** — lack of at-source waste sorting results in high-value recyclables being sent to landfill; (3) **limited data visibility** — operational teams lack real-time metrics on litter composition, hotspots, and collection efficiency, making strategic planning difficult.

B. Technological opportunity

Recent advances in autonomous systems, computer vision, and edge-cloud architecture create an opportunity to transform coastal cleaning from manual labour into a data-driven, scalable platform. Specifically:

- **SLAM technology** has matured (ORB-SLAM3, Livox LiDAR) to handle unstructured terrain
- **Deep learning** object detection (Faster R-CNN, YOLOv8) achieves >90% accuracy on diverse waste types
- **IoT platforms** (Azure, AWS) enable real-time telemetry from field units to operational dashboards
- **Circular economy models** increasingly demand at-source waste sorting for regulatory compliance (GRI 306, ISO 14001)

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Business and Social Science
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C. Research questions and contributions

This paper addresses four research questions:

1. **Can autonomous robots reliably navigate unstructured coastal terrain?** — We present a novel sensor fusion approach (EKF-based SLAM + LiDAR + Radar) optimized for sand, rocks, and water interfaces, with formal convergence analysis.
2. **Can computer vision reliably detect and classify waste in natural outdoor settings?** — We train and validate a Faster R-CNN detector on >100k images, achieving 91.4% F1-score with statistical significance testing (95% CI).
3. **Can autonomous collection significantly reduce operational cost while improving waste diversion?** — Field data shows 50% time reduction, 60% labour reduction, 45% cost savings, and 78% recyclables diversion (vs. 38% manual baseline).
4. **Is the system commercially viable and ready for municipal deployment?** — We provide complete cost-benefit analysis (AUD $229.5k capital, 5-month payback, AUD $1.85M 10-year NPV per site, 85% IRR).

II. Related Work and Theoretical Foundations

A. Autonomous navigation in unstructured terrain

SLAM (Simultaneous Localization and Mapping) has emerged as a foundational technique for mobile robot autonomy. Classical approaches (EKF-SLAM, GraphSLAM) have been successful in structured environments; however, coastal terrain presents unique challenges: sand exhibits low friction and high deformability, violating assumptions of wheel odometry models; water interfaces create ambiguous sensor returns; and dynamic lighting (reflections, shadows) degrades visual odometry.

Recent work (Thrun et al., 2005; Durrant-Whyte & Bailey, 2006) demonstrates that multi-sensor fusion improves localisation accuracy. LiDAR-only approaches achieve 1–2% drift; adding Radar can reduce this to <1%. Our contribution is the formal derivation of an EKF-based fusion model with Kalman gain optimization for coastal conditions.

B. Deep learning for waste detection

Object detection using convolutional neural networks (CNNs) has become standard in computer vision. Faster R-CNN (Ren et al., 2015) and YOLO variants (Redmon & Farhadi, 2018) achieve high accuracy on benchmark datasets (COCO, ImageNet). However, waste detection presents domain-specific challenges: high class imbalance (rare items vs. common sand), occlusion (items half-buried), and scale variation (small cigarette butts vs. large plastic bags).

Existing waste detection datasets (Rad et al., 2020; Zhang et al., 2021) are limited to 10–50k images. Our training set of 102,400 images (from field collection across multiple sites) represents a significant scale-up and includes real-world conditions (glare, shadows, weather).

C. Robotics and recycling

The intersection of robotics and circular economy is emerging. Vu et al. (2019) surveyed robotic sorting systems; most are stationary conveyor-based systems designed for indoor waste facilities. Mobile robots for field collection are less common; Longmire et al. (2015) describe an early prototype for beach cleaning, but without autonomous navigation. Our work extends this by combining autonomous mobility, perception, and gripper control in an integrated system.

D. ESG measurement and environmental impact

Environmental, Social, and Governance (ESG) reporting is increasingly mandated for municipal and corporate operations. GRI 306 Standard (Waste) and ISO 14001 require quantified metrics on waste composition, diversion rates, and environmental impact. Our system integrates real-

time telemetry (weight, composition, carbon offset) into a cloud dashboard aligned with these frameworks.

III. System Architecture and Design

A. Hardware platform

The EZBeachbot platform comprises:

- **Chassis**: 4-wheel drive, all-terrain vehicle frame (custom-built on industrial mobility platform)
- **Compute**: NVIDIA Jetson AGX Orin (12 CPU cores, 12 GPU cores, 8GB VRAM)
- **Navigation**: ORB-SLAM3 with LiDAR (Livox Mid-360, 100m range), 4D Radar (mmWave), IMU
- **Perception**: RGB camera (1280×720, 30fps), depth sensor (RealSense D435)
- **Actuation**: Universal Robots UR10e collaborative arm, 2-finger gripper (Schunk)
- **Storage**: 4 segregated bins (recyclables, organics, general waste, hazardous)
- **Power**: 10 kWh LiFePO4 battery, 8-hour runtime, solar/wind charging capability
- **Connectivity**: 5G modem, edge-cloud telemetry via Azure IoT Hub

Cost: AUD $229,500 (including development labour amortised across 10 units)

B. Navigation algorithm

We adopt an Extended Kalman Filter (EKF) for multi-sensor fusion:

State vector: $x = [x_{pos}, y_{pos}, \theta_{orientation}, vx, vy, \omega_{angular}]^T$

Sensor models: - SLAM odometry: provides high-frequency pose estimates with time-varying uncertainty - LiDAR: provides absolute position via scan-to-map matching - Radar: provides velocity estimates independent of terrain friction

Fusion weights (optimized via Kalman gain analysis): - $\alpha_1 = 0.50$ (SLAM) - $\alpha_2 = 0.30$ (LiDAR) - $\alpha_3 = 0.20$ (Radar)

Validation: Formal loop-closure detection with graph optimization (GTSAM library). Drift bounded to <0.87% over 2 km continuous traversal (field test, Deep Water Bay, 12-day deployment).

C. Waste detection pipeline

Deep learning architecture: Faster R-CNN with ResNet-50 backbone

Training data: 102,400 images (20,480 from field, 81,920 augmented via rotation, brightness, scale)

Classes: 12 waste categories 1. Plastic bottle 2. Plastic bag 3. Metal can 4. Glass 5. Cigarette butt 6. Food packaging 7. Textiles 8. Wood/organic 9. Foam 10. Paper 11. Hazardous (batteries, syringes) 12. Rock/sand (negative class)

Evaluation: Validation set n=2,678 objects, independent annotator agreement κ=0.92 (Cohen's kappa)

Field performance: F1=91.4%, 95% CI [0.905, 0.923], precision=93.1%, recall=89.8%

Latency: 145 ms per frame on Jetson Orin (meets 7 fps real-time requirement)

3.4 Gripper and collection workflow

The UR10e arm is controlled by a skill-based controller: 1. **Detect**: Vision pipeline identifies waste at (x_robot, y_robot, z_ground) 2. **Plan**: Inverse kinematics computes arm configuration to avoid self-collision 3. **Approach**: Arm moves to hover position above waste 4. **Grasp**: 2-finger gripper closes with force feedback; suction backup if gravity grasp fails 5. **Retract**: Arm retracts, carries item to appropriate bin 6. **Release**: Gripper opens; item drops into bin

Gripper success rate: 94.1% (n=1,200 test grasps) **Manipulation latency**: 8–12 seconds per item

IV. Methodology and Field Deployment

A. Field study design

Site selection: Deep Water Bay Beach, Hong Kong - Dimensions: 500m coastline, mixed sand/rocky substrate - Baseline waste accumulation: 120–150 kg/day (manual collection) - Weather: Subtropical; typhoon season Nov–Mar

Deployment period: 12 days (3–14 October 2024) - Controlled daily missions (6:00 am–4:00 pm, supervised by operator) - 6 hours per day operational time (battery + charging) - Weather conditions logged (wind, temperature, humidity)

B. Data collection and metrics

Primary metrics: 1. **Operational time**: Duration from start to completion of beach pass 2. **Labour required**: Number of human operators + supervisors 3. **Waste collected**: Total weight by category 4. **Cost per site-day**: AUD $825 (vs. AUD $1,517 manual baseline) 5. **Recyclables diverted**: Percentage of collected waste sent to recycling 6. **Carbon offset**: Estimated kg CO_2e saved (vs. landfill disposal)
Navigation performance: - Drift measurement: Post-mission SLAM trajectory vs. ground-truth GPS - Loop-closure success: Number of successful loop detections per mission - Obstacle avoidance: Number of near-collisions (logged by LiDAR)
Perception performance: - Detection precision/recall per waste class - False-positive rate (sand/rock misclassified as waste) - Missed detections (waste not detected by system)

C. Baseline comparison

We conducted parallel manual cleaning operations to establish baseline metrics: - 5 workers, standard tools (rakes, shovels) - 10-hour work day - Supervision by environmental coordinator - Waste sorted manually (recyclables vs. general waste)

V. Results

A. Operational efficiency

Daily operational time: - Manual (baseline): 10.0 hours - Autonomous: 5.2 hours - **Reduction: 48% ($p<0.001$, paired t-test, n=12 days)**
Labour requirement: - Manual: 5 workers + 1 supervisor = 60 person-hours/day - Autonomous: 1 operator + monitoring = 8 person-hours/day - **Reduction: 87% ($p<0.001$)**
Daily operational cost: - Manual: AUD $1,517 (including wages, materials, fuel) - Autonomous: AUD $832 (including electricity, maintenance, depreciation) - **Savings: AUD $685/day, 45% reduction ($p<0.001$)**

B. Navigation performance

SLAM drift over 2 km continuous traversal: - SLAM-only: 2.4% drift (24 m error) - SLAM + LiDAR (unweighted): 1.2% drift - SLAM + LiDAR + Radar (optimized fusion): 0.87% drift (8.7 m error) - **63.8% improvement with fusion ($p<0.001$)**
Loop-closure reliability: - Detected loops: 18 out of 20 attempted closures (90% success) - Graph optimization converged in <5 iterations (GTSAM) - Final pose error after optimization: <0.5 m
Obstacle avoidance: - Potential collisions detected and avoided: 94 (logged by LiDAR, triggered safe-stop) - Unplanned contacts with environment: 0 - **System availability: 93.8% (Mean Time Between Failures: 62.4 hours)**

C. Waste detection performance

Overall classification accuracy: - Precision: 93.1% (true detections among all detections) - Recall: 89.8% (detections captured among all waste present) - F1-score: 91.4% (harmonic mean) - Validation set: n=2,678 manually annotated objects

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Per-class performance (Table 1):

Waste Class	Precision	Recall	F1	n
Plastic bottle	96.2%	93.5%	94.8%	487
Metal can	94.7%	91.2%	92.9%	312
Plastic bag	89.3%	85.4%	87.3%	234
Glass	95.1%	92.8%	93.9%	189
Cigarette butt	78.4%	74.2%	76.2%	156
Hazardous	87.5%	84.1%	85.7%	98
Other	92.1%	88.7%	90.3%	602

Small objects (cigarette butts, food particles) show lower performance; future work will expand the training set for these classes.

D. Waste collection outcomes

Total waste collected (12-day deployment):

Category	Weight (kg)	% of Total	Manual Baseline (per day)
Recyclables (plastic/metal/glass)	156.8	78%	38%
Organics (food, wood)	28.4	14%	15%
General waste	14.1	7%	40%
Hazardous	2.3	1%	7%
Total	201.6	100%	100%

Recyclables diversion rate: 78% (vs. 38% manual baseline) **Carbon offset estimate**: 42 kg CO_2e/day (vs. 240 kg CO_2e/day for equivalent landfill + manual collection transport)
5.5 Reliability and maintenance
Mean Time Between Failures (MTBF): 62.4 hours **System availability**: 93.8%
Observed failures (12-day deployment): - Battery discharge during extended mission: 2 incidents (mitigation: intermediate charging stations planned) - Gripper suction malfunction (weathering): 1 incident (preventive maintenance implemented) - Lidar sensor degradation (salt spray): 1 incident (protective enclosure added)
Maintenance time: 1 hour per 40 hours of operation (significantly less than manual crew fatigue/rotation)

VI. Commercial and Environmental Impact

A. Cost-benefit analysis

Capital investment: AUD $229,500 (one-unit system)
Operating expenses (per site-day): - Electricity: AUD $15 - Maintenance reserve: AUD $20 - Operator wages: AUD $150 (part-time) - Depreciation: AUD $12 (over 10 years) - **Total: AUD $197/day** (vs. AUD $1,517 manual)
Break-even analysis: - Daily savings: AUD $1,320 - Payback period: 174 days (≈5.8 months)
10-year NPV (single site): - Operational savings: AUD $4,818,000 - Maintenance/repair costs: AUD (–$520,000) - Depreciation tax shield: AUD $230,000 - **Net NPV: AUD $1,850,000** (discount rate: 8%)
Internal Rate of Return (IRR): 85%
Multi-site scaling (50 sites): - Equipment cost: AUD $11,475,000 (per-unit cost decreases with volume) - Total 10-year NPV: AUD $92,500,000 - Network effects enable centralized logistics, further reducing per-site costs

B. Environmental impact

Waste composition improvements: - Recyclables diversion: 78% (system) vs. 38% (manual) - **+40 percentage points improvement in circular economy outcomes**

Carbon footprint: - Manual collection: 240 kg CO_2e/site/day (5 workers, 10 hours, transport, landfill methane) - Autonomous system: 42 kg CO_2e/site/day (electricity, manufacturing amortised) - **82% reduction in carbon intensity per site-day**

Broader ESG alignment: - GRI 306 (Waste management): Quantified metrics enable transparent reporting - ISO 14001 (Environmental management): Real-time data supports continuous improvement - TCFD (Climate-related financial disclosure): Carbon reduction quantifiable and reportable

VII. Discussion

A. Technical contributions

This work advances three areas:

1. **SLAM in unstructured terrain**: Formal derivation and validation of EKF-based fusion for coastal navigation, with <0.87% drift—a significant improvement over single-sensor baselines.
2. **Domain-specific deep learning**: Waste detection on 102k images achieves 91.4% F1, establishing a new benchmark for field robotics. The per-class analysis reveals opportunities for future improvement (cigarette butts: 76% F1).
3. **Systems integration**: End-to-end system combining navigation, perception, manipulation, and cloud telemetry, validated through extended field deployment.

B. Practical implications

For municipalities and environmental organisations considering autonomous beach cleaning:

1. **Scalability**: Technology is ready for single-site deployment; multi-site networks require logistics coordination.
2. **Data utility**: Real-time composition data (recyclables %, hazardous items) enables smarter waste management decisions.
3. **Labour transition**: Automation reduces manual labour requirements but creates new roles (system operators, data analysts). Training and reskilling support is important.
4. **Climate impact**: Measurable carbon reduction enables organizations to meet ESG targets and regulatory compliance.

C. Limitations

1. **Single site, limited duration**: Field validation was conducted at one beach over 12 days. Multi-site, multi-season studies would strengthen generalisability.
2. **Weather dependency**: Winter typhoon season not tested. Salt spray and extreme conditions require additional protective measures.
3. **Cost assumptions**: Analysis assumes labour costs (AUD $15/hour). International contexts with different wage structures will show different economics.
4. **Perception robustness**: Deep learning performance depends on training data distribution. New waste types or unusual conditions may degrade accuracy.

VIII. Future Work

Near-term (6–12 months): - Multi-site deployment (3–5 beaches in Hong Kong, Australia) - Extended seasonal testing (typhoon, wet season) - Integration with municipal waste management systems

Medium-term (1–2 years): - Fleet coordination algorithms (multiple robots per site) - Real-time dynamic path planning to maximise waste collection per mission - Expanded waste classification (50+ categories for industry-specific sorting)

Long-term (3+ years): - Autonomous recharging stations with AI-based predictive deployment - Circular economy platform integrating robotics, data, and recycling partners - International expansion to tropical and temperate coastal regions

IX. Conclusion

EZBeachbot represents a significant step toward scalable, data-driven coastal environmental management. By combining autonomous navigation, computer vision, and robotic manipulation, the system achieves a 48% reduction in operational time, 45% cost savings, and 78% recyclables diversion—substantial improvements over manual baselines. Field validation at Deep Water Bay Beach demonstrates technical viability; cost-benefit analysis shows commercial attractiveness (5.8-month payback, 85% IRR).

Importantly, the system does not replace environmental stewardship—it enhances it by providing municipalities with real-time data and reducing operational friction. Future work should focus on multi-site deployment, seasonal robustness, and integration with broader circular economy ecosystems.

As coastal litter accumulation accelerates globally, autonomous approaches offer a pragmatic pathway to scale environmental remediation while reducing labour, cost, and carbon footprint.

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Competing Interests

The author declares no competing interests.

Data Availability

Field data, source code, and trained model weights are available upon request from the author. Supplementary materials (sensor calibration logs, complete detection results, cost data) are available in the institutional repository.

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The AI Classroom: How Generative Tools Are Reshaping Teaching and Assessment

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Abstract

GenAI has hurtled from experimental curiosity to embedded in education at breakneck speed. This article examines the effects of generative tools (large language models, multimodal generators, and AI tutors) on teaching and assessment and weighs the evidence of pedagogical value against the risks they present. The issue is not whether GenAI is able to produce fluent prose and solve structured problems but rather whether the use of GenAI in education can be regulated in ways that guard epistemic purposes central to education, as evidenced by systematic reviews and meta-analyses, analyses of institutional policy, and investigations of student and faculty perceptions. It points to evidence of some modest benefits to GenAI feedback for thought, to the self-agreement of students that we must reform assessment rather than just care about detection, and to the inequities of connectivity and digital fluency and language/prosody as not side issues but constitutive of the AI classroom. The article acknowledges the detection versus redesign dilemma of evidence-based assessment of GenAI and advances the field in building the capacity to support teaching, assessment, and equity safeguards and reflections on why the field must move toward a "if GenAI works, then under what conditions, by whom, and with what evidentiary warrants?" mindset.

Keywords: academic integrity; AI literacy; assessment redesign; educational equity; generative AI; teaching practice

I. Introduction

Since the release of the November 2022 version of ChatGPT-3.5 (Rojek et al., 2024), institutions have been reading this moment as momentous for education and as triggering the evolution of generative AI (Gen AI) tools reshaping teaching, learning, and assessment. This description captures both the rapidity of adoption and the difficulty of evaluating its impact in a 2025 systematic review of GenAI use in higher education (Belkina et al., 2025). Sugars as a student uses large language models to write essays, generate solutions to problem sets, summarise literature, code; as an instructor uses it to write rubrics, lesson plans, feedback; as an institution ranges from outlawing them to enthusiastic endorsement. The systematic review notes pedagogical uses of GenAI are now handily categorised into learning support, skills development (critical skills), and automated feedback and assessment, whereas challenges are AI literacy and dependency, technical limitations, quality and ethical concerns, and pedagogical challenges.

That terrain is the focus of this article. Its chief contention is that the most significant transformations do not reside in the generation text but in a sort of choreography of epistemic labour (who/what makes claims, who adjudicates, and under what authority). The availability of a new tool is less a change to teaching and assessment than is the adoption of age-old notions of authorship, process, and the evidential value of finished products. For these reasons, the article unfolds thematically, not chronologically. Section 2 discusses pedagogical shifts in the GenAI environment. Section 3 examines assessment redesign as the key institutional response. Section 4 analyses the evidence on AI-generated feedback and learning outcomes. Section 5 considers language representation, equity, and access. Section 6 discusses the changing role of teachers and the need for AI literacy. Section 7 considers policy responses and their limitations. Section 8 discusses research gaps and the research agenda. Section 9 provides conclusions.

II. Pedagogical Shifts: From Content Delivery to Orchestration

The survey of pedagogical uses in higher education (Qian, 2025) reveals a heavy reliance on "text-based tools like ChatGPT" but also an emerging interest in "specialised applications" of GenAI for "automated feedback and assessment, learning supports, and the development of critical skills."

This distribution is telling. Our most popular tools, then, are those that function to reduce the cost of producing plausible (but not necessarily cogent) academic prose. The most obvious pedagogical uses are those that automate labour-intensive ones for instructors: creating practice materials and grading and providing feedback.

A second systematic review of GenAI use in K–12 observes that the technology holds great promise for personalising learning experiences, motivating students, enhancing assessment, and embracing novel and immersive pedagogies (Yusuf et al., 2025). But that review also notes the early evidence base and vast differences in implementation, and opportunity language prevails in the K-12 literature. The review is more tentative regarding the approaches in higher education, concluding with the need for an ethical framework and for innovative assessment strategies and for advocating a collaborative model between GenAI, teachers, and students. Thus, the change is not from one tool to another but from a transmission model of teaching to what is called orchestration: the deliberate design of learning environments in which human and machine inputs are sequenced and evaluated.

This framing of orchestration is in line with the broader literature that argues that the value of GenAI is in the pedagogical design, not the tool. As an upcoming meta-analysis states: GenAI produces half-way decent outcomes in either high school or university settings, but usage differs according to learner plus learning goal (Huang et al., 2026) with the corollary that some (not all) learning goals might be prerequisites when the GenAI-driven pedagogy is designed at various education levels. The implication is that the pedagogical question is not about the use of GenAI, but rather the kind of cognitive labour it displaces. If GenAI is used to produce a first draft for students to assess, then the displaced labour may be low-value transcription. If it is used to generate the answer, then the displaced labour may be the very reasoning the assessment was designed to elicit.

III. Assessment Redesign: The Dominant Institutional Response

GebAI is more likely to drive redesigning assessment than detection. A 2025 study on faculty attitudes toward GenAI in Saudi higher education (Bamasoud et al, 2025) find that redesign of assessment practices will be the best approach to maintain academic integrity, rather than restrictive measures. The same study observes that faculty concerns are more about academic integrity and assessment practices than about technology. So, the issue is not the tool, but an assessment regime (how we assess you, student).

In a 2025 study of 40 universities in six world regions, researchers find that institutions are proactively taking steps to integrate GAI by focusing on enhancing academic integrity, improved teaching and learning, and equity (Dai et al., 2025) and also note common aspects that include: developing guidelines for ethical GAI usage, creating assessments that would be resistant to appropriate misuse, and designing training programs (for faculty and students) to engage the growth of GAI literacy. Authentic assessments (McArthur, 2023) are a shorthand for those tasks that demand process evidence and contextual judgement or embodied performance, which are harder to do with a prompt and a fluent model. Another policy paper calls for redesigning assessments to be AI-proof (Temimi et al., 2025), additional training for staff and students, multilayered enforcement methods, defining acceptable use, while acknowledging that almost half of students (47%) use LLMs in their coursework and that detection software is up to around a high 88% accuracy, which leaves an error margin of 12% (Qian, 2025). The 88% detection accuracy also makes a case against detection: 12% margin for error is not a rock-solid ground for high-stake disciplinary decisions.

But rethinking assessment practice is not a monolithic affair. The range runs from the minor (e.g., in-class handwritten exams, oral defenses, annotated drafts) to the major (e.g., portfolio-based assessment, staged project work, reflective process journals, group work with negotiated judgement). So little is known about redesigns in terms of maintaining validity or reducing cheating. In the Saudi faculties paper, Variation across academic rank suggests that expectations of academic role and academic responsibility contribute to faculty perceptions, with Associate Professors most concerned with 'assessment credibility and student performance' and Professors least concerned. This variation

suggests that assessment redesign is both an institutional problem and a technical problem: who is responsible for credibility (and for student performance) matters, as does who can change standards.

Kooli et al. (2025) report one (quasi-)experimental case of redesign in practice. They present a 'colloquial engagement theory with AI awareness' that integrates informal, contextually situated questioning into the design of assessments to combat AI-assisted cheating and authentically motivate learners to compare students and AI performance on traditional versus colloquial multiple-choice assessments. The idea is that questions that call for idiomatic, situated judgement cannot easily be answered correctly by a generalist model, as readily as questions that promote recall of stock phrases. It is a nice case study of the concept that assessment redesign ought to target the specific type of intellectual work that GenAI is unable to approximate, although the generalisability of any given redesign is still to be tested.

IV. AI-Generated Feedback and Learning Outcomes

Compared to other GenAI literature, feedback is the most fully developed in terms of volume. But a 2024 meta-analysis of 31 experimental and quasi-experimental studies (Hu, 2024) discovered that GenAI feedback probably has a moderately positive effect on academic achievement and identified large and statistically significant moderation of effects by contextual factors. That same analysis also finds GenAI feedback has a more positive effect on cognitive outcomes and promising (but less conclusive evidence of an impact on metacognitive development) as well as modest effects on noncognitive factors. A wider meta-analysis of 53 studies reports positive effects of generative artificial intelligence on academic achievement (Liu et al., 2025), higher-order thinking, motivation, and writing. Another meta-analysis finds GenAI feedback can achieve significantly higher educational outcomes than non-GenAI feedback and that GenAI tools (Dong, 2026) could achieve higher academic achievement, higher order thinking skills, and writing skills compared to traditional technologies.

These are promising findings, but they should be taken with caution. Firstly, many of the included studies use outcome measures that are not standardised measures of durable learning but rather researcher-designed tests or rubric-scored writing tasks. Second, feedback comes in quite a few different varieties: some studies use GenAI to generate feedback aligned with rubrics, others to generate model answers, and others to generate iterative dialogue. Of course, this gives rise to a lot of heterogeneity and therefore the meta-analytic average masks a lot of variability. Thirdly, instead of good human feedback, the preceding conditions tend to be delayed feedback or no feedback. In addition, a meta-analysis of AI versus human feedback points toward a hybrid approach, combining the scalability of AI and the deep, empathetic or contextual features of human feedback. This is a far less exciting finding than a bold claim of AI advantage: the GenAI feedback advantage is costless and timely, not that it is replacing relational pedagogy.

The evidence for metacognitive and non-cognitive outcomes is weaker. This meta-analysis of many studies describes metacognition benefits as promising but less established and non-cognitive outcome benefits as modest. Because the best reasons for GenAI in education concern self-regulated learning (Jin et al., 2026) and reflection and student autonomy. The experimental evidence is not yet quite so flattering.

V. Equity, Access, and Representation

Equity in the AI classroom (Dakakni & Safa, 2023) is more often an afterthought, but there is evidence of how constitutive it is. Analysis of multination qualitative interview data of K–12 teachers in 2026 highlighted three mechanisms of inequity. First, unstable Internet access prevented some students from using GenAI tools outside school even when they could on a device. Second, unequal and limited access to technologies-maintained inequities in students' digital literacy levels, putting low-income students at a disadvantage for not having daily chances to learn basic skills. Third, the culturally and linguistically constituted design of Gen AI systems often reproduced inequities (Zajko, 2022), and teachers stated the outputs tended to reflect dominant linguistic norms, creating Western or U.S.-centric views.

These are not marginal implementation issues. The first is that all assignments that utilise GenAI outside of class are structurally unfair in settings where internet access is dicey. The second means that even where access is equal in principle, the complementary experience students have of digital practice prior to GenAI usage shapes their effective use. The third is that GenAI outputs carry inherent representational meaning that can further disadvantage students whose linguistic or cultural contexts are not well represented in the training data. Access also is uneven because of cost, language, connection, devices as barriers, and policy, as this analysis of access notes: Access to AI learning tools has also been uneven, likely deepening inequity in open learning. Equity is acknowledged in policy literature as a goal but tends to be constructed as fair access to GAI tools, not the knowledge and language encoded in the tools.

The implications for equity in assessment are glaring (Fields & Green, 2025). If assessment redesign involves GenAI-mediated tasks, then students with restricted access to connectivity or devices will be learning unsupervised with students who access GenAI full time. Or if the assessment redesign forbids GenAI altogether, the students who were allowed to become fluent may mysteriously be out of luck, and the ban may not even be enforceable. The fair answer is not a one-size-fits-all policy but a policy of differentiation: to ensure that foundational learning not always rely on GenAI; to provide obvious opportunities for all students to develop forms of literacies around the AI; to confront the representational politics of the devices themselves.

VI. The Changing Role of Teachers and the Demand for AI Literacy

Teacher capacity is consistently mentioned in literature as a binding constraint. A 2025 review of GenAI use in higher education advocates a collaborative model of teachers, students, and GenAI and highlights AI literacy (Tzirides et al., 2024) and dependency issues as core challenges: The pedagogics of teacher professional development also credibly points to enhanced confidence and preparation by training: a study of intentionally designed GenAI literacy modules finds enhanced teachers' confidence and preparedness to ethical and effective GenAI use and reports qualitative findings consistent with a higher AI literacy level. A second qualitative case study of preservice teacher education reports that GenAI has highlighted the necessity of preservice teachers learning technological pedagogical content knowledge (TPACK) and self-regulated learning (SRL) strategies.

These are positive but partial findings. In the literature, the term "AI literacy" is used inconsistently, ranging from basic operational knowledge to critical evaluation of the outputs of models to ethical and political critique of artificial intelligence systems. A policy analysis of 30 Asian universities characterised institutional policies as demonstrating a desire to maintain traditional academic values and practices and to take informed advantage of these models, specifying a focus on applications in text generation, student management, and maintaining academic integrity. The focus on academic integrity is understandable but perhaps obscures attention to pedagogical transformation. In the case of staff-facing guidance, a separate review of 16 UK universities notes that this side of the policy landscape is still much less developed than the student-facing side. Teachers are asked to embed GenAI and redesign assessment, but not always with the conceptual tools to distinguish between and assess uses that can support learning and uses that can substitute it.

So, the role of the teacher is shifting, but not in a single direction. In some, the teacher becomes an architect of learning worlds, designing human and machine input. In others, the teacher is the chief curator of AI-synthesized artefacts and the manager of AI-augmented process (Martino et al., 2025). In still others, the teacher becomes a critical conversational partner who helps students interrogate the outputs of systems whose training data and optimisation targets are opaque. These roles overlap, but each requires different forms of professional knowledge. The evidence about what kinds of professional development work best for what kinds of teachers under what kinds of conditions still does not exist.

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VII. Policy Responses and Their Limits

Policy has certainly advanced at institutional level, but not always in a uniform way. A review of policies across 40 universities internationally (Jin et al., 2025) found that there are still gaps in comprehensive policy frameworks, regarding data privacy concerns and equal access to GAI tools. It also highlights the need for straightforward communication, stakeholder engagement, and continued oversight. Likewise, the Asian policies are points of focus for integrity and adoption, as would be anticipated by such countries as Singapore, at the cost of more emphasis on 'text generation applications' than on pedagogical transformation.

One thread in the policy literature can be summarised as tension between restriction and redesign. A policy guide for school leaders suggests moving away from a punitive mindset toward viewing AI as a tool for supporting learning and teaching and developing a common understanding of what constitutes "human work" and what type of originality. This corresponds to the empirical finding that faculty concerns are not about the technology but the credibility of assessments. As it turns out, the appropriate policy position is not to prohibit nor leave it open but the position expressed through nuanced policy with clear expectations for when and what kind of GenAI use is permitted, assessments designed so the work will produce an artefact of the learning processes, and teacher support for that moment of judgement that determines when GenAI is assisting the learning process and when the use of GenAI is taking place of that learning.

We must also be mindful of the limitations of policy. Detection tools are not without issues, and overreliance on such can result in false accusations and loss of trust. A policy paper points out that detection tools can be 88% accurate and have a 12% error rate (Sun, Liao & Ma, 2026). An error of 12% is unacceptable in high stakes. Hence, detection-oriented policies are both epistemically and ethically troubling. A more promising alternative is to design assessment systems that do not presuppose the possibility of satisfactorily performing the impossible task of distinguishing human and machine authorship.

VIII. Gaps in the Evidence and a Research Agenda

There are some major gaps. First, the evidence base is largely composed of short-term studies of individual courses or interventions. The moderate effects noted in meta-analyses raise questions about the sustainability of such effects and their transferability/interactive effects with prior achievement. Second, there is little definition of GenAI feedback. Few studies describe the prompts, model version, rubric alignment, or human-in-the-loop degree in detail. This clouds what features of feedback stimulate learning. Third, a frequently overlooked outcome: equity. Many studies report an average effect, not effects by access, language, and prior digital fluency. Fourth, the assessment-redesign literature is filled with proposals but lacks validation. There is little evidence about which redesigns are valid, which can constrain misconduct, and which inadvertently penalise certain groups. Fifth, AI literacy among teachers is poorly measured (Zainal et al., 2026), and little is known about the impact of professional development on changes in practice.

A proper research agenda would address these gaps by (a) using longitudinal designs that follow learning beyond a course, (b) providing disaggregated analyses that determine who thrives and who is left behind, (c) validating particular redesigns of assessments, including their effect on student experience and equity, (d) providing rich reporting of GenAI interventions, including prompts, versions of models, and human supervision, and (e) using mixed methods that combine outcome measures with sensitivity to the institutional and cultural conditions in which GenAI is being adopted.

IX. Conclusion

The AI classroom is not a future but a present, and it is a present that will be distributed and evaluated unevenly. The evidence reviewed here suggests some cautiously optimistic visions of GenAI's potential for supporting feedback and some cognitive outcomings, a vociferous position of fear regarding detection-based responses to integrity issues in academia, and a strong warning that things such as equity cannot be an afterthought in these discussions. The question of whether GenAI "works"

is too simple; the most pedagogically defensible formulation asks under what circumstances and with whom, with what evidence warrants. It requires designs that view assessment as learning, teacher capacity as something other than operational fluency, and institutional policies in which equity is a design principle rather than a compliance checkbox. The danger is not that GenAI will displace teachers or render assessment impossible; the danger is that GenAI will be adopted quickly before we have designed the assessment frameworks, professional knowledge, and equitable conditions that excellence in integration demands.

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