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MODERATING EFFECT OF DIGITAL LITERACY IN TECHNOLOGICAL ADOPTION AND STAFF PERFORMANCE RELATIONSHIP AMONG ACADEMIC STAFF OF KADUNA POLYTECHNIC

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Abstract

This study investigates the effect of digital literacy between technological adoption and staff performance at Kaduna Polytechnic. By utilizing a quantitative research design and stratified random sampling, the study aimed to assess how digital literacy influences the effectiveness of technological tools in enhancing academic staff performance. A sample of 349 respondents, selected from a target population of over 1,776 academic staff, was surveyed using a structured questionnaire. The data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) through SMART PLS 4. The findings revealed that technological adoption significantly impacts staff performance and that digital literacy moderates this relationship. This study highlights the crucial role of both technological adoption and digital literacy in improving institutional efficiency and academic staff productivity. The research recommends strengthening digital literacy programs, expanding the study to multiple institutions, and exploring other moderating variables to further enhance staff performance.

Keywords: Digital Literacy, Technological Adoption, Staff Performance, Kaduna Polytechnic.

1. Introduction

In every institution the way and manner in which academic staff operate has a significant importance towards impacting knowledge. In an academic setting especially a higher institution, the academic staff performance cannot be over emphasised. It is a critical determinant of organizational success, particularly in educational institutions, where it directly influences the quality of education, research output, and overall institutional reputation. Despite its significance, a substantial proportion of higher education institutions in Nigeria struggle to achieve optimal staff performance (Ndubuisi & Jacob, 2021). Studies have shown reports a significant decline in productivity within Nigeria's tertiary education sector (Jacob & Garba, 2021). Addressing this practical issue is not only critical but also a key step toward leveraging global innovations to enhance institutional effectiveness and competitiveness.

Furthermore, one promising avenue for improvement lies in technological adoption, which has been widely recognized as a transformative factor in advancing institutional efficiency and employee performance. According to Deacon et al., (2023) integrating cutting-edge technologies into academic systems offers an opportunity to not only improve staff performance but also advance the quality of education, research outputs, and overall institutional governance. The World Bank (2023) emphasizes that adopting technology in education has the potential to increase productivity, reduce operational inefficiencies, and enhance decision-making processes. However, the impact of technological adoption on staff performance is not uniform and is often contingent upon other factors that influence how effectively technology is utilized (Narayanamurthy & Tortorella, 2021).

Therefore, one of such critical factors is digital literacy, which plays a pivotal role in determining the extent to which staff can navigate and leverage digital tools to enhance their performance. Without adequate digital literacy skills, even the most advanced technological systems may fail to deliver their intended benefits, leaving institutions struggling to maximize their investments in innovation and efficiency (Montero & Leite, 2021). This study uses digital literacy as a moderator in the relationship between technological adoption and staff performance. Digital literacy encompasses the ability to effectively navigate and use digital tools and platforms to achieve specific goals. According to Onyedinefy (2022), about 50% of Nigeria's population lacks digital skills. This gap limits the ability of staff to leverage technology effectively, undermining its potential benefits on performance. As technological adoption becomes increasingly integral to educational and administrative processes, digital literacy plays a pivotal role in determining how well staff can utilize these tools to improve their work. For example, advanced technological systems for student management or research collaboration may remain underutilized without adequate training in digital skills. This decline is critical because staff performance directly impacts the quality of education, research, and institutional competitiveness. While technological adoption has been recognized as a transformative tool for improving efficiency and productivity, its effectiveness in Nigeria's higher institutions is undermined by low digital literacy levels (Joseph & Sofoluwe 2025). This research addresses the critical issue of how digital literacy moderates the relationship between technological adoption and staff performance.

Therefore, this study seeks to explore the moderating effect of digital literacy in enhancing the relationship between technological adoption and staff performance at Kaduna Polytechnic. By focusing on this dynamic, it aims to provide insights into how leveraging digital skills alongside technology can maximize staff performance, contributing to the broader goals of

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institutional development and educational excellence. In the light of the foregoing, the following hypotheses are raised to guide the study:

H_{01}: There is no significant relationship between technological adoption and Staff performance

H_{02}: Digital literacy does not moderate the relationship between technological adoption and Staff performance

Literature Review

Concept of Staff performance

Staff performance refers to the efficiency, effectiveness, and quality with which employees carry out their roles and responsibilities to achieve organizational goals. According to Mafudz, Burhan, and Syamlan (2025), staff performance comprises productivity, compliance with organisational standards, timely task completion, quality of work output, teamwork, and overall contribution to organisational success. In an academic setting, staff performance significantly influences the quality of education, research output, and institutional reputation (Mather & Bam, 2025).

Furthermore, effective staff performance is critical for achieving institutional objectives, ensuring operational efficiency, and maintaining a competitive edge. High-performing staff members typically demonstrate strong commitment, adaptability, and a proactive approach to problem-solving. Factors such as motivation, skill levels, access to resources, and organizational culture play a significant role in determining performance outcomes. In higher education institutions, staff performance is often assessed through metrics such as research publications, teaching effectiveness, administrative efficiency, and student outcomes (Camilleri, 2021). According to Kulikowski, Przytuła and Sułkowski (2022), challenges such as insufficient training, resource constraints, and outdated systems can impede staff performance, leading to inefficiencies and declining productivity. Enhancing staff performance is therefore vital for institutions aiming to improve their educational standards, research contributions, and overall impact on society. Therefore, in this study the authors define staff performance as the capacity of employees to effectively achieve organisational goals through the execution of their assigned roles and responsibilities.

Concept of technological adoption

Technological adoption refers to the process through which individuals, organizations, or societies embrace and integrate new technologies into their operations and workflows to improve efficiency, productivity, and outcomes (Biradar, 2026). This concept involves acquiring, implementing, and sustaining the use of technology in daily activities (Winter & Chico, 2023). The adoption process is often influenced by factors such as perceived usefulness, ease of use, cost, compatibility with existing systems, and the social environment that encourages or discourages adoption. The benefits of technological adoption include increased efficiency, improved decision-making, enhanced communication, and the ability to maintain a competitive advantage (Haleem et al., 2022).

However, the process is not without challenges. Barriers such as resistance to change, inadequate technical skills, high costs, and infrastructural limitations can hinder the effective

adoption of technology (Malomane, Musonda & Okoro 2022). Overcoming these challenges often requires strategic planning, training, and the development of supportive environments that enable users to navigate and utilize technology effectively (Chuunga, Mpundu & Qutieshat, 2025). In the context of higher institutions, technological adoption is critical for improving teaching methods, research capacity, and administrative efficiency. By integrating digital tools such as data analytics platforms, learning management systems, and online collaboration tools, institutions can enhance the performance of academic staff, streamline operations, and offer students more engaging and personalized learning experiences (Aithal & Aithal, 2023). Despite its potential, the effectiveness of technological adoption often depends on factors such as the digital literacy of staff and the availability of adequate infrastructure. Addressing these limitations is essential for achieving the desired outcomes and ensuring that technology serves as a transformative tool in education. In the context of this study, we conceptualise technological adoption as the ability of individuals or organisations to accept and use information communication technology (ICT) in order to achieve a desired goal and objective.

Concept of digital literacy

Digital literacy refers to the ability to effectively locate, evaluate, create, and communicate information using digital technologies (Martínez-Bravo, Sádaba-Chalezquer & Serrano-Puche, (2022). It encompasses a broad range of skills, including the use of digital devices, software applications, and online tools, as well as the capacity to navigate and engage with digital content responsibly and securely. Digital literacy is not limited to basic technical proficiency but also includes critical thinking, problem-solving, and the ethical use of technology in various contexts (Hays & Kammer, 2023). In today's interconnected world, digital literacy is essential for participation in education, the workforce, and society at large. It enables individuals to access information, collaborate with others, and adapt to rapidly evolving technological landscapes. Proficiency in digital literacy empowers users to use technology efficiently, enhances their ability to work with data, and fosters creativity in solving complex problems (Dondi et al., 2021).

Furthermore, in the context of higher institutions, digital literacy plays a pivotal role in enabling academic staff to utilize digital tools for teaching, research, and administrative purposes (Kabakus, Bahcekapili & Ayaz, 2025). It ensures that educators can effectively integrate technology into their curricula, leverage online resources, and engage students in interactive and innovative ways (Montes-Iturrizaga et al., 2023). Moreover, digital literacy helps institutions enhance operational efficiency, reduce redundancies, and promote transparency in processes. However, the digital skills gap remains a significant challenge, particularly in developing regions where access to technology and training opportunities is limited. Closing this gap is crucial to harnessing the full potential of digital transformation in education and beyond. Therefore, for this study, the authors defined digital literacy as the ability to know how to use proper use of digital tools or devises in order to achieve the designed goal and objective.

Empirical review

Technological adoption and staff performance

Jeilani and Hussein (2025) examined the impact of digital health technology adoption on workers' performance and workload using the Technology Organisation Environment framework. The study adopted a stratified random sampling technique and surveyed 286 healthcare workers drawn from public and private hospitals in Mogadishu. Structural equation modelling was used to test the relationships among variables. The findings revealed that digital health technology adoption has a significant positive effect on employee performance and workload management. The results indicated that increased use of digital systems enhances operational efficiency, improves accuracy in task execution, and accelerates service delivery processes ($\beta = 0.452$, $p < 0.001$). This suggests that technological integration supports productivity by automating routine tasks, improving information management, and facilitating better service delivery.

The study further showed that improved employee performance significantly reduces workload ($\beta = 0.594$, $p < 0.001$), implying that digital technology utilisation helps to ease operational pressure and minimise manual work burden. The mediating effect of performance between technology adoption and workload was also confirmed, indicating that technology improves organisational outcomes mainly by strengthening employee effectiveness rather than directly eliminating workload challenges. In addition, organisational readiness and environmental factors were found to positively influence performance outcomes, supporting the Technology Organisation Environment framework which emphasises the role of internal capability, infrastructure, and external support systems in successful technology adoption. Although the study was conducted in a healthcare environment, its findings are relevant to other service organisations such as polytechnics where staff performance and technological adoption are critical for operational efficiency. The survey-based approach provides empirical insight into user experience and behavioural responses to technology use among workers.

However, the study was limited by its single-region focus, which may reduce the generalisability of the results to institutions with different administrative structures, technological capacities, and workforce characteristics. The cross-sectional design also restricts the ability to establish long-term causal effects between technological adoption and performance outcomes. Furthermore, future studies may consider incorporating qualitative or mixed-method approaches and examining additional factors such as digital literacy, institutional culture, and infrastructure quality to provide deeper understanding of technology adoption and staff performance in tertiary education environments.

The study by Kallmuenzer, et al., (2025), examined the adoption and performance outcomes of digitalisation in small and medium-sized enterprises using a qualitative research design. The study employed in-depth interviews with SME managers to explore factors that influence technology adoption and the resulting performance implications. The findings revealed that successful digitalisation depends on the availability of appropriate technologies and the presence of a workforce possessing adequate digital skills to operate digital systems effectively. This suggests that technological adoption alone is insufficient unless employees have the competence required to utilise digital tools productively.

The study further identified organisational and behavioural barriers that hinder digitalisation in SMEs. These include risk-averse organisational culture and continued dependence on obsolete legacy information systems. Such constraints limit the willingness of firms to invest

in or transition to modern digital platforms. The results indicate that digital transformation is not solely a technical process but also a managerial and cultural change process that requires organisational commitment and strategic planning. The study established that digitalisation contributes positively to business performance when supported by suitable technology infrastructure and skilled personnel. Digital tools improve operational efficiency, decision-making quality, and service delivery processes by automating routine tasks and enhancing information management. However, the study emphasised that digital transformation should be implemented strategically, balancing technological investment with human capital development.

Although the qualitative approach provided rich contextual insight into digitalisation adoption behaviour, the study was limited by its reliance on managerial perspectives, which may introduce subjective bias. The findings may also not be fully generalisable to other organisational sectors such as polytechnics, where staff performance and technological adoption are influenced by institutional governance, academic culture, and public service operational structures. Future research could introduce a moderating variable to test the indirect relationship to examine how digitalisation affects employee performance, service efficiency, and institutional productivity over time in educational settings.

The study of Kankia (2025), examined cloud computing adoption in higher education institutions in Nigeria by developing an integrated technology adoption framework combining several behavioural and innovation theories, including the Diffusion of Innovation, Unified Theory of Acceptance and Use of Technology, Technology Acceptance Model, Desire Framework, and Technology Readiness model. The study adopted a survey research design and collected data from 384 staff and students in selected Nigerian higher education institutions, with 260 valid responses used for analysis. Both descriptive and inferential statistical methods, including correlation and regression analysis, were employed to examine factors influencing cloud computing adoption.

The findings revealed that technological, organisational, and environmental factors significantly influence cloud computing adoption in higher education settings. Specifically, computer efficiency, subjective norms, perceived innovation, perceived usefulness, user attitude towards technology, and external pressure were identified as important predictors of adoption behaviour. Among the determinants, environmental factors such as external pressure had the strongest influence ($\beta = 0.369$), followed by technological factors ($\beta = 0.248$), and individual-level factors ($\beta = 0.122$). This indicates that successful cloud technology adoption in higher education institutions depends not only on system characteristics but also on organisational readiness and external ecosystem forces. The study also showed that staff and students generally possess positive perceptions of cloud computing and demonstrate moderate to high readiness for digital technology integration in academic environments. This suggests that digital transformation in higher education can be accelerated when institutions provide supportive infrastructure, improve computer literacy, and respond to external technological demands. The proposed CTRAM model was validated by domain experts and considered suitable for assessing cloud computing acceptance and guiding digital education implementation strategies.

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Despite the contributions of the study, several limitations were observed. The sample was drawn from selected institutions in Nigeria, which may limit the generalisability of the findings across all tertiary institutions. The cross-sectional survey design also restricts the ability to establish long-term behavioural effects of cloud adoption on academic performance. Furthermore, future research should consider incorporating moderating variables such as institutional policy environment, digital infrastructure quality, and continuous professional development of staff to provide deeper insight into technology adoption in higher education.

The study by Ainomugisha (2022), investigated the relationship between information technology adoption, supply chain integration, and logistics performance among logistics firms in Uganda using a quantitative cross-sectional survey design. The study sampled 230 logistics firms, with three respondents selected from each firm, giving a total of 690 potential participants. Data were analysed using SPSS version 26, applying descriptive statistics, Pearson correlation analysis, regression modelling, and mediation testing to examine the hypothesised relationships among variables.

The findings showed that information technology adoption has a significant positive relationship with supply chain integration and logistics performance. The results further revealed that supply chain integration plays a mediating role in the relationship between technology adoption and logistics performance, indicating that the impact of digital technology on performance is partly transmitted through improved coordination across supply chain networks. The regression analysis indicated that information technology adoption and supply chain integration collectively explained 14.6% of the variation in logistics performance (Adjusted $R^2 = 0.146$), suggesting that other operational, managerial, and environmental factors also influence performance outcomes. From the perspective of technological adoption and staff performance, the study demonstrates that digital system integration enhances organisational operational efficiency by improving information sharing, coordination, and service delivery processes. The results imply that organisations can improve performance outcomes by integrating internal information systems with those of suppliers and customers, thereby strengthening workflow connectivity and reducing operational delays. This is particularly relevant to service and academic institutions where digital integration supports administrative efficiency and staff productivity.

However, the study was limited by its cross-sectional survey design, which restricts causal inference between variables. The focus on logistics firms in a single country also limits the generalisability of the findings to other sectors such as higher education institutions. Future research should explore additional factors such as digital literacy, organisational culture, and infrastructure quality to provide a more comprehensive understanding of technology adoption and performance relationships.

Shen, Zhang and Liu (2022), in their study, titled: Digital technology adoption, digital dynamic capability, and digital transformation performance of the textile industry: Moderating role of digital innovation orientation, explored the relationship between digital technology adoption and digital transformation in Chinese textile firms. Using data from 367 questionnaires, the study employed multiple regression analysis to test the effects of digital technology adoption, digital dynamic capability, and digital innovation orientation on firm performance. They found that digital technology adoption alone did not significantly impact transformation performance

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but was mediated by digital dynamic capability. Moreover, digital innovation orientation, particularly efficiency-driven innovation, played a moderating role in this relationship.

However, while the study provides valuable insights into digital transformation in manufacturing, its application to higher education, such as Kaduna Polytechnic, is limited. First, the textile industry's dynamics differ significantly from those of academic institutions, where technology adoption is linked to teaching, research, and administration. Additionally, the study overlooks digital literacy, which is crucial for academic staff in utilizing technology effectively for improved performance. Digital literacy encompasses technical skills, critical thinking, and problem-solving, making it a key factor for academic staff success. Furthermore, the study's context in China differs from Nigeria's, where challenges such as inadequate digital infrastructure and lower levels of digital literacy may affect the adoption of technology. This highlights the need for research that focuses on the specific context of Nigerian higher education. While the study contributes to understanding technology adoption in the textile industry, it overlooks the importance of digital literacy and the unique challenges faced by educational institutions. Future research could address these gaps by examining the role of digital literacy in academic settings and comparing findings across sectors to better inform strategies for digital transformation in education.

Moderating effect of Digital literacy

The study by Zhao, Xicang et al. (2024) investigated the determinants of digital transformation and technology adoption in high-tech firms, with digital literacy examined as a moderating variable. The study employed a survey research design and collected data from 521 respondents working in high-tech organisations. Partial Least Squares Structural Equation Modelling (PLS-SEM) was used to analyse the relationships among perceived technological factors, digital transformation behaviour, and firm performance outcomes.

The findings revealed that perceived ease of use and time-saving benefits positively influence digital transformation adoption, indicating that technologies that simplify work processes and reduce operational time are more likely to be accepted by employees. In contrast, perceived security and financial risks were also significant determinants, suggesting that concerns about data protection and implementation costs can shape organisational technology adoption decisions. The study further demonstrated that digital transformation partially mediates the relationship between time-saving perception and firm performance, implying that technology adoption improves performance partly by enhancing operational efficiency.

The moderating role of digital literacy indicates that employees' ability to understand and use digital technologies strengthens the effectiveness of digital transformation initiatives. This finding highlights the importance of workforce digital competence in ensuring successful technology integration and sustainable performance improvement. In organisational contexts such as polytechnics, the result implies that technology adoption policies should be accompanied by continuous staff training, skill development programmes, and user-friendly system design to maximise performance benefits.

However, the study is limited by its focus on high-tech firms, which may reduce applicability to educational institutions where operational objectives and workforce characteristics differ. The use of self-reported survey data may also introduce response bias. Future research should

consider explore additional contextual variables such as institutional culture, infrastructure readiness, and management support to provide a more comprehensive understanding of digital transformation and staff performance relationships.

The study by Mahesa et al., (2025) examined the influence of work environment on employee performance with digital literacy functioning as a moderating variable. The study adopted a quantitative survey research design and collected data from 150 permanent employees working in the creative industry sector in Bandung City using purposive sampling technique. Measurement instruments were validated for reliability and analysed using multiple linear regression and moderated regression analysis with EViews software, while classical assumption tests were conducted to ensure model validity.

The findings indicated that the work environment has a significant positive effect on employee performance, suggesting that supportive physical and non-physical working conditions enhance productivity, task accuracy, and operational efficiency. The study further revealed that digital literacy strengthens the relationship between work environment quality and employee performance. This implies that employees with higher digital competence are better able to utilise workplace technology, translate environmental support into productive behaviour, and achieve improved work outcomes. The moderating effect observed was a strengthening interaction, indicating that digital skill proficiency amplifies the performance benefits derived from a conducive working environment. The study highlights the complementary roles of organisational infrastructure and human digital capability in performance enhancement. The results suggest that investment in workplace facilities and digital skill development programmes should be pursued simultaneously to maximise employee effectiveness in modern work settings. This finding is particularly relevant to service-oriented institutions such as polytechnics where staff productivity depends on both environmental conditions and technology utilisation.

However, the study has several limitations. The sample size was relatively small and limited to a single industry sector, which may restrict the generalisability of the findings to other organisational contexts such as higher education institutions. The purposive sampling approach may also introduce selection bias. Future research could adopt larger multi-sector samples, incorporate additional moderating variables such as organisational culture, technological infrastructure quality, and continuous professional development to provide deeper insight into performance determinants.

The study by Mita Mita, Rahmad Solling Hamid, and Goso Goso (2024) examined the role of transformational leadership and innovative work behaviour in influencing employee performance, with digital literacy functioning as a moderating variable. The study adopted a quantitative research design and collected data from 150 lecturers at Muhammadiyah University of Palopo using purposive sampling technique. Structural Equation Modelling using Partial Least Squares (Smart PLS 4) was applied to test the hypothesised relationships among variables.

The findings revealed that transformational leadership positively and significantly influences innovative work behaviour and employee performance. This suggests that leadership styles that encourage vision sharing, motivation, and intellectual stimulation enhance employee creativity and productivity. In addition, innovative work behaviour was found to have a

positive effect on employee performance, indicating that employees who actively generate and apply new ideas tend to demonstrate higher work effectiveness. The study also demonstrated that digital literacy plays a significant moderating role in strengthening the relationship between innovative work behaviour and employee performance. This implies that employees with strong digital competence are better able to translate innovative ideas into productive organisational outcomes through effective technology utilisation. In relation to technological adoption and staff performance, the findings highlight the importance of combining leadership development, behavioural innovation, and digital skill enhancement in promoting workplace productivity.

However, the study is limited by its focus on lecturers from a single university, which may restrict the generalisability of the results to other institutional settings such as polytechnics or administrative organisations. The use of purposive sampling and self-reported survey data may also introduce bias and affect external validity. Future research should consider multi-institutional samples and additional contextual variables such as organisational culture, technological infrastructure, and professional development programmes to improve understanding of digital literacy and performance relationships.

Theoretical framework

To underpin the moderating effect of digital literacy on the relationship between technological adoption and staff performance, The Diffusion of Innovations (DOI) Theory by Everett Rogers (2003) is highly relevant. According to the DOI theory, the adoption of new technologies follows a process influenced by individual characteristics, such as perceived innovation, communication channels, and the social system. Digital literacy plays a significant role in this process by determining how well individuals can understand, use, and integrate technology into their work routines (Nikou, De Reuver & Mahboob Kanafi, (2022). Employees with higher levels of digital literacy are more likely to successfully adopt technological innovations and leverage them effectively, leading to improved staff performance. Therefore, digital literacy serves as a moderating factor that enhances the relationship between technological adoption and staff performance by enabling a smoother and more effective integration of new technologies into the workforce.

3. Methodology

This study adopted a cross-sectional research design to examine the moderating effect of digital literacy on the relationship between technological adoption and staff performance among academic staff at Kaduna Polytechnic. Data were collected at a single point in time to analyse the interaction among the study variables. The design was considered appropriate because it allows for objective measurement, statistical analysis, and hypothesis testing of relationships among the study variables. The population figure was obtained from the official academic staff records provided by the Office of the Deputy Registrar, Establishment, Kaduna Polytechnic. The list comprised academic staff across six colleges within the institution, namely: College of Science and Technology (482), College of Business and Management Studies (236), College of Administrative Studies and Social Sciences (289), College of Engineering (341), College of Environmental Studies (192), and College of Technical and Vocational Education (236), giving a total population of 1,776 academic staff. This figure was used as the sampling frame for the study. A stratified random sampling technique was employed to ensure proportional

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representation of subgroups such as departments, academic ranks, and years of experience. Stratification guaranteed that every category of staff had an equal opportunity to be included, thereby enhancing the representativeness of the sample. Using the Krejcie and Morgan (1970) sample size determination table, a sample size of 317 respondents was considered adequate for the study population. To account for possible non-response and invalid questionnaires, 349 questionnaires were distributed to ensure sufficient valid responses for analysis (Israel, 2013). This was done to enhance statistical precision and improve the reliability and generalisability of the study findings.

Data were collected through a structured questionnaire designed to measure the three constructs technological adoption, digital literacy, and staff performance. Each construct was measured using items adapted from validated scales in previous related studies and modified to suit the polytechnic context. To ascertain internal consistency, the reliability of the instrument was tested using Cronbach's Alpha, where a coefficient value of 0.70 or above was considered acceptable.

Prior to data collection, permission was obtained from the Kaduna Polytechnic Research and Ethics Committee. The researcher distributed the questionnaires in person and through electronic means (Google Forms) to ensure wider coverage and participation. Respondents were informed of the study's objectives, the voluntary nature of their participation, and the confidentiality of their responses. Data collection was conducted over a four-week period to ensure adequate response rate and data completeness. Ethical considerations were strictly observed throughout the study. Participants voluntarily provided informed consent before taking part in the research, and their responses were kept confidential through data anonymisation. The information obtained was used exclusively for academic purposes, in compliance with institutional and national research ethics requirements for the protection of human participants. Data were analysed using inferential statistical method. Partial Least Squares Structural Equation Modelling (PLS-SEM) was performed using Smart PLS 4 to test the measurement and structural models. The measurement model was assessed for reliability, convergent validity, and discriminant validity, while the structural model was used to test the hypothesised relationships among the study variables.

The significance of the moderating effect was assessed using bootstrapping (5,000 resamples) to determine whether digital literacy significantly strengthens or weakens the effect of technological adoption on staff performance. This methodology ensures transparency, replicability, and analytical rigour, providing robust insights into how technological adoption and digital literacy jointly influence staff performance in higher education institutions.

Measurements and Instruments

The measurement of variables in this study was based on established instruments adapted from previous literature. Technological adoption was measured using a five-point Likert scale adapted from Venkatesh et al. (2003), focusing on perceived ease of use, perceived usefulness, and behavioural intention to use technology within the academic environment. Digital literacy was measured using a Likert scale adapted from Bawden (2008), assessing respondents' ability to use digital tools, navigate software applications, communicate digitally, and access online information effectively. Staff performance was measured using a combination of self-reported and supervisory-based assessments, adapted from Katzell and Thompson (1990), covering

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teaching effectiveness, research productivity, and administrative contribution. The instruments were modified to suit the polytechnic context while ensuring reliability and validity for analysing the moderating effect of digital literacy on the relationship between technological adoption and staff performance.

Results and Discussion

This study employed Structural Equation Modelling (SEM) using Partial Least Squares (PLS) to examine the moderating effect of digital literacy (DL) on the relationship between technological adoption (TA) and staff performance (SP) among academic staff at Kaduna Polytechnic. The approach was chosen for its robustness in handling complex models and small-to-moderate sample sizes (Jöreskog & Wold, 1982; Hair et al., 2021). The analysis followed two main stages: the measurement model and the structural model. The measurement model was assessed for reliability, convergent validity, and discriminant validity to ensure that the indicators adequately measured their intended constructs.

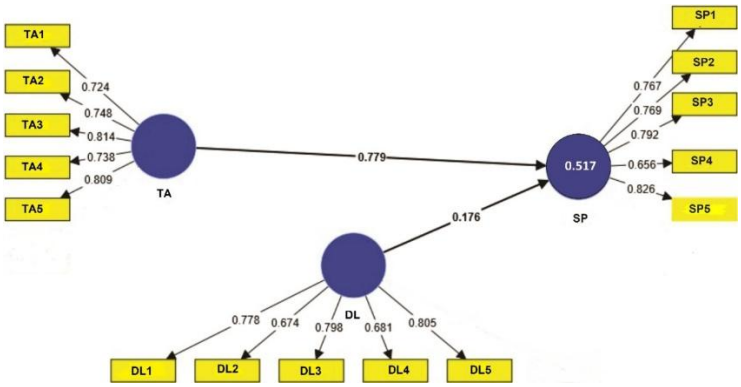

Figure 1: Shows the measurement model
Source: Authors, 2026

Reliability and Convergent Validity

Table 1 presents the reliability and validity statistics for all constructs. The factor loadings for all indicators exceeded the 0.5 threshold, as recommended by Hair et al. (2011), confirming indicator reliability. The Composite Reliability (CR) values were above 0.7, and the Average Variance Extracted (AVE) values were greater than 0.5, indicating satisfactory convergent validity.

Table 1: Construct Reliability and Validity Assessment

Construct	Indicator Loadings	CR	AVE
Technological Adoption (TA)	0.724–0.814	0.873	0.604
Digital Literacy (DL)	0.674–0.805	0.887	0.604
Staff Performance (SP)	0.656–0.826	0.870	0.590

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This format is acceptable for thesis and journal reporting standards. Ensure that indicator loadings are above 0.50, CR is above 0.70, and AVE is above 0.50 to meet recommended threshold values.

Discriminant Validity

Discriminant validity was first assessed using the Fornell–Larcker Criterion, which requires that the square root of AVE for each construct exceeds its correlations with other constructs. Table 2 shows that this condition is satisfied, confirming that the constructs are distinct.

Table 2: Discriminant Validity (Fornell–Larcker Criterion)

Construct	DL	TA	SP
DL	**0.777**	0.652	0.684
TA	0.777	**0.764**	0.768
SP	0.684	0.768	**0.764**

To further confirm discriminant validity, the Heterotrait–Monotrait Ratio (HTMT) was computed, following Henseler et al. (2015). All HTMT values were below the liberal threshold of 0.90, indicating adequate discriminant validity (see Table 3).

Table 3: Heterotrait–Monotrait Ratio (HTMT)

Construct Pair	HTMT Value	Interpretation
DL ↔ TA	0.839	Acceptable (Below 0.85)
DL ↔ SP	0.812	Acceptable (Below 0.85)
TA ↔ SP	0.884	Acceptable (Below 0.90)

These results confirm that the three constructs measure distinct yet related dimensions of staff technological engagement and performance.

Structural Model Evaluation

The structural model (inner model) was assessed to determine the relationships among the latent constructs. The R^2 value indicates the explanatory power of the model.

Table 4: Coefficient of Determination (R^2)

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Construct	R^2	Adjusted R^2	Interpretation
Staff Performance (SP)	0.517	0.516	Moderate explanatory power

The R^2 value of 0.517 shows that technological adoption and digital literacy together explain approximately 51.7% of the variance in staff performance, demonstrating a moderate model fit (Chin, 1998; Hair et al., 2021). The remaining 48.3% of the variation in staff performance is explained by other factors not included in this model. This indicates that additional organisational, behavioural, and environmental variables may also influence staff performance beyond technological adoption and digital literacy. These may include institutional culture, management support, infrastructure quality, motivation, and workload conditions.

Assessment of Structural Model/Inner Loading

This subsection discusses the assessment of the structural model, completing the SEM framework. It describes the correlations among the latent variables that constitute the SEM model (Henseler & Chin, 2010).

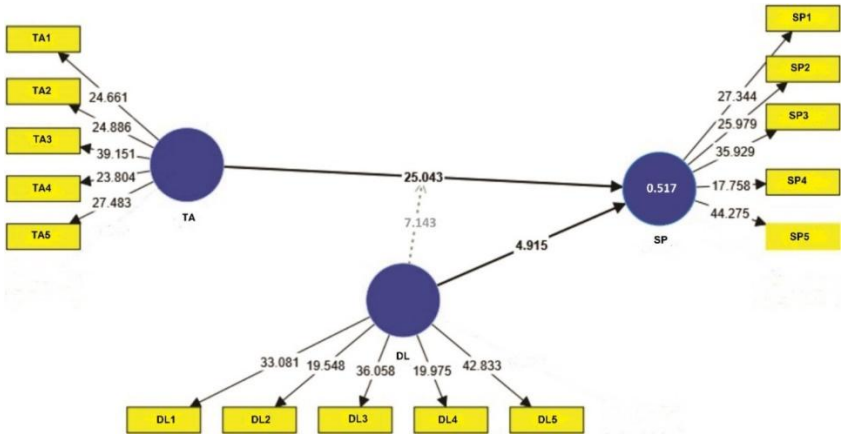

Figure 2 Bootstrapping Result of Direct Relationship

Figure 2 presents the bootstrapping results for the direct relationship between the independent variables and the dependent variable of the study, as well as the hypothesis tests. The results of the hypothesis testing are detailed in Table 4 below.

Hypothesis Testing and Moderation Analysis

Bootstrapping (5,000 resamples) was conducted to test the direct and moderating relationships. Table 5 summarises the path coefficients, t-statistics, and p-values.

Table 5: Path Coefficients and Hypothesis Testing

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Path	β	t-Value	p-Value	Decision
TA → SP	0.770	25.043	0.000	Supported
DL × TA → SP	0.250	7.143	0.000	Supported

Figure 2 illustrates the bootstrapping results for the direct and moderating effects.

The results indicate a strong, positive, and statistically significant relationship between technological adoption and staff performance ($\beta = 0.770$, $p < 0.001$). This means that higher adoption of technology among academic staff leads to better performance outcomes in teaching, research, and administrative tasks. This is in line with the studies of (Jeilani & Hussein 2025; Kallmuenzer et al., 2025; Ainomugisha 2022; Kankia 2025), which reported that technology adoption positively influences performance outcomes. But not in line with the study of Shen, Zhang, and Liu (2022), who reported that technology adoption alone may not significantly enhance performance.

Moreover, digital literacy significantly moderates this relationship ($\beta = 0.250$, $p < 0.001$), implying that the positive effect of technological adoption on performance increases with higher levels of digital literacy. Staff who are digitally proficient are better able to utilise technological tools effectively, translating adoption into tangible productivity gains. This is consistent with the findings of (Zhao et al., 2024; Mahesa et al., 2025; Mita et al., 2024), which reported that digital literacy strengthens the relationship between technology-related factors and performance outcomes by enhancing users' ability to effectively utilise digital tools. The theoretical explanation of the Diffusion of Innovations (DOI) theory supports the finding that digital literacy strengthens the relationship between technological adoption and staff performance by enabling the effective use of digital tools to enhance productivity and work efficiency.

Conclusion and Recommendation

This study investigated the moderating effect of digital literacy on the relationship between technological adoption and staff performance among academic staff at Kaduna Polytechnic. Using a quantitative research design and Partial Least Squares Structural Equation Modelling (PLS-SEM), the study established that technological adoption significantly enhances staff performance. Furthermore, digital literacy was found to strengthen this relationship, suggesting that staff members with higher digital competence are more capable of utilising technological tools effectively to achieve higher performance outcomes. These findings reaffirm the critical role of digital capacity-building in optimising technology-driven academic environments and enhancing institutional efficiency.

Recommendations

Building on the study's findings and the identified limitations, the following recommendations are proposed

1. Implement Continuous Digital Literacy Training: Institutions should design structured and periodic digital literacy programmes tailored to different academic ranks. This directly addresses the limitation of self-reported data bias by ensuring verifiable skill enhancement rather than perceived competence.

2. Adopt a Multi-Institutional Research Design: Future research should examine the relationship across multiple tertiary institutions. This would help overcome the limitation of the cross-sectional approach and enhance generalisability.
3. Integrate Policy Support and Institutional Frameworks: Policymakers and administrators should institutionalise ICT-friendly policies that promote continuous innovation and performance monitoring. This addresses the limitation of uncontrolled external factors by embedding supportive systems.
4. Enhance Technological Infrastructure and Accessibility: Adequate provision of ICT facilities, stable internet connectivity, and technical support should accompany any digital transformation initiative. This ensures that technology adoption efforts are not hindered by infrastructural constraints.
5. Explore Broader Moderating and Mediating Variables: Future studies should investigate the influence of organisational culture, leadership support, and motivation as additional moderating or mediating variables. This will provide a more holistic understanding of performance dynamics in technology-enabled institutions.

Suggestion for Future studies

Future studies may extend this research by adopting multi-institutional research designs to examine the effects of technological adoption and digital literacy on staff performance across different higher education institutions. In addition, future research should consider incorporating other moderating or mediating variables such as organisational culture, leadership support, motivation, digital infrastructure quality, and continuous professional development to provide a more comprehensive understanding of technology-driven performance outcomes in academic environments.

Contribution to Knowledge

This study makes important contributions to knowledge in theoretical, methodological, and practical dimensions. Theoretically, it extends existing technology adoption models by empirically validating digital literacy as a moderating variable, thereby providing deeper insight into how employee capability influences the effectiveness of technological adoption on performance outcomes in higher education. Methodologically, the study demonstrates the suitability of Partial Least Squares Structural Equation Modelling (PLS-SEM) for analysing moderating relationships in institutional performance research, offering a reliable and replicable analytical approach for future studies. Practically, the findings provide useful guidance for institutional administrators by identifying digital literacy as a strategic factor that can strengthen the positive impact of technology adoption on staff performance within academic environments.

Limitations

Despite its significant findings, the study has several limitations that should be considered when interpreting the results. The reliance on self-reported questionnaire data may introduce response bias, as participants may overestimate their levels of digital competence and performance. In addition, the cross-sectional research design limits the ability to establish causal relationships and examine long-term effects of technological adoption and digital

literacy on staff performance. The study was also conducted within a single institution, Kaduna Polytechnic, which may restrict the generalisability of the findings to other higher education institutions with different digital environments. Furthermore, some external factors, such as institutional ICT policies, management support, and infrastructure availability, were not directly measured, although they may influence technology adoption and performance outcomes.

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