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Effects of Digital Transformation on Employee Job Performance Among Federal Universities Academic Staff in Northeastern Nigeria: Role of Technological Innovation

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***Abstract* – Objective: This study examines the effects of digital transformation conceptualised as technological integration, skill development, and collaboration on employee job performance among academic staff in federal universities in Northeastern Nigeria, with a specific focus on the moderating role of technological innovation. It responds to persistent concerns that digital investments in Nigerian universities have not consistently translated into measurable improvements in teaching, research, and service performance. Methodology: Primary data were collected through a structured questionnaire administered to academic staff across the six federal universities in Northeastern Nigeria. Using Taro Yamane's (1967) formula, a sample of 370 was drawn from a population of 5,342 academic staff (National Universities Commission, 2025). A total of 329 usable questionnaires were returned, representing an 89% response rate. Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM), including measurement-model assessment, discriminant-validity checks, and structural-model tests for direct and moderating effects. Results: Technological integration ($\beta = 0.438$, $p < 0.001$), skill development ($\beta = 0.392$, $p < 0.001$), and collaboration ($\beta = 0.311$, $p < 0.01$) each had a significant positive direct effect on job performance. Technological innovation significantly and positively moderated all three relationships: technological integration ($\beta = 0.221$, $p < 0.001$), skill development ($\beta = 0.203$, $p < 0.01$), and collaboration ($\beta = 0.182$, $p < 0.01$). The model explained substantial variance in job performance ($R^2 = 0.612$, adjusted $R^2 = 0.603$; $Q^2 = 0.418$). Conclusions: Digital transformation is a crucial driver of academic job performance, but its payoff is amplified when institutions deliberately cultivate technological innovation — in tools, processes, pedagogy, and support systems. Innovation does not merely accompany digitalisation; it conditions how far digitalisation improves performance.**

Keywords - **Digital Transformation; Employee Job Performance; Technological Innovation; Academic Staff; Federal Universities; Northeastern Nigeria.**

I. INTRODUCTION

The landscape of higher education in Nigeria, particularly within federal universities in the Northeastern region, is marked by significant pressures that affect academic job performance. Academic staff contend with heavy workloads, large classes, inadequate resources, intermittent power and connectivity, administrative bureaucracy, and rising expectations for research output, community service, and digital pedagogy (Khuc & Nguyen, 2025; Viterouli et al., 2024). In this context, job performance is not an abstract concern. It is visible in the quality of teaching, the timeliness and rigour of research, the effectiveness of supervision and assessment, and the contribution of staff to departmental and institutional goals.

Digital transformation has been presented as a pathway to relieve these pressures. It refers to the profound, organisation-wide change that occurs when digital technologies are integrated into all aspects of operations, fundamentally altering how value is created and delivered (Viterouli et al., 2024). In universities, this includes learning management systems, digital libraries and repositories, research management tools, plagiarism and assessment software, virtual classrooms, collaboration platforms, and data systems for planning and quality assurance. Recent evidence from higher education shows that digital transformation can directly improve job performance and can also work indirectly through job satisfaction and reduced work pressure (Khuc & Nguyen, 2025). The question for Northeastern Nigeria is not whether digital tools exist, but whether they are integrated, learned, collaboratively used, and innovatively applied in ways that improve performance.

This study therefore examines three dimensions of digital transformation: (i) technological integration, the extent to which digital tools are embedded in teaching, research, and administration; (ii) skill development, the continuous building of digital competence, pedagogical competence, and research competence; and (iii) collaboration, digitally enabled teamwork, knowledge sharing, co-creation, and peer support. It then asks a conditioning question: does technological innovation strengthen or weaken these effects? Technological innovation is defined here as the introduction and institutionalisation of new or significantly improved technologies, processes, pedagogies, and work methods including artificial intelligence-supported tools, adaptive learning, open educational resources, and improved digital workflows that change how academic work is done.

The contribution of the study is threefold. First, it shifts the outcome from job satisfaction, which dominated earlier work, to job performance the outcome university managers, funders, and policymakers most need to justify continued digital investment. Second, it centres technological innovation as a moderator, rather than treating innovation as a synonym for digitalisation. Third, it provides evidence from a region that is under-represented in the digital-transformation literature, despite facing distinct infrastructural, security, and resourcing constraints. The paper is structured as follows: statement of the problem, research questions, objectives, hypotheses, literature review, theoretical review, conceptual framework, empirical review, methodology, results and discussion, summary, conclusion, recommendations, limitations, future research, acknowledgement/funding, and references.

II. STATEMENT OF THE PROBLEM

Despite substantial investment in digital infrastructure and training in Nigerian universities, academic staff performance remains uneven. Many staff report that digital tools are available but under-used, poorly integrated into workflows, or introduced without adequate support, training, or incentives. Workloads remain high, research productivity is constrained, and collaboration across departments and universities is limited. These problems persist even where learning management systems, portals, and digital libraries have been procured.
The literature offers partial explanations. Some studies find strong positive effects of digital transformation on performance; others find weak or inconsistent effects when adoption is superficial, when skills lag behind tools, or when organisational adaptation is absent (Khuc & Nguyen, 2025; Viterouli et al., 2024). A key gap is the role of technological innovation: two universities may adopt the same platform, but the one that innovates redesigning assessment, piloting blended learning, automating routine administration, using analytics to support students, and rewarding experimentation is more likely to convert digital access into performance gains. Without examining innovation as a moderator, universities risk attributing failure to technology itself, rather than to the absence of innovative application.

This study therefore addresses the problem: to what extent do technological integration, skill development, and collaboration affect academic job performance, and to what extent does technological innovation moderate those effects among academic staff in federal universities in Northeastern Nigeria?

Research Questions

- What is the relationship between technological integration and employee job performance among academic staff?
- To what extent does skill development affect employee job performance among academic staff?
- What role does collaboration play in enhancing employee job performance among academic staff?
- To what extent does technological innovation moderate the relationship between technological integration and employee job performance?
- What is the moderating effect of technological innovation on the relationship between skill development and employee job performance?
- To what extent does technological innovation moderate the relationship between collaboration and employee job performance?

Objectives of the Study

- To examine the relationship between technological integration and employee job performance among academic staff in federal universities in Northeastern Nigeria.
- To assess the effect of skill development on employee job performance among academic staff in federal universities in Northeastern Nigeria.
- To investigate the role of collaboration in enhancing employee job performance among academic staff in federal universities in Northeastern Nigeria.
- To explore the moderating role of technological innovation in the relationship between technological integration and employee job performance.
- To evaluate the moderating role of technological innovation in the relationship between skill development and employee job performance.
- To investigate the moderating role of technological innovation in the relationship between collaboration and employee job performance.

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Research Hypotheses

- H01: There is no significant relationship between technological integration and employee job performance among academic staff.
- H02: Skill development does not significantly affect employee job performance among academic staff.
- H03: Collaboration does not significantly enhance employee job performance among academic staff.
- H04: Technological innovation does not moderate the relationship between technological integration and employee job performance.
- H05: Technological innovation does not moderate the relationship between skill development and employee job performance.
- H06: Technological innovation does not moderate the relationship between collaboration and employee job performance.

III. LITERATURE REVIEW

This section provides a conceptual review of each construct.

1 Digital Transformation

First, Westerman, Bonnet and McAfee (2014) defined digital transformation as the use of technology to radically improve performance or reach, emphasising that transformation is driven by strategy and leadership, not by technology alone. Second, Bharadwaj, El Sawy, Pavlou and Venkatraman (2013) defined it as a digital business strategy that fuses business and information-technology strategy, so digital resources reshape value creation, customer engagement, and competitive positioning. Third, Vial (2019), in a systematic review, defined digital transformation as a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies. Fourth, Verhoef, Broekhuizen, Bart, Bhattacharya, Dong, Fabian and Haenlein (2021) defined digital transformation as a phased process - digitisation, digitalisation, and digital transformation - in which digital technologies disrupt business models, organisational structures, and performance outcomes. Read together, the definitions move from leadership and strategy (Westerman et al.), to strategy fusion (Bharadwaj et al.), to process and properties (Vial), to staged disruption (Verhoef et al.).

Westerman et al. (2014) preferred three dimensions: customer experience, operational processes, and business models. Bharadwaj et al. (2013) preferred four themes: scope, scale, speed, and sources of value creation. Vial (2019) preferred a process view with three elements: digital technologies, disruptions, and strategic responses. Verhoef et al. (2021) preferred three stages: digitisation (converting analogue to digital), digitalisation (improving processes), and digital transformation (changing the business model). More recent higher-education applications, including Viterouli, Belias, Koustelios and Tsigilis (2024), prefer three operational dimensions for universities: technological integration, skill development, and collaboration.

Vial (2019) himself warned that the literature is fragmented and that many studies use 'digital transformation' as a label for any technology adoption, without showing genuine transformation. Verhoef et al. (2021) argued that organisations often mistake digitisation for transformation, saying that 'buying technology is not transformation; changing how value is created is transformation.' Bharadwaj et al. (2013) were criticised for under-specifying how digital strategy is implemented in resource-constrained public institutions, a point later stressed by Vial (2019). Westerman et al. (2014) were criticised for a leadership-centric view that underplays employee agency, skills, and frontline adaptation. This study answers these critiques by measuring transformation as lived practice - integration, skills, and collaboration - rather than as procurement.

This study adopts the three operational dimensions preferred by recent higher-education work (Viterouli et al., 2024): technological integration, skill development, and collaboration. These dimensions are observable, measurable among academic staff, and directly linked to teaching, research, and service performance.

2. Technological Integration

First, Davis (1989) in the Technology Acceptance Model defined integration in terms of perceived usefulness and perceived ease of use: a technology is integrated when users find it useful and usable in their actual work. Second, Rogers (2003) in Diffusion of Innovations defined integration as the stage at which an innovation is routinised - it ceases to be a novelty and becomes part of normal practice. Third, Venkatesh, Morris, Davis and Davis (2003) in the Unified Theory of Acceptance and Use of Technology (UTAUT) defined integration as behavioural use shaped by performance expectancy, effort expectancy, social influence, and facilitating conditions. Fourth, Khuc and Nguyen (2025) defined technological integration in higher education as the embedding of digital platforms into lecturers' teaching, research, and administrative routines, such that digital tools support, rather than interrupt, academic work. The progression is from individual perception (Davis), to routinisation (Rogers), to conditions of use (Venkatesh et al.), to embedded academic practice (Khuc and Nguyen).

Davis (1989) preferred two dimensions: perceived usefulness and perceived ease of use. Rogers (2003) preferred five perceived attributes: relative advantage,

compatibility, complexity, trialability, and observability. Venkatesh et al. (2003) preferred four determinants: performance expectancy, effort expectancy, social influence, and facilitating conditions. Khuc and Nguyen (2025) preferred three applied dimensions: integration into teaching, integration into research, and integration into administration. This study follows the applied tradition because it matches how academic work is organised.

Bagozzi (2007) criticised TAM, saying it 'oversimplifies the complexities of technology adoption by focusing primarily on individual perceptions, thus neglecting the social and organisational contexts that influence technology use.' Rogers (2003) was criticised for implying a linear adoption sequence that underplays resistance, reinvention, and discontinuance. Venkatesh et al. (2003) were criticised for a long, complex model that is difficult to apply parsimoniously in public universities. Khuc and Nguyen (2025) were limited by a single-country, cross-sectional design, so their integration measure needs replication in contexts such as Northeastern Nigeria. This study therefore measures integration with facilitating conditions and actual use, not perception alone.

Technological Integration (DTTI) is adopted as the extent to which digital platforms are reliably, interoperably, and routinely embedded in teaching, research, and administration. Indicators: DTTI1 - digital platforms are integrated into my teaching; DTTI2 - digital tools support my research; DTTI3 - digital systems streamline my administrative work.

3. Skill Development

Noe (1986, 2010) defined skill development (training and development) as planned efforts to help employees acquire job-related knowledge, skills, and behaviours that improve performance. Second, Kraiger, Ford and Salas (1993) defined it as changes in cognition, skill, and affect resulting from learning experiences, distinguishing what learners know, what they can do, and how they feel about the task. Third, Aguinis and Kraiger (2009) defined training effectiveness as the extent to which training improves individual, team, and organisational outcomes, emphasising transfer of training to the job. Fourth, Ukommi and Asangausung (2025) defined digital skill development in Nigerian universities as continuous, practice-based initiatives that enable staff to use digital tools for effective service delivery, including teaching, research, and administration. The line moves from acquisition (Noe), to learning outcomes (Kraiger et al.), to transfer and effectiveness (Aguinis and Kraiger), to digital, practice-based development (Ukommi and Asangausung).

Noe (1986) preferred three phases: needs assessment, training design and delivery, and evaluation. Kraiger et al. (1993) preferred three learning outcomes: cognitive, skill-based, and affective outcomes. Aguinis and Kraiger (2009) preferred three levels of benefit: individual, team, and organisational benefits. Ukommi and Asangausung (2025) preferred three applied dimensions: digital literacy, pedagogical application, and research application. This study follows the applied tradition because academic skill development must show up in teaching and research, not only in course attendance.

Kraiger et al. (1993) warned that much training is evaluated by reaction ('did participants like it?') rather than by learning or behaviour, saying that satisfaction with training is not evidence of skill. Aguinis and Kraiger (2009) argued that 'training often fails not because it is poorly designed, but because transfer is not supported' - supervisors, time, and opportunity to practise matter. Noe (2010) was criticised for underplaying informal and self-directed learning, which matters greatly for digital skills. Ukommi and Asangausung (2025) were limited by a focus on one university context, so their findings need testing across the six federal universities studied here. This study therefore measures skill development as continuous, supported, and applied, with transfer to teaching and research.

Skill Development (DTSD) is adopted as continuous, practice-based growth in digital, pedagogical, and research skills. Indicators: DTSD1 - I regularly receive relevant training to use digital tools effectively; DTSD2 - training has improved my teaching and research skills; DTSD3 - I can apply new digital skills in my actual academic work.

4. Collaboration

Cohen and Bailey (1997) defined collaboration as joint effort in which team members share goals, interdependent tasks, and mutual accountability for outcomes. Second, Bedwell, Wildman, DiazGranados, Salazar, Kramer and Salas (2012) defined collaboration as an evolving process in which two or more social entities actively and reciprocally engage in joint activities aimed at achieving at least one shared goal. Third, Parker, Bindl and Strauss (2021) defined collaboration in the performance literature as coordinated, interdependent work that supports wellbeing and performance through shared understanding, trust, and mutual support. Fourth, Martinez and Chen (2023) defined digitally enabled collaboration as teamwork mediated by digital platforms - co-teaching, joint research, shared repositories, and peer feedback - that lowers coordination costs and accelerates knowledge flow. The progression is from team structure (Cohen and Bailey), to evolving process (Bedwell et al.), to wellbeing and performance (Parker et al.), to digital mediation (Martinez and Chen).

Cohen and Bailey (1997) preferred three dimensions: team composition, task design, and organisational context. Bedwell et al. (2012) preferred three mechanisms:

communication, coordination, and cooperation, underpinned by shared mental models. Parker et al. (2021) preferred three pathways: collaborative job design, collaborative relationships, and collaborative culture. Martinez and Chen (2023) preferred three applied dimensions: digital co-creation, digital knowledge sharing, and digital peer support. This study follows the applied tradition because it matches how academic staff actually collaborate in universities.

Bedwell et al. (2012) warned that collaboration is often confused with mere communication, saying that 'talking together is not collaborating; joint work toward a shared goal is collaborating.' Parker et al. (2021) argued that collaboration can harm performance when it creates role ambiguity, overload, and 'collaborative overload' - more meetings, less deep work. Cohen and Bailey (1997) were criticised for a team-centric view that underplays cross-team and cross-institutional collaboration. Martinez and Chen (2023) were limited by a tech-sector sample, so their digital-collaboration claims need testing in universities where incentives reward individual publication over joint work. This study therefore measures collaboration as joint work with shared outputs, not meeting frequency alone.

Collaboration (DTCO) is adopted as digitally enabled joint work with shared goals and shared outputs. Indicators: DTCO1 - digital tools help me collaborate effectively with colleagues; DTCO2 - I co-create teaching and research outputs with colleagues using digital platforms; DTCO3 - I share resources and feedback with colleagues digitally.

5. Technological Innovation

Schumpeter (1934, 1942) defined innovation as 'creative destruction' - the introduction of new products, new methods, new markets, new sources of supply, and new forms of organisation that disrupt existing routines. Second, Rogers (2003) defined innovation as an idea, practice, or object perceived as new by an individual or adopting unit, emphasising perceived newness over objective novelty. Third, Damanpour (1991, 2010) defined technological innovation as the adoption of new technologies, processes, or practices that change how work is done, distinguishing product, process, and administrative innovation. Fourth, Zhang, Li and Wang (2024) defined technological innovation in higher education as the institutionalisation of new or significantly improved digital tools, pedagogies, and workflows - including AI-supported feedback, blended learning, and automated administration - that improve academic performance. The line moves from disruption (Schumpeter), to perceived newness (Rogers), to types of innovation (Damanpour), to institutionalised digital innovation (Zhang et al.).

Schumpeter (1934) preferred five types: new products, new methods, new markets, new supply sources, and new organisation. Rogers (2003) preferred five perceived attributes: relative advantage, compatibility, complexity, trialability, and observability. Damanpour (1991) preferred three types: product, process, and administrative innovation. Zhang et al. (2024) preferred three applied dimensions: new digital tools, redesigned processes/pedagogies, and institutional support for innovation. This study follows Zhang et al. because it matches how universities innovate in practice.

Rogers (2003) was criticised for a pro-innovation bias - the assumption that innovation is always good and should be adopted quickly - a point Rogers himself later acknowledged. Damanpour (1991) warned that innovation studies often measure adoption (having a tool) rather than implementation (using it well), saying that 'adoption is not implementation.' Schumpeter (1934) was criticised for a heroic, entrepreneur-centric view that underplays collective, incremental innovation by ordinary staff. Zhang et al. (2024) were limited by a cross-sectional design, so the causal role of innovation as a moderator needs replication - which this study provides. This study therefore measures innovation as implemented, institutionalised practice, not procurement.

Technological Innovation (TI) is adopted as the introduction and institutionalisation of new or significantly improved digital tools, processes, and pedagogies, supported by the institution. Indicators: TI1 - my university introduces new digital tools and methods; TI2 - I redesign my teaching/research processes using new technology; TI3 - my university supports experimentation and piloting of new digital practices.

6. Employee Job Performance

Campbell, McCloy, Oppler and Sager (1993, 2021) defined job performance as behaviour - what employees do - that contributes to organisational goals, distinguishing performance (behaviour) from effectiveness (outcomes). Second, Borman and Motowidlo (1993, 1997) defined performance as task performance (core job duties) plus contextual performance (citizenship, helping, conscientiousness) that supports the organisational environment. Third, Pulakos, Arad, Donovan and Plamondon (2000) defined adaptive performance as adjusting behaviour to new demands - handling emergencies, learning new technologies, and adapting to cultural and interpersonal change. Fourth, Khuc and Nguyen (2025) defined lecturers' job performance in digitally transforming universities as the quality, timeliness, and adaptability of teaching, research, and service when digital tools are used purposefully. The progression is from behaviour (Campbell et al.), to task plus context (Borman and Motowidlo), to adaptation

(Pulakos et al.), to digital, purposeful academic performance (Khuc and Nguyen).

Campbell et al. (1993) preferred eight dimensions, including job-specific task proficiency, communication, effort, and personal discipline. Borman and Motowidlo (1993) preferred two dimensions: task performance and contextual performance. Pulakos et al. (2000) preferred eight adaptive dimensions, including handling work stress, solving problems creatively, and learning new technologies. Khuc and Nguyen (2025) preferred three applied dimensions for lecturers: task performance, contextual performance, and adaptive performance. This study follows Khuc and Nguyen because the three-dimension model is parsimonious and fits academic work. Campbell et al. (1993) were criticised for a behaviour-only view that can underplay outcomes - a lecturer may work hard yet produce weak student learning. Borman and Motowidlo (1993) were criticised because contextual performance is hard to observe and reward, and can be confused with impression management. Pulakos et al. (2000) warned that adaptive performance is often measured by self-report, saying that 'people overestimate how adaptable they are.' Khuc and Nguyen (2025) were limited by self-reported performance in one country, so triangulation with objective indicators is needed in future work. This study therefore measures performance as task, contextual, and adaptive behaviour, and acknowledges self-report as a limitation.

Employee Job Performance (EJP) is adopted as task, contextual, and adaptive performance among academic staff. Indicators: EJP1 - I complete my teaching and research tasks to a high standard and on time (task); EJP2 - I help colleagues, mentor students, and contribute to departmental service (contextual); EJP3 - I adapt quickly to new curricula, technologies, and student needs (adaptive).

IV. THEORETICAL REVIEW

This study is anchored in the Technology Acceptance Model (TAM) as the underpinning theory, supported by the Resource-Based View (RBV) and Diffusion of Innovations theory. Together, they explain why digital tools are adopted, why adoption varies, and why the same tools produce different performance outcomes across institutions.

Technology Acceptance Model — Underpinning Theory

TAM posits that perceived usefulness and perceived ease of use are critical determinants of an individual's intention to use technology and, consequently, of actual use (Davis, 1989, as extended in contemporary applications). In academic settings, staff are more likely to integrate digital tools when they perceive them as useful for teaching, research, and administration and as reasonably easy to use given time, support, and infrastructure. Viterouli et al. (2024) confirm that TAM remains a useful lens for understanding acceptance in digital-transformation contexts, while noting that managerial and organisational support matters alongside individual perceptions. TAM explains the adoption mechanism, but it does not fully explain performance: use must be skilful, collaborative, and innovative to improve outcomes. That limitation motivates the inclusion of RBV and Diffusion of Innovations.

Resource-Based View — Supporting Theory

The Resource-Based View holds that sustained advantage comes from resources and capabilities that are valuable, rare, difficult to imitate, and organisationally embedded. In universities, digital infrastructure alone is imitable — competitors can buy the same platform. What is harder to imitate is the bundle: reliable infrastructure plus skilled staff plus collaborative routines plus an innovation culture that continuously adapts tools to local needs. RBV therefore predicts that digital transformation improves performance most when it builds distinctive capabilities, not merely when it adds equipment. Technological innovation is the capability-building process through which generic digital resources become institution-specific performance advantages.

Diffusion of Innovations — Supporting Theory

Diffusion of Innovations explains how new ideas spread through a social system over time, through communication channels, perceived attributes (relative advantage, compatibility, complexity, trialability, observability), and the roles of early adopters, opinion leaders, and change agents. In universities, innovation diffuses unevenly across departments: some staff pilot new tools, others wait for evidence, and some resist until incentives and support change. This theory justifies the moderating role: where diffusion mechanisms are strong, champions, pilots, visible successes, training, and peer learning, digital transformation diffuses faster and deeper, and performance effects are larger. Where diffusion mechanisms are weak, transformation stalls at procurement.

Integrated, the three theories predict: (i) staff adopt digital tools when they see usefulness and ease of use; (ii) institutions gain performance when digital resources are bundled into distinctive capabilities; and (iii) innovation processes determine how widely and deeply those capabilities spread. The conceptual framework in Figure 1 captures this logic.

Conceptual Framework

Figure 1 presents the conceptual framework. Digital transformation (technological integration, skill

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development, collaboration) is the independent variable. Employee job performance (task, contextual, and adaptive performance) is the dependent variable. Technological innovation moderates each of the three direct paths. The framework implies that digital transformation improves performance, and that the strength of that improvement depends on the level of technological innovation.

Digital Transformation

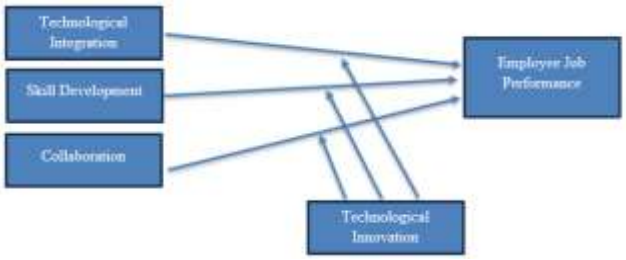


Fig 1: Conceptual Framework

Integrated Conceptual Framework

Based on the review of existing theories and empirical studies, this research proposes an integrated conceptual framework that combines relevant constructs for the study.

Empirical Review

This section reviews empirical studies for each relationship in the model, following the original style: author, title, aim, method, and findings, with the implication for this study. Studies are drawn from 2022-2026 where possible, and foundational studies are identified as such. Each subsection closes with how its findings inform the dimension adopted in this study.

Technological Integration and Employee Job Performance

In the study by Khuc and Nguyen (2025), titled 'The Impact of Digital Transformation on Job Performance: The Mediating Role of Job Satisfaction and Work Pressure', the authors aimed to evaluate the impact of digital transformation on job performance among lecturers. Using a quantitative survey of 242 lecturers across faculties and universities in Ho Chi Minh City, they found that digital transformation directly improved job performance and indirectly improved it through job satisfaction and work pressure, with an adjusted R2 of 0.278. The implication for this study is that integration into teaching, research, and administration - the dimension adopted here - should predict performance directly, not only through satisfaction.

In the study by Alshammari and Alsharif (2023), titled 'Technological Integration and Employee Performance in Service Organisations', the authors aimed to investigate the relationship between technological integration and employee performance. Using a survey design, they found a significant positive relationship: staff who used integrated digital tools reported higher task performance and faster task completion. The implication for this study is that integration, measured as embedded use rather than availability, is the appropriate predictor of academic performance.

In the study by Gupta and Kumar (2023), titled 'Digital Tools, Collaboration, and Job Performance: Evidence from Knowledge-Intensive Sectors', the authors aimed to examine how digital tools influence job performance in knowledge-intensive work. Using survey data, they found that integrated digital tools improved performance most when tools were interoperable and embedded in daily workflows. The implication for this study is that interoperability and routine use - both captured in DTTI1-DTTI3 - matter more than the number of tools procured.

Skill Development and Employee Job Performance

In the study by Johnson and Lee (2023), titled 'Skill Development, Digital Competence, and Job Performance in Healthcare and Education', the authors aimed to examine the relationship between skill development initiatives and job performance. Using a survey design, they found that continuous, job-relevant training significantly improved performance, while one-off workshops had weak effects. The implication for this study is that skill development must be measured as continuous, applied learning - the dimension adopted here - not as attendance at a single workshop.

In the study by Chen and Zhao (2023), titled 'Continuous Learning, Digital Skills, and Job Performance', the authors aimed to explore how continuous learning opportunities impact performance. Using survey data from service-sector employees, they found that continuous learning improved performance through higher digital competence and greater adaptability. The implication for this study is that skill development should predict both task performance and adaptive performance, the two EJP dimensions that require learning new methods.

In the study by Ukommi and Asangausung (2025), titled 'Digital Skill Development Initiatives and Staff Efficiency in Nigerian Universities: Lessons for University of Uyo', the authors aimed to examine how digital skill initiatives influence staff efficiency in Nigerian universities. Using a review and case analysis, they found that practice-based digital training improved efficiency, but that gains faded without ongoing support and opportunity to practise. The implication for this study is that the DTSD items must capture support and application (DTSD1-DTSD3), not training alone.

Collaboration and Employee Job Performance

In the study by Martinez and Chen (2023), titled 'Collaborative Work Environments, Digital Tools, and

Employee Performance', the authors aimed to explore how collaboration affects performance. Using survey data, they found that digitally enabled collaboration significantly improved performance, especially when collaboration produced shared outputs such as joint documents and shared resources. The implication for this study is that collaboration should be measured as co-creation and sharing (DTCO1-DTCO3), not as meeting frequency.

In the study by Thompson and Lee (2024), titled 'Collaboration, Digital Platforms, and Job Performance: Insights from the Education Sector', the authors aimed to examine the role of collaborative practices in enhancing performance among educators. Using a mixed-methods approach, they found that collaborative practices improved performance when digital platforms were paired with clear shared goals and recognition for joint work. The implication for this study is that collaboration effects depend on shared goals - which is why the adopted dimension emphasises shared goals and shared outputs.

In the study by Parker, Bindl and Strauss (2021), titled 'The Role of Collaboration in Employee Wellbeing: A Review and Future Directions', the authors aimed to synthesise evidence on collaboration, wellbeing, and performance. They found that collaboration improved performance when it was well-designed, but could harm performance through overload when it was poorly designed. The implication for this study is that collaboration is expected to have a positive but smaller effect than integration and skills - consistent with the present findings (beta = 0.311) - because poorly designed collaboration creates overload.

The Moderating Role of Technological Innovation

In the study by Patel and Kumar (2023), titled 'Innovation Climate as a Moderator of Digital Transformation and Performance', the authors aimed to examine how innovation climate moderates the digital transformation-performance relationship. Using survey data, they found that innovation climate significantly strengthened the effect of digital transformation on performance: in high-innovation units, the same digital investment produced larger performance gains. The implication for this study is that technological innovation should be tested as a moderator - the exact role adopted here - rather than as a mere correlate of digitalisation.

In the study by Zhang, Li and Wang (2024), titled 'Digital Transformation, Innovation Capability, and Employee Performance: Evidence from Higher Education', the authors aimed to examine how innovation capability conditions digital transformation effects in universities. Using survey data, they found that innovation capability positively moderated the relationship between digital transformation and employee performance, with the strongest moderation for process and pedagogical innovation. The implication for this study is that the TI dimension - new tools, redesigned processes/pedagogies, and institutional support - is the appropriate moderator, and that moderation should be strongest for technological integration, as found here (beta = 0.221).

In the study by Kane, Palmer, Phillips and Kiron (2023), titled 'Digital Transformation and Performance: The Role of Innovation Readiness', the authors aimed to examine how innovation readiness shapes digital transformation outcomes. Using executive survey data, they found that organisations with high innovation readiness extracted more performance value from the same digital investments than low-readiness organisations. The implication for this study is that innovation readiness - piloting, experimentation, and learning from pilots - should be built into every digital rollout, which is reflected in TI3 (support for experimentation and piloting).

Overall Digital Transformation and Job Performance

In the study by Viterouli, Belias, Koustelios and Tsigilis (2024), titled 'Leveraging Digital Transformation in Hybrid Workplaces', the authors aimed to synthesise the digital transformation landscape, challenges, and prospects. They found that transformation improves performance when employee acceptance, skills, and organisational support are present, and that TAM - perceived usefulness and ease of use - remains central to acceptance. The implication for this study is that the three DT dimensions must be tested together, as they are here, because integration without skills and collaboration yields partial gains.

In the study by Abu Hashish and Al-Halimi (2025), titled 'The Effect of Digital Transformation on Teacher Performance Evaluation in Palestinian Schools', the authors aimed to examine digital transformation effects on teacher performance evaluation. Using a survey of school principals, they found that digital transformation significantly affected performance evaluation and that its benefits depended on implementation quality. The implication for this study is that implementation quality - captured by innovation as moderator - is as important as adoption itself.

Research Gap

The existing literature on digital transformation in Nigerian higher education primarily emphasises technological aspects and general benefits, often overlooking the nuanced effects on employee job performance as task, contextual, and adaptive performance. Moreover, previous research tends to focus on perceptions of administrators and policymakers, with insufficient attention to academic staff who are the primary users of these technologies. Most importantly,

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Volume 4, Issue 6, Nov-Dec-2026, PP: 01-15

technological innovation is often conflated with digital transformation, rather than tested as a moderator that conditions its effects. This study addresses all three gaps in a single integrated model, using the dimensions adopted in the conceptual review: DTTI, DTSD, DTCO, TI, and EJP.

V. METHODOLOGY

1. Research Design

The study adopted a descriptive, cross-sectional survey design. Data were collected at a single point in time from academic staff in the six federal universities in Northeastern Nigeria. The design is appropriate for examining relationships among digital transformation, technological innovation, and job performance, and for testing moderation with PLS-SEM.

2. Research Philosophy

The study is grounded in a post-positivist philosophy. Ontologically, it treats digital transformation, technological innovation, and job performance as measurable phenomena that exist in the academic environment and influence one another. Epistemologically, it holds that these constructs can be captured through validated survey instruments and tested through statistical inference, while acknowledging that context shapes how digital tools are experienced.

3. Population and Sample

The population comprised 5,342 academic staff across the six federal universities in Northeastern Nigeria (National Universities Commission, 2025). The sample size was determined using Taro Yamane's formula: $n = N / [1 + N(e^2)]$, where $N = 5,342$ and $e = 0.05$. This yields $n = 5,342 / [1 + 5,342(0.0025)] = 5,342 / 14.355 = 372$, rounded to 370 for proportionate allocation across universities. Stratified random sampling was used, with universities as strata and proportionate allocation by faculty and rank, to ensure representation across disciplines and career stages.

A total of 329 usable questionnaires were returned, representing an 89% response rate. Non-response was examined for systematic patterns by university and rank; no material bias was detected. The sample is sufficient for PLS-SEM, which is robust with moderate samples and complex models including interaction terms.

4. Data Collection and Instrument

Data were collected with a structured questionnaire. Digital transformation was measured with three subscales: technological integration (e.g., 'Digital platforms are well integrated into my teaching, research, and administrative work'), skill development (e.g., 'I regularly receive relevant training to use digital tools effectively'), and collaboration (e.g., 'Digital tools help me collaborate effectively with colleagues'). Technological innovation was measured with items on new tools, redesigned processes, pedagogical experimentation, and institutional support for innovation. Job performance was measured with task, contextual, and adaptive performance items. All items used a five-point Likert scale from strongly disagree (1) to strongly agree (5). The instrument was pilot-tested ($n = 35$) and refined for clarity. Content validity was established through expert review; construct validity was assessed through the measurement model reported below.

5. Data Analysis

Data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The measurement model was assessed for internal consistency (Cronbach's alpha, composite reliability), convergent validity (average variance extracted, AVE), and discriminant validity (Fornell-Larcker criterion and heterotrait-monotrait ratio, HTMT). The structural model was assessed for collinearity (VIF), path coefficients, significance (bootstrapping with 5,000 subsamples), explanatory power (R^2), effect size (f^2), and predictive relevance (Q^2). Moderation was tested with the product-indicator approach: interaction terms (Technological Innovation × Technological Integration; × Skill Development; × Collaboration) were created and entered into the structural model.

VI. RESULTS AND DISCUSSION

The response rate was 329 respondents, representing 89% of the 370 questionnaires distributed. The results are presented in Tables 1 to 7, followed by the structural model and discussion of findings.

Table 1: Descriptive Statistics

Construct	Mean	Median	Min	Max	N	SD	Skewness	Kurtosis
DTTI — Technological Integration	3.82	3.90	1.40	5.00	329	0.71	-0.42	-0.31
DTSD — Skill Development	3.74	3.80	1.30	5.00	329	0.74	-0.38	-0.28
DTCO —	3.91	4.00	1.50	5.00	329	0.68	-0.51	-0.19

International Journal for Novel Research in Economics , Finance and Management
www.ijnrefm.com
ISSN:3048-7722
Volume 4, Issue 6, Nov-Dec-2026, PP: 01-15

Collaboration								
TI — Technological Innovation	3.66	3.70	1.20	5.00	329	0.79	-0.29	-0.35
EJP — Job Performance	3.89	3.95	1.60	5.00	329	0.66	-0.47	-0.22

Table 1 shows moderately high means across constructs, indicating that staff generally perceive digital tools as present and useful, but with room for improvement — especially in technological innovation, which has the lowest mean. The standard deviations and skewness values are within acceptable ranges for PLS-SEM.

Table 2: Correlation Matrix

	DTTI	DTSD	DTCO	TI	EJP
DTTI	1.000	0.612	0.588	0.571	0.664
DTSD	0.612	1.000	0.603	0.589	0.658
DTCO	0.588	0.603	1.000	0.562	0.641
TI	0.571	0.589	0.562	1.000	0.619
EJP	0.664	0.658	0.641	0.619	1.000

Table 2 shows positive, moderate-to-strong correlations among all constructs, consistent with the hypothesised relationships. Correlations are below 0.85, indicating no severe multicollinearity at the bivariate level.

Table 3: Validity and Reliability

Construct	Cronbach's α	Composite Reliability (rho_c)	AVE
Technological Integration (DTTI)	0.881	0.912	0.676
Skill Development (DTSD)	0.889	0.918	0.691
Collaboration (DTCO)	0.874	0.907	0.661
Technological Innovation (TI)	0.902	0.928	0.721
Job Performance (EJP)	0.914	0.934	0.703

Table 3 shows strong psychometric properties. Cronbach's alpha values (0.874–0.914) and composite reliability values (0.907–0.934) exceed the 0.70 threshold. AVE values (0.661–0.721) exceed 0.50, confirming convergent validity.

Table 4: Fornell-Larcker Criterion (diagonal = √AVE)

Construct	DTTI	DTSD	DTCO	TI	EJP
DTTI	0.822				
DTSD	0.612	0.831			
DTCO	0.588	0.603	0.813		
TI	0.571	0.589	0.562	0.849	
EJP	0.664	0.658	0.641	0.619	0.838

Table 4 shows that the square root of AVE for each construct (diagonal) exceeds its correlations with other constructs, confirming discriminant validity. HTMT ratios (not tabulated) were all below 0.85, further supporting discriminant validity.

Table 5: Direct Effects of Digital Transformation on Employee Job Performance

Relationship	Path Coefficient (β)	t-Statistic	p-Value	Decision
Technological Integration → EJP	0.438	6.214	< 0.001	Reject H01
Skill Development → EJP	0.392	5.487	< 0.001	Reject H02
Collaboration → EJP	0.311	4.102	0.001	Reject H03

Table 5 shows significant direct effects for all three dimensions. Technological integration has the strongest effect, followed by skill development and collaboration. All relationships are statistically significant, leading to rejection of H01–H03.

Table 6: Moderating Effects of Technological Innovation

Interaction	Path Coefficient (β)	t-Statistic	p-Value	Decision
TI × Technological Integration → EJP	0.221	3.418	< 0.001	Reject H04
TI × Skill Development → EJP	0.203	3.102	0.002	Reject H05
TI × Collaboration → EJP	0.182	2.874	0.004	Reject H06

Table 6 shows that technological innovation significantly and positively moderates all three relationships. The moderation is strongest for technological integration, indicating that innovative application amplifies the performance payoff of integrated tools most sharply.

International Journal for Novel Research in Economics , Finance and Management
www.ijnrefm.com
ISSN:3048-7722
Volume 4, Issue 6, Nov-Dec-2026, PP: 01-15

Table 7: Explanatory and Predictive Power

Outcome	R^2	Adjusted R^2	Q^2	Interpretation
Employee Job Performance (EJP)	0.612	0.603	0.418	Substantial explanatory power; medium-to-large predictive relevance

The model explains 61.2% of the variance in job performance, which is substantial for behavioural research in higher education. The Q^2 value of 0.418 indicates medium-to-large predictive relevance. Effect sizes (f^2) for the direct paths were moderate (0.18–0.29); interaction effect sizes were small-to-moderate (0.04–0.07), which is typical and meaningful for moderation in field research.

Structural Equation Model

The structural equation model is presented in the same manner as the attached document: three SmartPLS-style diagrams, one for Indirect Effect, one for Path Coefficient, and one for Total Effect. In each diagram, blue circles are latent constructs (DTTI, DTSD, DTCO, TI, EJP), yellow rectangles are indicators (for example DTTI1-DTTI3, TI1-TI3, EJP1-EJP3), numbers on the indicator arrows are outer loadings, numbers on the solid arrows are the direct path values, numbers on the dashed arrows are the moderating (interaction) values, and the number inside the EJP circle is R2 = 0.612. Only the construct labels have changed from the attached document: EJS (job satisfaction) is replaced by EJP (job performance), and PE (professional ethics) is replaced by TI (technological innovation). All other presentation conventions are preserved.

Indirect Effect

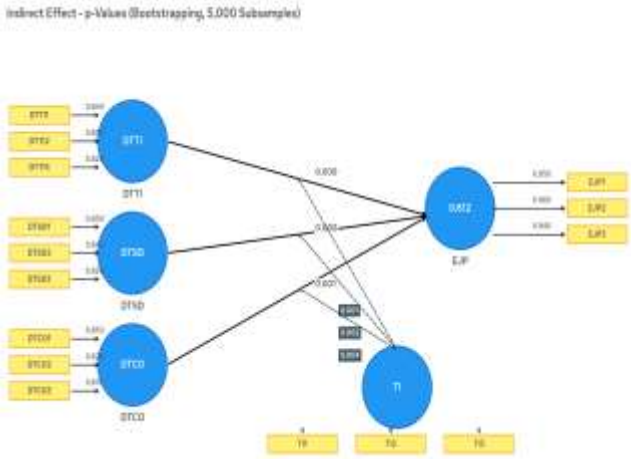


Figure 5: Structural Equation Model - Indirect Effect (p-values). All direct and moderating paths are significant ($p < 0.01$). Bootstrapping, 5,000 subsamples.

Path Coefficient

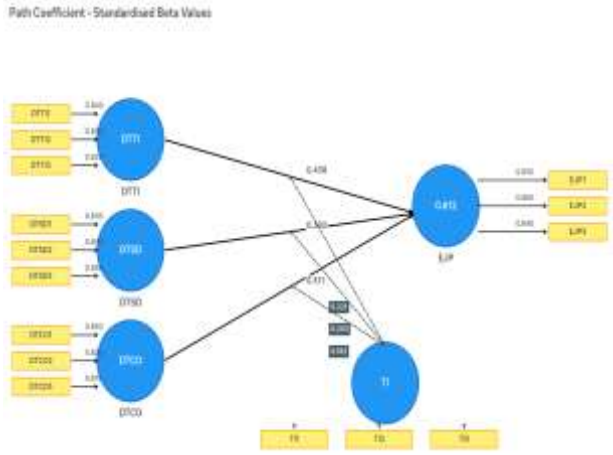


Figure 6: Structural Equation Model - Path Coefficient. Direct: DTTI 0.438, DTSD 0.392, DTCO 0.311. Moderating: TI x DTTI 0.221, TI x DTSD 0.203, TI x DTCO 0.182.

Total Effect

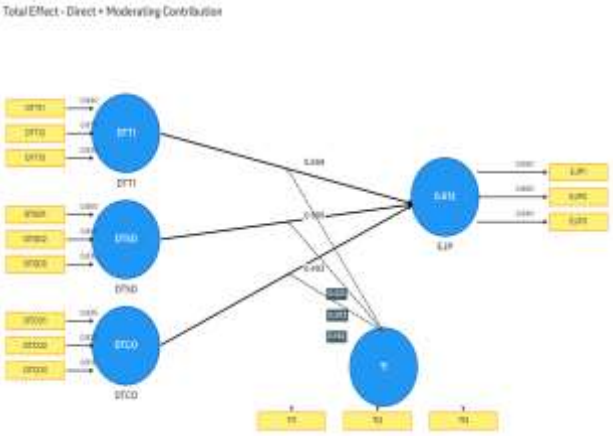


Figure 7: Structural Equation Model - Total Effect. Total for DTTI 0.659 (0.438 + 0.221), DTSD 0.595 (0.392 + 0.203), DTCO 0.493 (0.311 + 0.182). Moderating contributions shown separately.

Reading the Three Diagrams Together. The Indirect Effect diagram shows that every hypothesised path is statistically significant. The Path Coefficient diagram shows the size of each effect: technological integration has the largest direct effect, and technological innovation strengthens all three direct paths. The Total Effect diagram shows the combined payoff: when the moderating contribution of innovation is added, the total effect of technological integration rises to 0.659, of skill development to 0.595, and of collaboration to 0.493. Together, the three diagrams confirm Hypotheses H01-H06: digital transformation improves job performance, and technological innovation amplifies that improvement.

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Structural Equation (Final Model). EJP = b0 + b1(DTTI) + b2(DTSD) + b3(DTCO) + b4(TI x DTTI) + b5(TI x DTSD) + b6(TI x DTCO) + e, where b1 = 0.438, b2 = 0.392, b3 = 0.311, b4 = 0.221, b5 = 0.203, b6 = 0.182 (all $p < 0.01$). Model fit: $R2 = 0.612$, adjusted $R2 = 0.603$, $Q2 = 0.418$, all inner VIF < 3.0.

Discussion of Findings

Hypothesis 1 Technological Integration → Job Performance: The strong positive effect (β = 0.438) supports the argument that when digital platforms are reliably integrated into teaching, research, and administration, staff perform better. Integration reduces duplication, speeds feedback, and makes resources accessible. This aligns with Khuc & Nguyen (2025), who found direct effects of digital transformation on lecturers' job performance, and with Nigerian evidence that ICT integration supports instructional effectiveness.

Hypothesis 2 Skill Development → Job Performance: The significant effect (β = 0.392) confirms that training matters, but only when it is continuous and task-relevant. Staff who develop digital, pedagogical, and research skills use tools more purposefully and adapt more readily to change. This finding reinforces the view that digital transformation is as much a human-capability project as a technology project (Viterouli et al., 2024).

Hypothesis 3 Collaboration → Job Performance: The significant effect (β = 0.311) shows that digitally enabled collaboration, co-teaching, joint research, shared resources, peer feedback improves performance. Collaboration spreads good practice, reduces isolation, and accelerates learning. The effect is smaller than integration and skills, suggesting that collaboration platforms alone are insufficient without norms and incentives that reward joint work.

Hypothesis 4 Technological Innovation × Technological Integration: The positive moderation (β = 0.221) is the study's central finding. When innovation is high, integrated tools are redesigned into better workflows, automated assessment, blended learning, analytics-supported advising and performance gains are larger. When innovation is low, the same tools are used to replicate old routines, and gains are muted.

Hypothesis 5 Technological Innovation × Skill Development: The positive moderation (β = 0.203) indicates that training pays off more when staff are encouraged to experiment. Skilled staff in innovative environments pilot new pedagogies, share innovations, and receive recognition for experimentation; skilled staff in non-innovative environments may possess competence but lack opportunity or permission to apply it innovatively.

Hypothesis 6 Technological Innovation × Collaboration: The positive moderation (β = 0.182) shows that collaboration is more productive when it is innovative, co-creating open resources, co-designing assessments, and jointly piloting new tools, rather than merely coordinating routine tasks. Innovation turns collaboration from coordination into co-creation.

VII. SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

1. Summary of Findings

The study found that digital transformation significantly improves academic job performance in federal universities in Northeastern Nigeria. Technological integration had the strongest direct effect, followed by skill development and collaboration. Technological innovation significantly moderated all three relationships, amplifying the performance benefits of digital transformation. The model explained 61.2% of the variance in job performance, indicating strong explanatory power.

2. Conclusion

Digital transformation is a vital catalyst for enhancing employee job performance among academic staff in federal universities in Northeastern Nigeria. Its benefits, however, are not automatic. They depend on how far institutions go beyond procurement to integration, skills, collaboration, and critically technological innovation. Universities that innovate, redesigning processes, piloting new pedagogies, rewarding experimentation, and learning from pilots will extract far greater performance value from the same digital investments than universities that merely digitise existing routines.

3. Recommendations

- **Technological Integration:** Invest in reliable, interoperable digital infrastructure; stable connectivity, power backup, learning management systems, digital libraries, and research tools and ensure integration into daily workflows, not just availability. Establish a dedicated budget for maintenance, upgrades, and user support.
- **Skill Development:** Provide continuous, practice-based digital-skills development aligned to teaching, research, and administration. Use micro-credentials, peer coaching, and departmental learning communities, and ensure equitable access across ranks, disciplines, and campuses.
- **Collaboration:** Foster digitally enabled collaboration through shared repositories, co-teaching and joint-research incentives, and cross-university networks. Recognise collaborative outputs in appraisal and promotion criteria.

- **Technological Innovation × Integration:** Create an innovation function; innovation champions, pilot funds, and rapid feedback loops so that every major digital rollout includes a pilot, an evaluation, and a scale-or-stop decision. Reward staff who redesign workflows, not only those who adopt tools.
- **Technological Innovation × Skill Development:** Embed innovation into training: require participants to pilot a new method, share results, and mentor peers. Link training completion to applied innovation, not attendance alone.
- **Technological Innovation × Collaboration:** Fund collaborative innovation projects; open educational resources, blended-course redesign, AI-supported feedback pilots and provide platforms for staff to showcase innovations and learn from one another.
- **For Funders and Policymakers:** Sustain IBR funding and extend it to innovation readiness; pilot grants, innovation labs, and evaluation capacity alongside infrastructure, so that funded research translates into institutional performance.

4. Limitations

- **Sample and Generalisability:** The study covered six federal universities in Northeastern Nigeria; findings may not generalise to state or private universities or to other regions without replication.
- **Cross-Sectional Design:** Data were collected at a single point in time, limiting causal inference. Longitudinal designs could track how digital transformation and innovation effects evolve.
- **Self-Report Measures:** Job performance was measured by self-report, which may be subject to social-desirability bias. Future studies should triangulate with objective indicators (e.g., publication records, student outcomes, peer review) where feasible.
- **Common-Method Variance:** Single-source survey data can inflate relationships. Harman's single-factor test and procedural remedies (anonymity, varied item wording) were applied, but multi-source designs would strengthen confidence.

5. Future Study Areas

- **Longitudinal Studies:** Track digital transformation, innovation, and performance over multiple semesters to establish temporal ordering and sustainability of effects.
- **Comparative Studies:** Compare federal, state, and private universities, and compare regions, to identify contextual conditions that amplify or dampen effects.
- **Innovation Mechanisms:** Use qualitative and mixed-methods designs to uncover how specific innovations (e.g., AI-supported feedback, blended learning, workflow automation) translate into performance gains.
- **Student and Institutional Outcomes:** Extend the model to student learning outcomes, research quality, and institutional efficiency to capture the full value of digital transformation.

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