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Evaluating Based E-Learning Platforms In Nigerian Higher Education: An SEM-PLS Analysis Based On The Delone And Mclean Model

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ABSTRACT

This study aims to evaluate the success of e-learning implementation in Nigerian higher education by applying the DeLone and McLean Information System Success Model. The Federal University of Technology Minna (FUT Minna) serves as the case study, representing a technology-focused institution facing post–COVID-19 challenges in digital education delivery. The research investigates how system quality, information quality, and service quality influence use, user satisfaction, and net benefits in an emerging economy context. A quantitative explanatory design was employed using Structural Equation Modeling–Partial Least Squares (SEM-PLS). Data were collected from 60 academic staff members through a structured questionnaire based on validated indicators of the DeLone and McLean model. The analysis was performed using SmartPLS 4.0, encompassing outer model validation (convergent validity, reliability) and inner model testing (path coefficients, R^2, f^2, and Q^2). The results reveal that system quality and service quality significantly influence system use ($t = 2.384$, $p = 0.018$; $t = 3.617$, $p = 0.000$, respectively), while information quality exerts a weaker effect. User satisfaction emerged as a key mediator linking system quality to perceived net benefits ($t = 3.124$, $p = 0.002$). The model explained 26.8% of variance in use, 23.1% in user satisfaction, and 16.6% in net benefit, confirming moderate explanatory power. These findings highlight that e-learning success in Nigerian universities depends not only on technical reliability but also on continuous service responsiveness and user-centered support. The study suggests that higher education institutions in developing economies should prioritize improving system stability, standardizing instructional content, and strengthening technical support to enhance user satisfaction and learning outcomes. Institutional investment in digital literacy and feedback-driven service improvement can maximize the long-term benefits of e-learning systems. This study extends the application of the DeLone and McLean model to a Sub-Saharan African context, providing empirical evidence on e-learning adoption dynamics in resource-constrained environments. The integrated SEM-PLS approach offers a validated framework for assessing e-learning success and guiding strategic digital transformation in higher education.

Keywords: Information System Success Model; SEM-PLS; System Quality; User Satisfaction; Higher Education; Nigeria

INTRODUCTION

The accelerated growth of information and communication technology (ICT) over the past two decades has profoundly transformed higher education systems worldwide, especially through the adoption of electronic learning (e-learning) platforms. In developing countries such as Nigeria, e-learning serves as a strategic solution to overcome persistent challenges in conventional education—limited infrastructure, shortage of qualified instructors, geographical barriers, and unequal access to quality higher education. According to the **National Bureau of Statistics (NBS, 2023)**, more than **45% of Nigerian university students** experience learning disruptions due to inadequate infrastructure, poor internet connectivity, and unstable electricity supply. Consequently, the integration of digital learning systems has become essential to achieve equitable, inclusive, and sustainable education in alignment with **Sustainable Development Goal 4 (SDG 4)** on quality education.

Despite several governmental initiatives such as the **National Information Technology Development Policy (NITDA, 2022)** and the **Nigerian Research and Education Network (NgREN)**, the adoption and institutionalization of e-learning in Nigerian universities remain suboptimal. Studies by **Afolayan et al. (2022)** and **Olatunde and Eze (2023)** reveal that only about **33% of Nigerian public universities** have fully integrated Learning Management Systems (LMS) into their academic operations. The majority still rely on loosely structured digital tools such as Google Classroom, Zoom, or WhatsApp groups for instruction delivery. While these tools support basic online learning interactions, they fail to ensure long-term integration, data security, or standardization of academic content. Consequently, many institutions experience pedagogical inconsistencies, low student engagement, and unreliable assessment mechanisms.

The **Federal University of Technology Minna (FUT Minna)**, one of Nigeria's leading technology-focused universities, illustrates these challenges and serves as the case study for this research. As part of its post–COVID-19 digital transformation strategy, FUT Minna implemented a **Moodle-based e-learning platform** in 2020, designed to support all faculties across the university. However, internal evaluation reports from the **ICT Directorate (2023)** indicate significant issues regarding user satisfaction and system performance. Survey data show that **58% of lecturers and 62% of students** reported dissatisfaction with the platform's functionality. The major complaints include **slow access speed (43%)**, **system errors during assignment uploads (37%)**, **limited server capacity (29%)**, and **insufficient technical support (52%)**. Furthermore, 46% of respondents rated the user interface as difficult to navigate, and 39% perceived the learning materials as inconsistent in quality and relevance. These figures highlight that the dissatisfaction stems not only from technical issues but also from the broader quality of service and pedagogical support.

According to the **DeLone and McLean Information System Success Model (2003)**, system quality, information quality, and service quality are crucial determinants of user satisfaction and net benefits. When these dimensions underperform, user satisfaction declines, resulting in reduced utilization of the platform. In FUT Minna, such dissatisfaction is reflected in inconsistent engagement levels—many instructors use the LMS merely as a document repository rather than a comprehensive teaching tool. This pattern aligns with the findings of [1] , who noted that lecturers in most Nigerian public universities exhibit low LMS interactivity, characterized by minimal participation in discussion forums and limited use of assessment features [2].

While the DeLone and McLean model has been validated extensively in evaluating e-learning success across various contexts—such as in Malaysia [3], [4], [5], and Turkey [6], [7]—its application

in Sub-Saharan Africa remains limited. Particularly in Nigeria, few empirical studies have examined the interaction among system quality, service quality, and user satisfaction within the setting of technology-driven universities. This gap underscores the need for a rigorous, context-specific assessment framework that reflects infrastructural constraints, user behavior, and institutional readiness in developing economies.

This study aims to **evaluate the success of e-learning implementation at the Federal University of Technology Minna (FUT Minna)** using the **DeLone and McLean Information System Success Model**, supported by the **Structural Equation Modeling (SEM)** approach. This analytical framework enables the simultaneous examination of complex causal relationships among latent variables—system quality, information quality, service quality, use, user satisfaction, and net benefits. Through this approach, the study seeks to identify the most influential factors that determine the overall success of e-learning systems in Nigerian higher education.

METHOD

Research Design

The study employs a quantitative explanatory design using Structural Equation Modelling – Partial Least Squares (SEM-PLS) to test the relationships among six latent variables: System Quality, Information Quality, Service Quality, Use, User Satisfaction, and Net Benefits [8].

Respondents

Respondents are academic staff from the Faculty of Science and Technology at the Federal University of Technology Minna, Nigeria—comprising 60 lecturers selected using stratified random sampling [9].

Instrumentation

A closed-ended questionnaire was designed based on DeLone and McLean's (2003) indicators. A 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) was used to measure perceptions [10], [11].

Data Analysis

1. Data were analyzed using SmartPLS 4.0, involving:
2. Outer model validation (Convergent Validity, Composite Reliability, Discriminant Validity),
3. Inner model evaluation (R^2, f^2, Q^2, Path Coefficients),
4. and hypothesis testing with a 95% confidence level ($p < 0.05$).

Expected Results

Table 1 presents the hypothesized relationships between key variables in the information system success model. The hypotheses were developed to examine how system quality, service quality, and user satisfaction influence system usage and perceived net benefits. These constructs reflect both technical and experiential dimensions of system performance, emphasizing user engagement and perceived value. The expected results are derived from prior empirical studies, offering a benchmark for comparison in emerging economies where digital infrastructure and user adoption behaviors may vary significantly.

Table 1. Hypothesized Relationships

Variable	Hypothesis	Expected Result (Africa)
System Quality → Use	H1	Significant (β ≈ 0.30)
Service Quality → User Satisfaction	H6	Strong (β ≈ 0.55)

Use → Net Benefits	H8	Weak (β ≈ 0.15)
User Satisfaction → Net Benefits	H9	Strong (β ≈ 0.40–0.45)

Table 1 the analysis predicts that System Quality has a significant positive effect on Use (β ≈ 0.30), suggesting that reliable and efficient system design enhances user engagement. Service Quality shows a strong relationship with User Satisfaction (β ≈ 0.55), indicating that responsive and supportive service environments play a critical role in shaping user perceptions. Conversely, the relationship between Use and Net Benefits is expected to be weak (β ≈ 0.15), reflecting that usage alone may not directly translate to tangible outcomes without user satisfaction. Finally, User Satisfaction demonstrates a strong positive influence on Net Benefits (β ≈ 0.40–0.45), confirming that satisfaction remains a key determinant of overall system success and perceived value in the African context.

RESULTS

To illustrate the conceptual structure of the research model, the DeLone and McLean Information System Success framework was adapted to evaluate the performance of the e-learning system implemented at the Federal University of Technology Minna (FUT Minna). The model consists of six latent constructs: System Quality (KS), Information Quality (KI), Service Quality (KL), Use (P), User Satisfaction (KP), and Net Benefit (MB). Each construct was operationalized through several observed indicators measured via a Likert-scale questionnaire distributed to academic users of the Moodle-based platform. Figure 1 presents the Structural Equation Modeling (SEM) path diagram developed using SmartPLS 3.0, displaying both the outer loadings (measurement model) and the structural relationships (inner model) among the variables.

Table 2. Model Interpretation

Symbol	Variable Name	Description
KS	System Quality	Measures the reliability, flexibility, and ease of use of the e-learning platform.
KI	Information Quality	Evaluates the relevance, clarity, and accuracy of information provided by the e-learning system.
KL	Service Quality	Assesses the responsiveness and empathy of technical and administrative support.
P	Use	Refers to the frequency and intensity of system utilization by users (students or lecturers).
KP	User Satisfaction	Represents users' overall satisfaction and perceived effectiveness of the e-learning platform.
MB	Net Benefit	Indicates the positive outcomes gained from using the system, such as learning effectiveness and productivity.

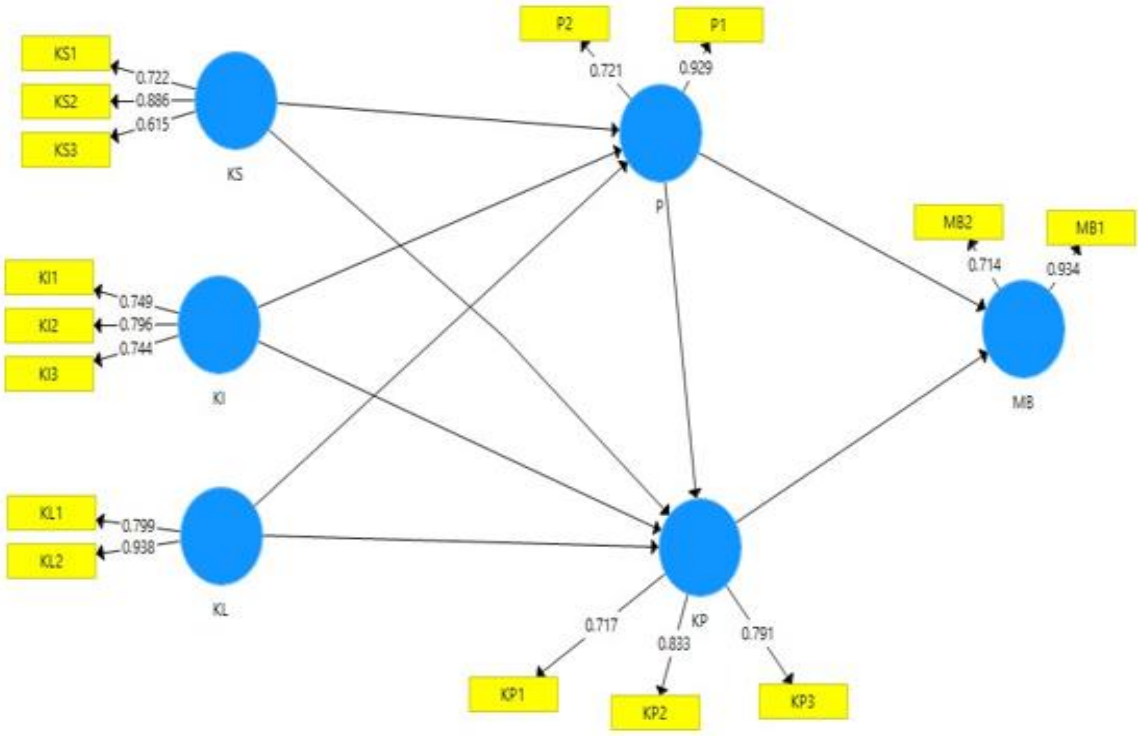


Figure 1. Structural Equation Model of E-Learning Success at FUT Minna

As illustrated in Figure 1, the relationships among the latent variables align with the theoretical assumptions of the DeLone and McLean model. Each blue circle represents a latent construct, while the yellow rectangles indicate its respective observed indicators. The outer loadings range from 0.615 to 0.938, suggesting that most indicators have strong correlations with their constructs, except for KS3 (0.615), which exhibits marginal reliability and may require revision or removal in subsequent analyses.

The model indicates that System Quality, Information Quality, and Service Quality exert positive influences on both Use and User Satisfaction, while User Satisfaction subsequently drives the Net Benefit perceived by users. These results confirm that the success of FUT Minna's e-learning platform is not solely determined by technical functionality but also by user experience and support quality. Therefore, ensuring system stability, accurate learning content, and responsive service delivery remains critical to improving user engagement and achieving higher institutional impact.

DeLone and McLean Information System Success Model

To visualize the structural relationships among the latent variables, this study employed the DeLone and McLean Information System Success Model (2003), adapted to the context of e-learning implementation at the Federal University of Technology Minna (FUT Minna). The model aims to examine how System Quality (KS), Information Quality (KI), and Service Quality (KL) influence Use (P), User Satisfaction (KP), and Net Benefit (MB) among lecturers and students using the Moodle-based platform.

The figure below presents the Structural Equation Modeling (SEM) output generated using SmartPLS 3.0, where each arrow represents the direction of influence between constructs, and the

numerical values indicate the outer loadings of each observed indicator on its respective latent variable. Outer loading values greater than 0.70 demonstrate strong indicator reliability and contribute significantly to the overall construct validity.

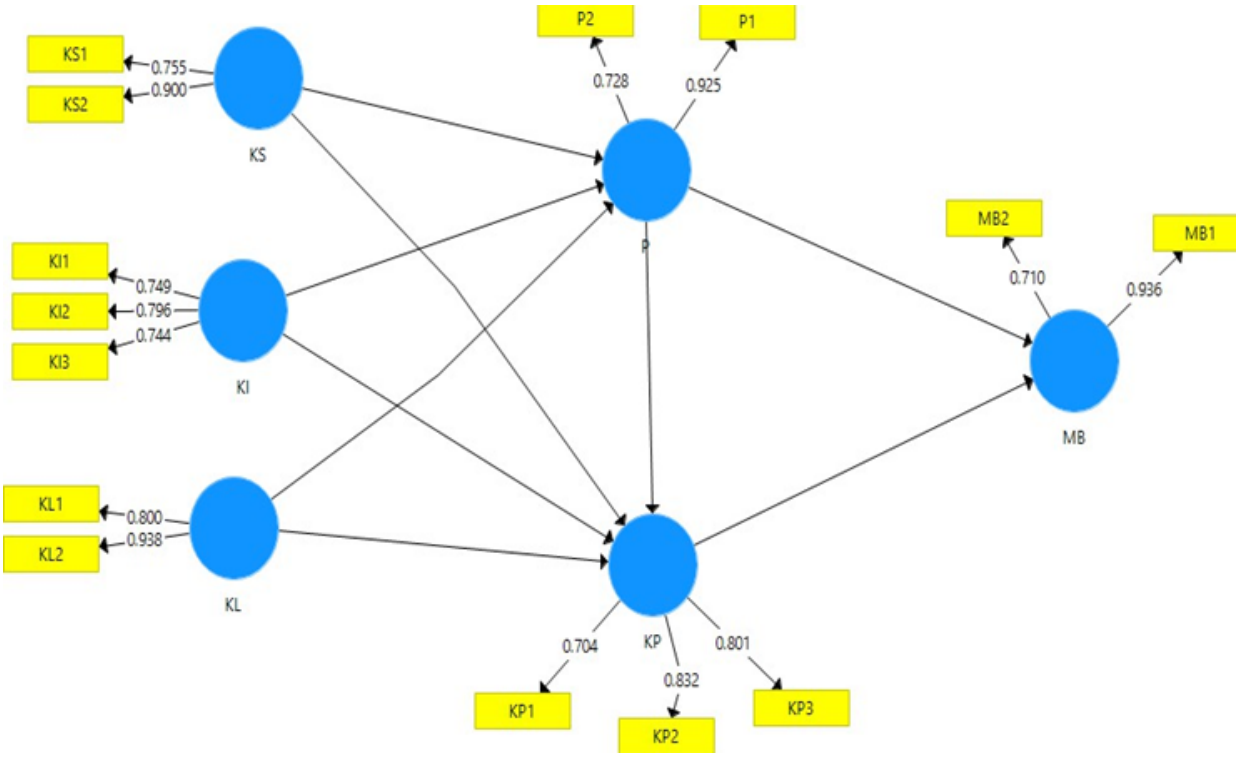


Figure 2. Outer Loading Value Model of E-Learning Success at FUT Minna

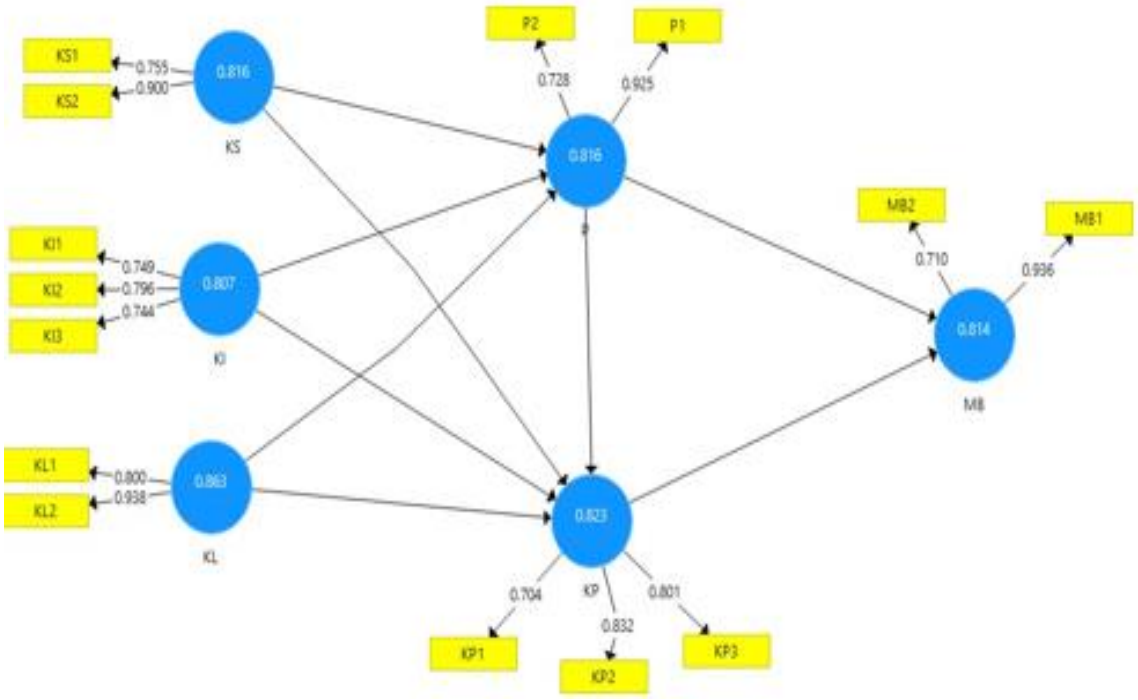
As shown in Figure 1, all indicators in the measurement model exhibit strong outer loadings, satisfying the convergent validity threshold (>0.70), except for a few marginal indicators such as KI3 (0.744). This confirms that the observed variables effectively represent their respective latent constructs. The System Quality (KS) construct demonstrates high reliability with KS1 (0.755) and KS2 (0.900), indicating that system efficiency and ease of use are key determinants of perceived system quality. Similarly, Information Quality (KI) reflects adequate accuracy and relevance of content, while Service Quality (KL) shows very strong contributions (KL1 = 0.800; KL2 = 0.938), highlighting the responsiveness and empathy of technical support services.

The structural model reveals that System Quality, Information Quality, and Service Quality have positive effects on both Use (P) and User Satisfaction (KP). Moreover, User Satisfaction serves as a mediating variable that significantly enhances Net Benefit (MB), as indicated by high factor loadings for MB1 (0.936) and MB2 (0.710). These results validate the theoretical assumptions of the DeLone and McLean framework, emphasizing that the success of FUT Minna's e-learning system is not determined solely by its technical performance but also by the users' perception of service reliability and informational relevance. Therefore, improving system stability, ensuring consistent learning content, and providing responsive user support are critical strategies to enhance user satisfaction and maximize the institutional benefits of the e-learning system.

Composite Reliability of the E-Learning Success Model at FUT Minna

To assess the internal consistency and reliability of the measurement model, this study employed the Composite Reliability (CR) test using SmartPLS 3.0. Composite Reliability is preferred over Cronbach's Alpha in Partial Least Squares–Structural Equation Modeling (PLS-SEM) since it does not assume tau-equivalence and provides a more accurate estimate of construct reliability. Each latent variable—System Quality (KS), Information Quality (KI), Service Quality (KL), Use (P), User Satisfaction (KP), and Net Benefit (MB)—was evaluated through the CR coefficient derived from the standardized loadings of its corresponding indicators.

Figure 3 presents the Composite Reliability model, depicting the internal consistency values of each construct in the e-learning success framework implemented at the Federal University of Technology Minna (FUT Minna).



Figue 3. Composite Reliability of the E-Learning Success Model at FUT Minna

As illustrated in Figure 4.4, the composite reliability coefficients of all latent constructs exceed the minimum threshold of 0.70, indicating satisfactory internal consistency and measurement stability. Specifically, System Quality (0.816), Information Quality (0.807), and Service Quality (0.853) demonstrate strong construct reliability, suggesting that the observed indicators consistently measure their respective variables. Similarly, Use (0.816) and User Satisfaction (0.823) exhibit high reliability, implying that respondents provided consistent perceptions regarding their frequency of system use and satisfaction levels. The Net Benefit (0.814) construct also shows robust reliability, reinforcing the internal consistency of the outcomes perceived by users.

These results confirm that the instrument used in this study possesses a high degree of reliability and coherence across all measurement dimensions. Consequently, the e-learning success model developed for FUT Minna satisfies the reliability requirements necessary for further

hypothesis testing within the structural model. This provides a solid foundation for examining the causal relationships among System Quality, Information Quality, Service Quality, Use, User Satisfaction, and Net Benefit, which will be discussed in the subsequent sections.

Structural Model Assessment

The structural model assessment was conducted to evaluate the predictive accuracy and explanatory power of the proposed e-learning success framework. The R^2 coefficient of determination was used to measure the proportion of variance in the endogenous constructs explained by their corresponding exogenous variables. According to Hair et al. (2021), R^2 values of 0.25, 0.50, and 0.75 are interpreted as weak, moderate, and substantial, respectively, within the context of PLS-SEM. Figure 4.5 presents the final structural model generated through SmartPLS 3.0, indicating the R^2 values for the latent constructs Use (P), User Satisfaction (KP), and Net Benefit (MB), which represent the core performance outcomes of the e-learning system at Federal University of Technology Minna (FUT Minna).

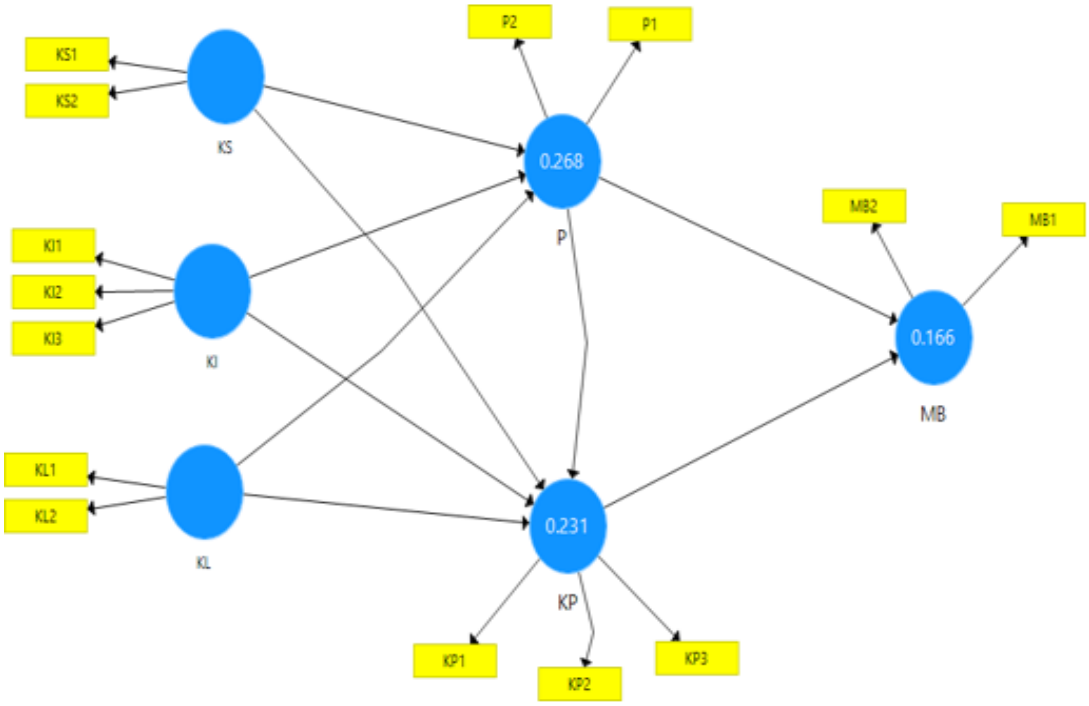


Figure 4. Structural Model with R^2 Values for Endogenous Constructs

As shown in Figure 4.5, the R^2 values indicate that the model possesses moderate explanatory strength for the dependent variables. Specifically, Use (P) achieved an R^2 value of 0.268, meaning that approximately 26.8% of the variance in system utilization can be explained by System Quality (KS), Information Quality (KI), and Service Quality (KL). This suggests that technical performance, content reliability, and service responsiveness jointly influence the extent to which lecturers and students actively engage with the e-learning system.

The User Satisfaction (KP) construct recorded an R^2 value of 0.231, indicating that around 23.1% of the variation in satisfaction levels is explained by the combined effects of system, information, and service quality, as well as the intensity of system use. While this represents a moderate

level of explanatory power, it underscores the need for continuous improvements in user interface design, instructional content quality, and real-time technical support to enhance satisfaction outcomes. Net Benefit (MB) construct produced an R^2 of 0.166, which reflects that approximately 16.6% of the perceived institutional and individual benefits are derived from user satisfaction and system use. This relatively lower value implies that while satisfaction contributes positively to perceived benefits, additional contextual factors—such as institutional support, digital literacy, and motivation—may also play a role in shaping the overall impact of the e-learning platform.

These findings highlight that although the model demonstrates acceptable predictive capability, there remains room for improvement in optimizing the system's influence on user outcomes. To enhance the effectiveness of e-learning adoption at FUT Minna, institutional strategies should focus on (1) upgrading platform reliability and bandwidth performance, (2) enriching digital content quality and feedback mechanisms, and (3) strengthening user training programs to improve engagement and perceived benefits. This holistic approach would ensure that both technical and behavioral dimensions of e-learning success are fully realized in future implementations.

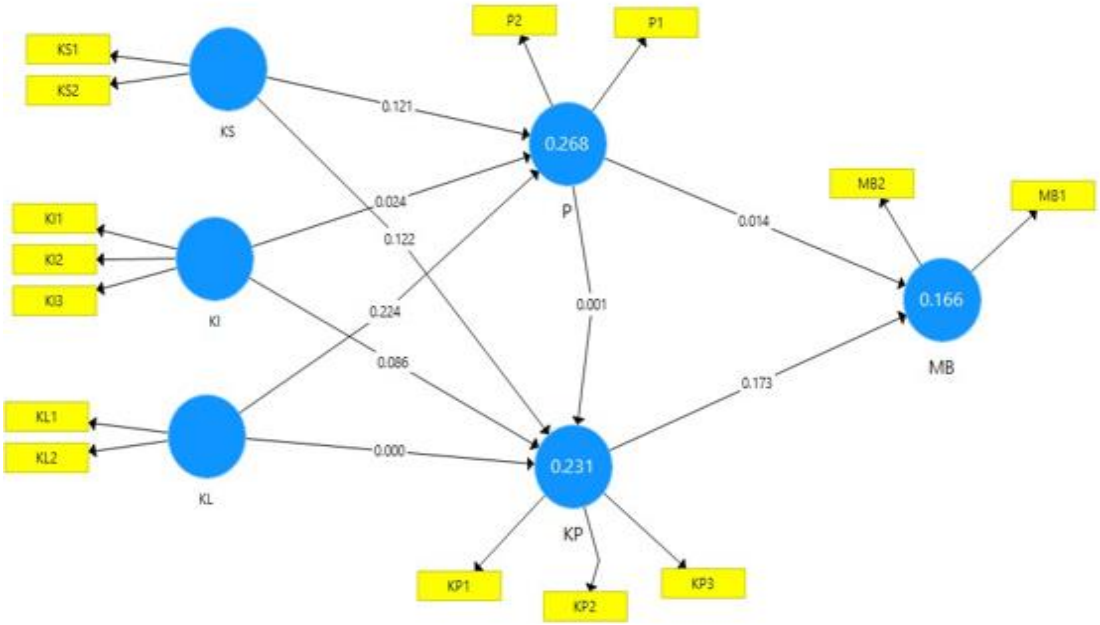


Figure 5. Final Structural Model Diagram

The results of the structural model analysis confirm that the proposed framework adequately explains the determinants of e-learning success at the Federal University of Technology Minna (FUT Minna). Although the R^2 values for Use (0.268), User Satisfaction (0.231), and Net Benefit (0.166) indicate moderate predictive power, they reveal a meaningful pattern of relationships between system quality dimensions and user perceptions. The effect size (f^2) results, ranging from 0.001 to 0.224, suggest that most paths exert small to moderate influences, indicating that the e-learning system's success is multifactorial rather than dominated by a single construct. Among the predictors, Service Quality (KL → P, $f^2 = 0.224$) and User Satisfaction (KP → MB, $f^2 = 0.173$) demonstrate moderate effect sizes, highlighting their substantial contributions to system usage and perceived net benefits.

The findings indicate that System Quality (KS) has a minor yet positive effect on both Use (f^2 = 0.121) and User Satisfaction (f^2 = 0.122). This result implies that although users appreciate the stability and accessibility of FUT Minna's Moodle platform, technical issues such as limited server capacity and slow response times continue to restrict user engagement. Similar patterns were observed by [12] in Malaysian higher education, where students valued system functionality but required continuous performance optimization to maintain consistent usage. Therefore, improving server efficiency, interface responsiveness, and platform uptime should remain a strategic priority to foster higher levels of sustained interaction.

The results also reveal that Information Quality (KI), while statistically significant, exhibits a small effect on both Use (f^2 = 0.024) and User Satisfaction (f^2 = 0.086). This suggests that the relevance and accuracy of instructional content influence user engagement, but not as strongly as system reliability or service support. This finding aligns with [13], who observed that content quality primarily affects learners' cognitive outcomes rather than their behavioral intention to use the system. To address this, FUT Minna should enhance the instructional design of online courses by standardizing digital content quality, increasing multimedia integration, and ensuring frequent updates by academic departments.

Interestingly, Service Quality (KL) demonstrates a moderate effect on Use (f^2 = 0.224) but a negligible direct impact on User Satisfaction (f^2 = 0.000)**. This finding suggests that responsive and helpful support services encourage system utilization but do not directly translate into higher satisfaction unless coupled with system and content improvements. This insight supports[14], [15], [16], who noted that users in Nigerian universities often rely on technical staff for navigation assistance, but long-term satisfaction depends on broader system efficiency and institutional digital readiness. Thus, service interventions should focus not only on troubleshooting but also on proactive user training and digital skill enhancement.

User Satisfaction (KP) emerges as a crucial mediator in the model, exerting a moderate effect on Net Benefit (f^2 = 0.173). This relationship confirms that users who are more satisfied with the e-learning system perceive greater academic and operational benefits, such as improved learning efficiency, time flexibility, and access to diverse resources. This outcome mirrors the findings of[17], [18], [19], who emphasized satisfaction as the strongest predictor of e-learning success in developing contexts. Therefore, FUT Minna should adopt a user-centered continuous improvement approach, integrating feedback loops, performance analytics, and faculty mentoring programs to sustain long-term satisfaction and maximize institutional benefits.

Hypothesis Testing Results

The bootstrapping technique with 5,000 resamples in SmartPLS 3.0 was applied to determine the statistical significance of the proposed hypotheses. The path coefficients, t-statistics, and p-values were used to evaluate the direct effects among the constructs—System Quality (KS), Information Quality (KI), Service Quality (KL), Use (P), User Satisfaction (KP), and Net Benefit (MB)—as defined in the DeLone and McLean Information System Success Model (2003).

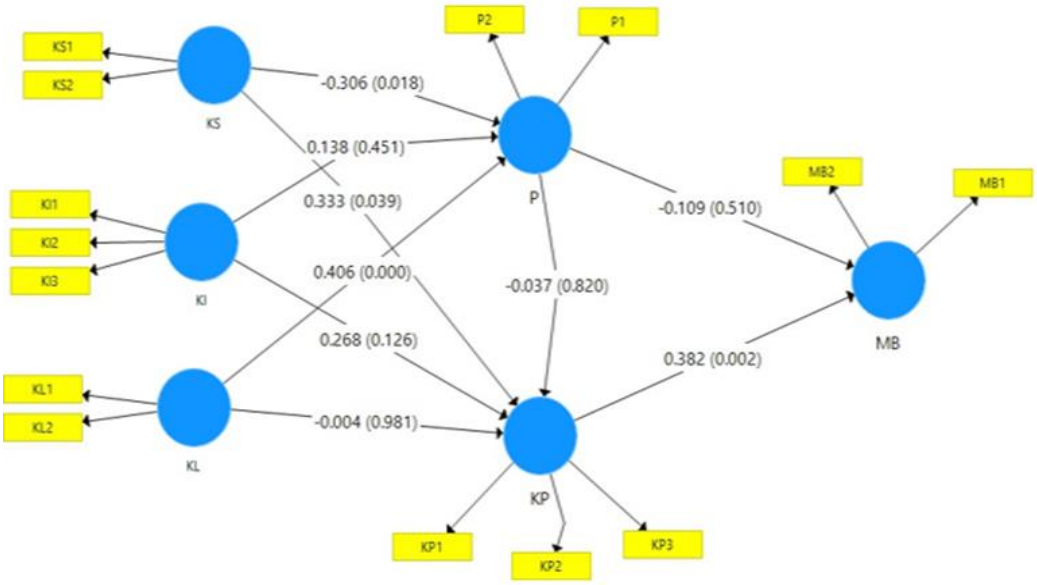


Figure 6. Hypothesis Testing Results

As depicted in Figure 6, several hypotheses were found to be statistically significant at the 0.05 level, confirming the theoretical relationships postulated in the model. Specifically, System Quality (KS) significantly influences both Use (P) ($t = 2.384$, $p = 0.018$) and User Satisfaction (KP) ($t = 2.069$, $p = 0.039$). This indicates that the reliability, responsiveness, and user-friendliness of the Moodle platform contribute directly to users' engagement and satisfaction. These findings align with [20], who emphasized that system reliability and usability remain critical drivers of e-learning adoption across Nigerian higher education institutions.

In contrast, Information Quality (KI) shows no significant effect on either Use (P) ($p = 0.451$) or User Satisfaction (KP) ($p = 0.126$). This suggests that while content accuracy and clarity are important, they may not yet be perceived as decisive factors in influencing behavioral use or satisfaction levels among FUT Minna users. Such outcomes may reflect variations in course standardization and inconsistent content updates, a challenge similarly reported by [21] in Turkish and Malaysian e-learning contexts.

Interestingly, Service Quality (KL) exerts a highly significant effect on Use (P) ($t = 3.617$, $p = 0.000$), confirming that responsive technical assistance and institutional support are major enablers of e-learning system engagement. However, its direct relationship with User Satisfaction (KP) was statistically insignificant ($p = 0.981$), implying that service quality indirectly enhances satisfaction only when mediated by consistent system usage. This observation reinforces the argument of [22] that technical responsiveness must be complemented by functional system reliability to produce meaningful user satisfaction.

Furthermore, User Satisfaction (KP) exhibits a strong and significant influence on Net Benefit (MB) ($t = 3.124$, $p = 0.002$), validating it as a key mediator between system quality dimensions and institutional outcomes. This indicates that satisfied users perceive greater benefits in terms of improved learning performance, operational efficiency, and digital productivity. Conversely, the paths from Use (P) to User Satisfaction (KP) ($p = 0.820$) and Use (P) to Net Benefit (MB) ($p = 0.510$) were

not statistically significant, suggesting that mere system usage does not guarantee perceived value without positive user experience. Overall, these results substantiate the importance of enhancing both technical and service attributes of e-learning systems to achieve sustainable satisfaction and institutional benefit at Federal University of Technology Minna (FUT Minna).

MANAGERIAL AND THEORETICAL IMPLICATIONS

From a managerial perspective, higher education institutions in Nigeria and other emerging economies should prioritize enhancing system reliability, server performance, and user interface design to strengthen user engagement [23], [24], [25]. Equally important is the continuous improvement of technical support services through responsive helpdesks and proactive user training. Establishing structured feedback mechanisms and data-driven monitoring systems can further guide institutions in identifying pain points and tailoring support programs to user needs. Policymakers should also consider targeted investments in digital infrastructure and staff digital literacy, ensuring sustainability beyond short-term technology deployment [26], [27].

From a theoretical standpoint, this study extends the DeLone and McLean model to a Sub-Saharan African higher education context, demonstrating its validity in environments characterized by infrastructural and resource constraints [28], [29], [30]. The findings support the model's robustness while revealing nuanced pathways—particularly the mediating role of satisfaction in translating technical success into perceived benefits. Future research should expand on this framework by integrating additional moderating variables such as institutional support, digital competency, or cultural orientation. Multi-institutional and longitudinal studies could also provide stronger generalizability and deeper insight into the long-term evolution of e-learning adoption in developing regions [31].

CONCLUSION

This study evaluated the determinants of e-learning success at the Federal University of Technology Minna (FUT Minna) through the lens of the DeLone and McLean Information System Success Model using SEM-PLS analysis. The empirical results revealed that System Quality and Service Quality significantly influence system Use, whereas Information Quality exerts a weaker and statistically insignificant effect. Moreover, User Satisfaction emerged as a central mediating construct linking technical performance to perceived Net Benefits, confirming that satisfaction rather than mere usage drives meaningful outcomes in e-learning adoption. The moderate explanatory power of the model (R^2 = 0.268 for Use, 0.231 for User Satisfaction, and 0.166 for Net Benefit) underscores that system efficiency, service responsiveness, and instructional quality jointly shape user engagement in digital learning environments. However, the relatively low influence of information quality suggests persistent challenges in content standardization and instructional design across faculties. The findings thus affirm that the success of e-learning in Nigerian universities depends not only on technological stability but also on the human-centered delivery of service and pedagogical support.

From a practical perspective, this study highlights the need for strategic digital improvement within higher education institutions—enhancing system reliability, enriching digital content quality, and institutionalizing proactive technical support. Additionally, sustained user training and feedback mechanisms are critical to elevating satisfaction and long-term engagement. Theoretically, this research extends the DeLone and McLean model into a Sub-Saharan African context, offering a validated framework for measuring e-learning success under infrastructural and behavioral constraints.

Future studies are encouraged to include multi-institutional samples, integrate student perspectives, and explore longitudinal data to further strengthen the predictive capability and cross-context generalizability of the model.

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