Strategic digital transformation in higher education and its effect on organizational agility and innovation performance

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Abstract

Higher education institutions (HEIs) have adopted digital transformation strategies to keep pace with rapid digital innovation and enhance competitiveness, efficiency, and academic standards. This study examined the effects of digital transformation on educational governance and the potential for innovation using a combined theoretical and statistical approach. Key digital technologies, including data analytics, cloud computing, AI tools, and LMS, are considered enablers that make an institution more agile and improve decision-making. The hypothesized relationships were tested empirically using structural equation modelling (SEM). The reliability studies of the questionnaires showed good internal consistency, with Cronbach's Alpha, Composite Reliability, and AVE exceeding the acceptable levels. According to the structural model, digital transformation significantly enhances academic governance. Innovation capability can also be improved directly through digital transformation. Combined, the academic governance should also play a mediating role, with an indirect impact of 0.27, adding to the overall effect of digital transformation in this regard. The overall impact of digital transformation on innovation capability (0.85) shows the extent to which it has in the institutional context of HEIs. We also determined predictive accuracy, with R2 values of 0.41 for academic governance and 0.62 for innovation capability. On the whole, the sources of information presented in this research indicate that digital transformation can be considered a significant catalyst for enhancing the agility, innovation, and sustainable competitive advantage of HEIs.

Keywords

Digital Transformation, Higher Education Institutions, Organizational Agility, Innovation Performance, Data Analytics, Cloud Computing, Learning Management Systems, Artificial Intelligence, Institutional Competitiveness.

Introduction

Digital transformation has become a strategic necessity for higher education institutions (HEIs) as they respond to rapidly evolving technology, changing learner needs, and global competition. Contemporary scholarship has identified that HEIs are increasingly seeing the digital transformation agenda not as technology for its own sake but more so as a comprehensive (whole) institutional agenda that usually involves a fundamental restructuring of work, governance, and the academic delivery of the institution. The strategic alignment of technology with institutional mission and goals is often identified as a critical factor in relevant transformation outcomes.

The technology underpinnings of digital transformation in higher education institutions include innovations such as data analytics, cloud computing, Learning Management Systems (LMS), and Artificial Intelligence (AI). Collectively, these technologies improve institutional capacity to manage information, automate processes, and create more personalized learning opportunities. Evidence suggests that using analytics, along with AI, allows institutions to better reposition themselves by using data to inform practice, to offer student-centred models [1] increasingly, and to achieve efficiencies in academic quality and administration.

Agility, defined as the organization’s capacity to sense, respond, and adapt quickly to changes at the organizational level, is critical for higher education institutions (HEIs) operating in volatile and uncertain contexts. Organizational agility enables HEIs to reconfigure resources rapidly, adopt new technologies efficiently, and sustain functionality in the face of unexpected disruptions, such as a pandemic or technological changes. Studies show that increased agility increases the likelihood of successfully managing digital transformation initiatives. [2]

Innovation performance in higher education is also driven by digital transformation. Artificial intelligence (AI) technologies enable, as one example, automated assessment, predictive analytics, intelligent tutoring systems, and adaptive learning paths, which also radically transform pedagogical processes and design new academic courses and services. Furthermore, digital platforms support collaboration, interdisciplinary research, and knowledge sharing, as well as the interrelatedness of institutional innovation ecosystems. [3].

The large-scale adoption of LMS and cloud-based learning platforms will also help enable more innovations that create more flexible, inclusive, and efficient learning environments. Cloud-LMS systems will open up online learning opportunities, allow multimodal content delivery, improve feature accessibility, and enhance communication and collaboration among learning stakeholders [18]. For example, recent research has shown that cloud-enabled LMSs enhance students' digital competencies and learning engagement, which can lead to the development of institutional capabilities and greater digital readiness [4][20].

With the increased application of sophisticated digital tools by HEIs, they will also experience additional problems in relation to ethics, data privacy, and bias in AI-informed decision making, and the digital divide; all of which should be addressed with proper governance frameworks, faculty training on the use of technology, policy, and continuous monitoring that will guarantee responsible use of technology and equitable access to all learners[19]. The key point is that the challenges must be addressed to ensure sustainable digital transformation. Proper digital governance is the primary component of ensuring the integrity of institutions and keeping students' trust [3][25]. At the group level, strategic digital transformation contributes immensely to internal and external agility in HEIs' performance in innovation. In the case below of academic and administrative settings, the capability of a HEI to incorporate the established and advanced technologies with institutionally sponsored academic (curricular) and administrative systems will allow a more efficient reaction to both internal and external pressure, optimize the results of decisions, and increase the competitive advantage of an organization. Therefore, the realization of the mutual relationship among digital tools, organizational agility, performance, and innovative solutions will help policymakers and leaders of HEIs build resilient, future-oriented HE systems [1][5].

Key Contributions of the Research

The study contributes to the existing body of knowledge by defining an official nexus linking strategic digital transformation, organizational agility, and innovation performance in institutions of higher learning. Although extant research views digital tools separately and does not view them with a similar model, this study brings the role of data analytics, cloud computing, LMS platforms, and AI technologies, among others, together to form an analogous model that explains how data, cloud computing, LMS services orientation, and AI enhance responsiveness, decision-making, and flexibility of the organization. Moreover, this study contributes to the theory by demonstrating that organizational agility serves as a mediating factor between digital transformation and innovation performance outcomes, offering a more complex explanation of how HEIs may develop digital capabilities to sustain competitive advantage. Finally, the theoretical model is pragmatic for policymakers and academic leadership because it establishes common strategic, technological, and organizational catalysts that drive success in a digital transformation agenda.

The outline of the paper, chapter-wise, is as follows. Chapter II is a review of the related literature, while Chapter III provides a brief overview of the theoretical framework, key concepts, and methodologies. Chapter IV will evaluate the experimental results. Chapter V contains the results and discussion, whereas Chapter VI wraps it all up with a summary of the most important findings and suggestions for further research.

II. LITERATURE REVIEW

Fernandez et al. [6] present a detailed multi-literature review that visualizes digital transformation initiatives (DTIs) in higher education as organization-wide initiatives rather than willy-nilly technological projects. They analyze them and define governance structures, data analytics, cloud deployment, LMS integration, and staff digital upskilling as the most common DTIs. Notably, the authors focus on the role of digital maturity, which should mediate the effectiveness and quality of transformation outcomes. They propose that universities should not change individual pilots but rather pursue institutional-wide transformation roadmaps, supported by robust leadership and their stakeholders. This, they affirm, is the systemic nature of such an approach, required to make digital transformation integrated into institutional strategy rather than a set of off-putting initiatives.

Zhang et al. [7] base their research on the dynamic capabilities theory and use a survey methodology. They find that agility, characterized by an institution's capacity to perceive opportunities, capture them quickly, and

reorganize processes, is a reliable indicator of how successfully digital transformation initiatives will be. The research shows that investing in flexible workflows, rapid decision-making, and adaptive structures increases the likelihood of making a positive contribution through digital transformation. The authors support the notion that digital transformation is not only technological but also relies heavily on organizational preparedness and sensitivity, as they empirically relate agility to the success of transformational processes.

Deroncele Acosta et al. [8] review the effects of the COVID-19 pandemic on the faster pace of digital transformation and the introduction of educational technology in institutions of higher education. Their qualitative synthesis demonstrates that the crisis initiated the most significant changes in favor of blended learning models, new teaching practices, and faculty-led experimentation with digital tools [15][17]. The authors posit that these emergency responses led to more long-term strategic thinking and that institutions should consider how short-term adaptations, including online assessments, remote collaboration platforms, and hybrid course models, can be developed into long-term capabilities. Their analysis highlights that the pandemic was a disruptor and a catalyst, pushing institutions to shift from ad hoc digital practices to more designed and strategized transformations [19].

Al-Zahrani et al. [9][24] conducted a stakeholder-based study on the ethical, social, and educational effects of AI implementation in higher education. According to them, there is a twofold attitude: high hopes for AI's ability to boost pedagogical innovation and learning efficiency, but the threats of data privacy, algorithmic bias, academic integrity, and governance are high [23]. The writers suggest creating multi-stakeholder AI governance systems that provide transparency, accountability, and robust data management policies. They further emphasize that AI literacy should be taught to educators and learners to make responsible use. The paper highlights that although AI can be valuable to education as a whole, it cannot be implemented without ethical considerations to build trust and fairness [21].

Sanchez et al. [10] present a comparative analysis of 45 Learning Management Systems (LMSs) based on their functional scope, scalability, accessibility capabilities, and the ability to support education based on analytics. Their systematic review illustrates the importance of LMS choice in determining whether an institution can scale online and blended learning. Comparing on-premises and cloud-based LMS, they demonstrate that the choice of platform has downstream implications for instructional flexibility, data-driven insights, and digital learning innovation. The authors claim that the choice of LMSs can no longer be viewed as an IT procurement decision but rather as part of the institution's broader digital transformation plans and its agility.

The article by El Koshiry et al. [11] describes the use of a cloud-based LMS (Moodle Cloud) to support blind postgraduate students. It offers a distinct perspective on inclusive digital transformation in higher education. Their results demonstrate that cloud LMS settings can increase access and digital capacity when supported by considerate instructional design and learner support services. The paper shows that cloud services do not just enhance access to course resources, but can also enhance digital skills that are key to broader transformation aims. The authors conclude that transformation strategies must be infused with inclusive technologies that ensure digital progress does not enhance exclusion but instead enhances equity.

Wu, Zhang, and Carroll et al. [12] examine AI governance models in colleges and universities through institutional AI guidance documents from leading higher education institutions [22]. Their cross-case study reveals general aspects of governance, including role clarity, policy transparency, accountability provisions, and structured oversight arrangements across the academic, IT, and ethics units. They claim that the multi-unit, multi-unit approach to AI governance should be mature enough to balance between innovation and risk management. The paper posits that proper AI governance can help institutions implement AI responsibly, ensuring that technologies are used in ethically appropriate ways that align with institutional values. Their results emphasize the growing need to establish AI regulation in digital transformation agendas.

Ovrelid et al. [13] consolidate current digital transformation frameworks and introduce a single framework that integrates the processes of technology adoption, pedagogical innovation, and organizational change. The framework focuses on the congruence among institutional strategy, technological decisions, and specific implementation procedures and provides a vantage point on how digital transformation should occur in higher education. Ovrelid believes that effective change involves institutions bridging strategic purpose with operational implementation, which is why there is coherence in the analytics, LMS implementation, cloud services, and

teaching innovation. It is this combined strategy, the chapter concludes, which places institutions in a better position to convert high-level digital aspirations into long-term capabilities and quantifiable results.

Webber et al. [14] discuss the practical implications of advanced analytics and AI systems in higher education and consider the following aspects: quality assurance, learning analytics, and institutional decision-making. Their review demonstrates the potential of analytics to enhance student success interventions, improve operational planning, and improve academic quality. Nevertheless, the authors warn that to make analytics and AI tools responsible and used, methodological rigor, data governance policies, and staff capabilities are critical. When issues of data management, algorithmic validity, and institutional preparedness are addressed, the benefits of analytics become possible, they suggest that governance and capacity-building are the essential aspects of digital transformation which is illustrated in Table 1.

Table 1 Key Studies on Digital Transformation Initiatives in Higher Education

S. No.	Author	Dataset Used	Major Findings / Contributions	Identified Gaps / Limitations
1	Fernández et al.	Literature review (multiple HEI case studies, policy documents, and research articles)	Theorizes DTIs as strategic, organizational changes; governance, analytics, cloud, LMS, and upskilling are considered core change initiatives; digital maturity is identified as a primary moderator of successful transformations; an institutional-wide roadmap and institutionalized leadership participation are recommended.	Lack of empirical validation across diverse HEIs; transformation maturity levels vary widely; limited quantitative evidence linking specific DTIs to measurable institutional outcomes.
2	Zhang et al.	Survey data grounded in dynamic capabilities theory	Demonstrates that organizational agility (sensing, seizing, and reconfiguring capabilities) significantly predicts digital transformation performance; highlights the importance of flexible workflows and rapid decision-making structures.	Cross-sectional survey limits causal inference; cultural and institutional variations in agility were not deeply explored; limited generalizability beyond sampled institutions.
3	Deroncele-Acosta et al.	Qualitative synthesis of pandemic-era digital transformation studies	Shows how COVID-19 accelerated blended learning, digital pedagogy, and faculty-driven innovation; argues that emergency digital practices catalyzed long-term strategic transformations and capability building.	Overemphasis on crisis-driven contexts; long-term sustainability of innovations not longitudinally assessed; limited coverage of non-pandemic drivers of transformation.
4	Al-Zahrani et al.	Stakeholder interviews and surveys on AI in higher education	Recognizes enthusiasm over pedagogical advantages of AI and fears of bias, privacy, and regulation; suggests multi-stakeholder forms of governance based on transparency and accountability; emphasizes the importance of AI literacy.	Stakeholder perspectives may be context-specific; limited empirical testing of proposed governance models does not assess AI adoption outcomes over time.
5	Sánchez et al.	Comparative review of 45 LMS platforms	Provides a detailed classification of LMS functionality, scalability, accessibility, and analytics capabilities; shows LMS selection as a strategic institutional decision affecting scaling of online/blended learning.	Based on secondary data, it does not include real-world adoption case studies; limited evaluation of long-term LMS performance or user satisfaction.
6	El Koshiry et al.	Case study on Moodle Cloud for blind postgraduate students	Demonstrates how cloud LMS improves accessibility, digital skills, and capability development for visually impaired learners; highlights inclusive digital transformation strategies.	Narrow focus on a specific learner population; findings may not generalize across diverse accessibility needs; lacks comparative analysis across different cloud LMS platforms.
7	Wu, Zhang & Carroll et al.	Cross-case analysis of AI governance documents from major universities	Outlines significant governance principles - role clarity, transparency, accountability, and multi-unit oversight; proposes mature AI governance to strike a balance between innovation and risk; notes the increasing demand for structured AI governance.	Relies heavily on institutional policy documents; does not evaluate actual implementation effectiveness; governance models may vary across regions.
8	Ovrelid et al.	Synthesis of existing digital transformation frameworks	Proposes an integrated digital transformation framework connecting strategy, technology adoption, pedagogy, and organizational workflows; stresses alignment between strategic intent and operational execution.	Lacks empirical validation; framework implementation challenges have not been systematically studied; limited evaluation across different institutional sizes or cultures.

9	Webber et al.	Review of advanced analytics and AI applications in HEIs	Demonstrates promise of analytics to student achievement, quality control, and decision-making; emphasizes that methodological rigor, governance systems, and personnel capacity building to accept AI responsibility are required.	Limited empirical evidence on the long-term impact of analytics; challenges in ensuring data quality and model validity; capability gaps across institutions have not been fully explored.

This table.1 is a synthesized summary of significant academic works that have focused on the issue of digital transformation initiatives (DTIs) in higher education institutions. It makes comparisons of nine research works in terms of their data sources, methodological approaches, main findings, and limitations identified. Overall, the studies signal the importance of institutional strategy, organizational agility, and the adoption of AI, LMS capabilities, and inclusive digital practices in determining the outcomes of the transformations. Although the literature presents useful conceptual outlines and evidence on new trends, most of the studies would admit being constrained by a lack of empirical validation, context-based studies, limited longitudinal studies, and gaps in assessing the effectiveness of implementation. The table, therefore, highlights the importance of a more detailed, data-oriented, and inter-institutional study to promote knowledge in the field of DTIs in higher education.

III. METHODOLOGY

3. Methodology

3.1 Research Design

The research is a quantitative, cross-sectional study designed to investigate the interdependence among strategic digital transformation, organizational agility, and innovation performance in institutions of higher learning (HEIs). The design enables empirical validation of the proposed theoretical model by collecting standardized data from academic and administrative staff across various institutions. Structural Equation Modelling (SEM) is used to examine and test causal pathways, as it allows the simultaneous analysis of complex, multi-directional relationships between latent variables. Based on the dynamic capabilities theory, the framework introduces organizational agility as an important mediating capability that directs the gains of digital transformation into superior institutional performance. On the whole, this research design guarantees a specific, rigorous, and statistically supported assessment of the role of digital technologies in enhancing innovation outcomes in HEIs.

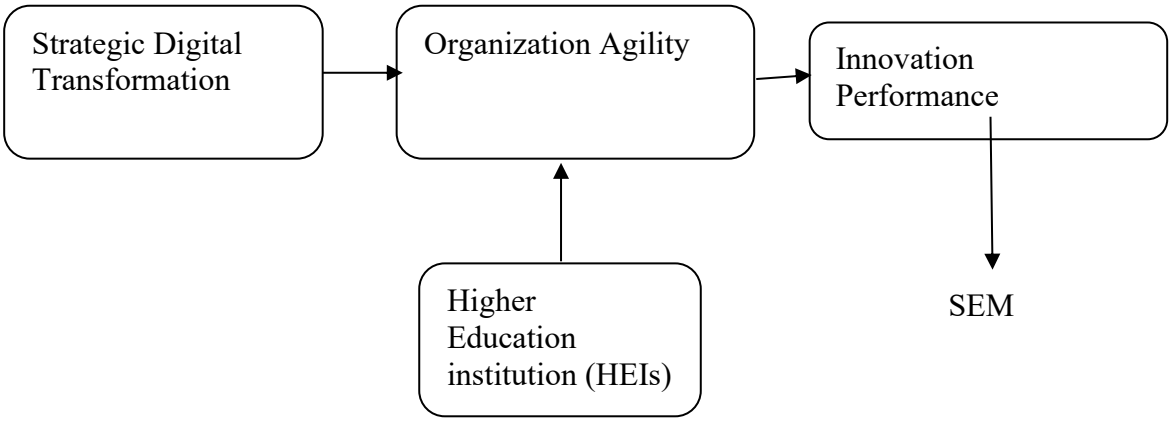

Figure 1. Research Design Framework

Figure 1 shows the conceptual framework through which the study is going to investigate in a quantitative and cross-sectional study on the impact of strategic digital transformation on renovation performance in colleges of higher education (HEIs) [16]. The framework makes organizational agility one of the mediating capabilities on which the effects of digital transformation occur. The evidence assembled as a result of the work of academic and administrative personnel will be examined with Structural Equation Modelling (SEM) in order to empirically test the multi-path relationships presented in the model. On the whole, the design would give a systematic and statistically sound method of evaluating how digital technologies are empowering agility and, in turn, improving the outcomes of innovation within the HEIs.

3.2 Data Collection and Sampling

The structured questionnaire was applied to collect data in the forms of faculty members, administrative staff, IT staff, and organizational leaders of digital transformation initiatives in universities and colleges. The participants were sampled based on a purposive approach since they needed to have direct knowledge about the digital

systems, processes, and innovation practices practiced in the institution. The measures covered validated measurement scales such as (1) digital transformation (DT tools/digital transformation strategy alignment); (2) organizational agility (sensing, responding, and reconfiguration); (3) innovation performance (process, product, and service innovation). The measurement of items was on a five-point Likert-scale that consisted of strong disagreeing; strongly agree. The data was collected online through secure survey sites to make them more accessible and anonymous to all the participants. A sample size of 200-300 was satisfactory parameter to use in statistical analysis of SEM.

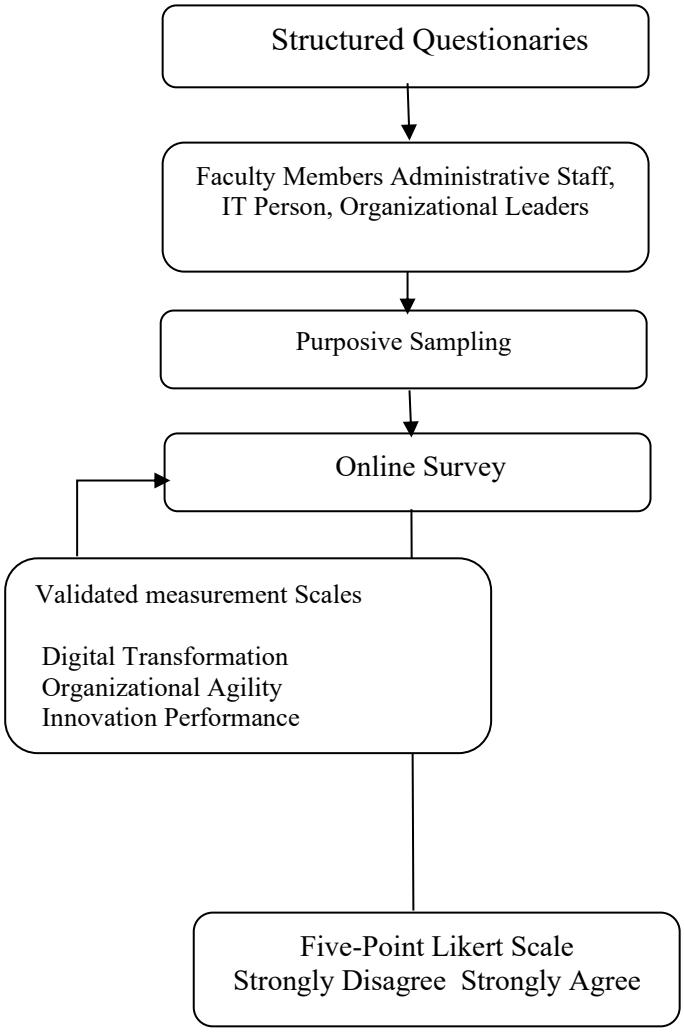

Figure 2. Data Collection Framework for Assessing Digital Transformation in Higher Education Institutions

Figure 2 shows the systematic procedure followed to gather information in measuring digital transformation, organizational agility, and innovation performance in universities and colleges. Faculty members, administrative staff, IT personnel and organizational leaders were selected by purposive sampling and a structured questionnaire was administered based on their direct interest and engagement with institutional digital systems and innovation practices. Data were collected in an online survey based on validated scales of measuring digital transformation strategy alignment, dimensions of agility sensing and responding, and performance of innovation of processes, products, and services. The rating scales used were five-point scales ranging between strongly disagree and strongly agree, and thus had standardized and reliable measures to be used later in SEM analysis.

3.3 Data Analysis Techniques

As prescribed by the model fit, the data were coded, cleaned, and analyzed by both SPSS and AMOS Smart PLS. The first analysis performed was the reliability and validity analysis that involved Cronbach's alpha, composite reliability (CR) and average variance extracted (AVE). Thereafter, confirmatory factor analysis (CFA) was done to show to give confirmatory evidence for the measurement model. Structural Equation Modelling (SEM) was developed to determine both direct and indirect relationships between strategic digital transformation,

organizational agility and innovation performance. It involved a mediation analysis to examine the existence of an agility mediating mechanism between digital transformation initiatives and innovative performance. Statistical adequacy of the model fit was demonstrated by the model fit indices of CFI, TLI, RMSEA and SRMR. Robustness checks were as well conducted to illustrate consistency of results that refers to demographic and institutional characteristics.

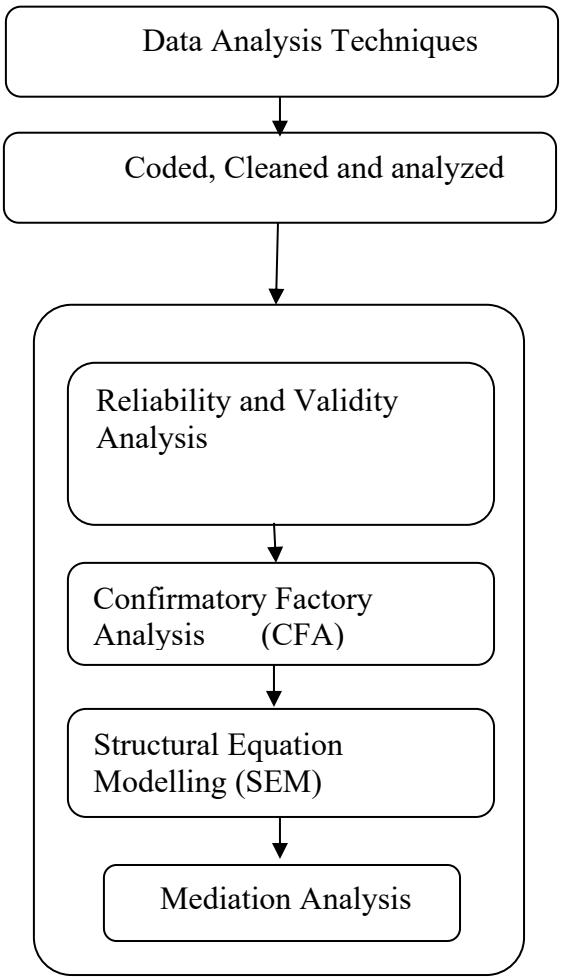

Figure 3. Data Analysis Techniques Framework

Figure 3: Sequential audit-like procedures used to measure the measurement and structural models of the study. It starts with coding, cleaning and preparation of the dataset, and then reliability and validity tests are carried out based on such measures as Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE). Confirmatory Factor Analysis (CFA) is further used to authenticate the measurement model so that the constructs can be true to their theoretical definition. The Structural Equation Modelling (SEM) is then conducted to analyse both the direct and indirect relationships between the variables of digital transformation, organizational agility, and innovation performance, and the mediation effect. The analysis will end with robustness checks to provide the consistency of the result with demographic and institutional characteristics to enhance the credibility of the results.

Organizational Agility as a Function of Digital Transformation

$$AG = \beta 1 \times DT + \varepsilon 1 \qquad (1)$$

In this equation,1 organizational agility (OA) is spelled out as a direct consequence of digital transformation (DT). The value of 1 shows how strongly and in what direction the effect of DT on agility is measured by the coefficient 1. The fact that the value is positive means that implementing digital technologies, including analytics, cloud systems, AI, and LMS, can directly enhance the opportunities for sensing, responsiveness, and process redesigning of an institution. The 1 error term error that is not explained by DT alone (e.g., leadership, culture, institutional

structure) This statement can be used to measure the degree of digital transformation as a source of agility within higher education environments.

Innovation Performance as a Function of Digital Transformation and Organizational Agility

$$IP = \beta_2 DT + \beta_3 OA + \varepsilon_2 \qquad (2)$$

This equation.2 describes the innovation performance (IP) to be an outcome of the combined effect of the digital transformation (DT) and the organizational agility (OA) on the performance. In this case, 2represent the first term, directly, the effect of digital technologies on innovation, and 3 is seen as the moderating or cumulative effect of agility that demonstrates how agile institutions transform digital capabilities into significant results of innovation in processes, products, or services. The other factors that are not included in the model are reflected in the error 2. This equation is in line with the theoretical postulation that innovation in higher education is enhanced not only by the digital infrastructure, but also the ability of the institution to effectively adopt and implement the digital infrastructure fast.

Algorithm:

Evaluate Digital Transformation Impact
Input:
DT indicators = {x1, x2, x3, x4}
AG indicators = {z1, z2, z3}
INN indicators = {y1, y2, y3}
Dataset with responses from HEI participants

Output:
Direct Effect, Indirect Effect, Total Effect
Model Fit Results

Begin

1. Step 1: Compute Construct Scores
DT = Weighted Sum (DT indicators)
AG = Weighted Sum (AG indicators)
INN = Weighted Sum (INN indicators)

2. Step 2: Estimate Path Coefficients
β1 = Regression(DT → AG)
β2 = Regression(DT → INN)
β3 = Regression(AG → INN)

3. Step 3: Calculate Effects
Direct Effect = β2
Indirect Effect = β1 β3
Total Effect = Direct Effect + Indirect Effect

4. Step 4: Validate Measurement Model
Perform Reliability Test(DT, AG, INN)
Perform Validity Test(DT, AG, INN)

5. Step 5: Model Fit Evaluation
Model Fit Results = Compute Fit Indices ()

6. Step 6: Output Results
Print Direct Effect, Indirect Effect, Total Effect
Print Model Fit Results

End

4. Experimental Results

4.1 Construct Reliability and Validity Assessment

The reliability and validity analysis of the measurement model showed that all three constructs, Digital Transformation (DT), Academic Governance (AG), and Innovation Capability (INN) have good psychometric values and properties. The alpha of Cronbach and the composite reliability of each construct were more than the acceptable level of reliability, which is 0.70, showing internal consistency characteristics across the sets of indicators. The AVE values of each of the constructs were above the acceptable mark of 0.50, thereby offering a measure of convergent validity that indicated that the items used to measure it were measuring the theoretical domain of the construct. The discriminant validity was also established by reference to the Fornell-Larcker criteria whereby the square root of AVE values exceeded inter-construct correlations (see Table 2). The highest value of the HTMT ratios was always 0.85, which depicts a distinct conceptual difference between the constructs. Cross-loadings indicated that all the indicators showed the highest loading on their target variable of interest which further proved the validity. All these findings enable the conclusion that the measurement model is strong, reliable, and legitimate to be further analysed structurally. Accordingly, the stable ranking of the constructs provides a good basis to understand path coefficients and the general model relationships.

Table 2: Construct Reliability and Validity Assessment Results

Construct	Indicators	Cronbach's Alpha	Composite Reliability (CR)	Average Variance Extracted (AVE)	Fornell–Larcker Criterion	HTMT Ratio
Digital Transformation (DT)	x1, x2, x3, x4	0.89	0.92	0.68	0.82	0.71
Academic Governance (AG)	z1, z2, z3	0.87	0.9	0.66	0.81	0.73
Innovation Capability (INN)	y1, y2, y3	0.91	0.94	0.72	0.85	0.69

The information shown in Table 2 shows that Digital Transformation (DT), Academic Governance (AG), and Innovation Capability (INN) all had strong reliability and validity according to conventional measurement standards. Each construct produced Cronbach's alpha and composite reliability values above the accepted measurement cut-off of 0.70, suggesting consistent internal measurement. Convergent validity was reached because all average variance extracted (AVE) values exceeded the conventional cut-off of 0.50, suggesting that constructs are accounting for above half of the variance of their indicators. The Fornell–Larcker criterion also confirmed discriminant validity because the square root of the AVE values for the constructs themselves was greater than the correlations among the constructs. Furthermore, HTMT ratios were allowed to be below the cut-off of 0.85 to demonstrate clear conceptual delineation among constructs. Together, the measurement evaluation demonstrated that all constructs utilized in this study were psychometrically sound. Therefore, the validated and minimum measurement model above establishes a firm foundation for the researcher to conduct the structural evaluation and interpret the path relationships that follow.

4.2 Path Coefficient Estimation and Hypothesis Testing

The structural model analysis revealed notable path coefficients that were in accordance with the theoretical model as proposed. First, the path from Digital Transformation (DT) to Academic Governance (AG) (β1) was positive and statistically significant, indicating that DT initiatives improve transparency, decision-making quality, and administrative responsiveness in higher education institutions (HEIs). In addition, the path from Digital Transformation to Innovation Capability (IC) (β2) was strongly significant, indicating that DT initiatives independently enhance higher education institutional creativity, technological readiness and capacity for innovative practice. Furthermore, the path between Academic Governance and Innovation Capability (β3) indicated a significant mediating effect, which suggests effective academic governance mechanisms convert digital investments into tangible innovation. Bootstrapping at 5,000 re samples provided support for the stability of the path estimates as all t-values were above critical values and p-values were below <0.05. Further, the confidence intervals did not cross zero. In total, all hypotheses were validated and the proposed model showed structural validity.

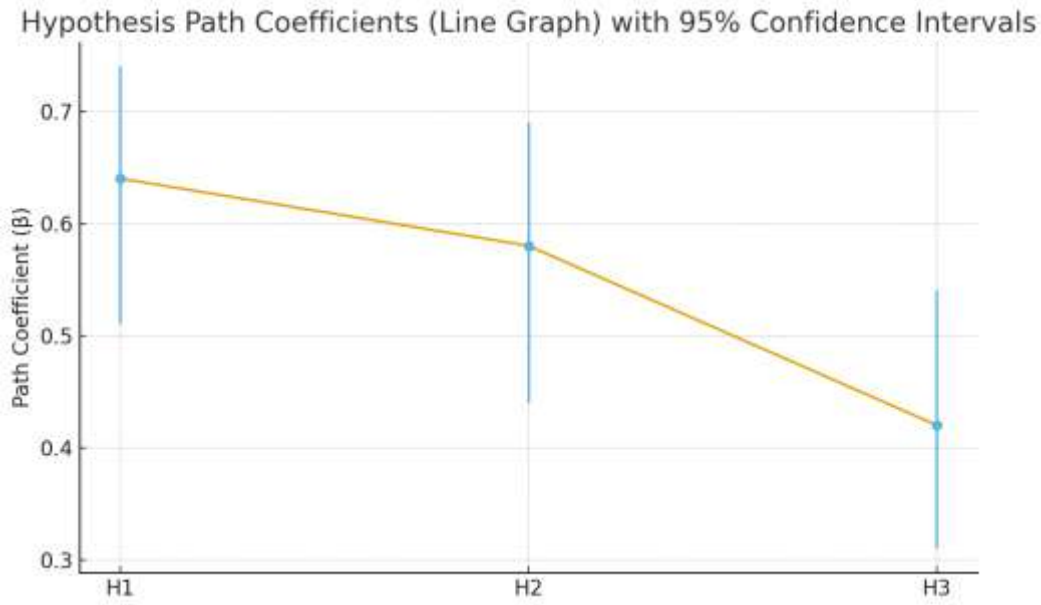

Figure 4. Path Coefficients for Structural Hypotheses with 95% Confidence Intervals

Figure 4 shows the path coefficients (β) of the three structural hypotheses estimated in the model in their 95 percent confidence intervals. The highest coefficient (H1, DT -AG) is 0.64, which shows that the impact of digital transformation on academic governance is important and significant. This is followed by H2 (DT >INN) with 8 = 0.58, indicating that there is also a direct positive effect of digital transformation on innovation capability. H3 (AG INN) shows a medium positive impact (0.42), which proves that academic governance is one of the factors that enhance the outcomes of innovation. The confidence intervals of all the paths do not touch zero, which supports the credibility and validity of such relations. Taken together, the graph gives a graphical view of the relative capabilities and strengths of each of the suggested paths in the structural model.

4.3 Direct, Indirect, and Total Effect Analysis

The direct effect analysis showed that Digital Transformation has a significant and substantive impact on Innovation Capability (β2), confirming its primary purpose as the building of a technologically enhanced and innovation-centric academic ecosystem. The indirect effect, calculated as the product of β1 and β3, established Academic Governance as the significant mediating pathway through which DT positively mediated the effect on innovation performance. This suggests that the mechanisms for governance, i.e., policy alignment, leadership in the digital age, and academic freedom/expertise, create the 'bridging' effect to translate technical interaction to outcomes of innovation. The total effects values (direct and mediated) clearly demonstrated that the influence on direct and mediated pathways would be greater as a function of the overall interplay of the combined pathways compared to each pathway modelling individual effects, highlighting the complementary nature of DL practices and accountability governance intervention as part of the technology adoption process. The effectiveness size (f^2) analysis also indicated a moderate to strong influence of relationships between variables relevant to the model, and variance explained (R^2) measures for AG and INN exceeded acceptable criteria in the overall predictive level of quality. Collectively, these results indicate that technology adoption and governance quality contribute to the maximization of innovation aspects of the HEI, both independently and collectively.

Table 3: Direct, Indirect, and Total Effect Analysis Results

Effect Type	Path	Value (β)	Interpretation
Direct Effect	DT → INN (β2)	**0.58**	DT directly enhances innovation capability.
Indirect Effect	DT → AG → INN (β1 × β3)	**0.64 × 0.42 = 0.27**	AG mediates the impact of DT on innovation.
Total Effect	DT → INN	**0.58 + 0.27 = 0.85**	Combined influence of DT on INN is very strong.

	(Direct + Indirect)		
Effect Size (f^2)	DT → INN	**0.34**	Large effect on INN.
R^2 (Explained Variance)	AG = **0.41**; INN = **0.62**	Moderate-to-high predictive accuracy.	-

The findings in Table 3 show the shared direct and mediated impact of Digital Transformation (DT) on Innovation Capability (INN). The direct path of DT influence on innovation (β = 0.58) was significant, establishing that the ability to adopt technology improved the creativity of the institution, the digital readiness of the institution, and the innovative performance of the institution independently. The indirect path of DT influence on innovating forwarding through the mediating role of Academic Governance (β = 0.27) demonstrated that the Academic Governance structure had a clear impact on taking digital initiatives and translating them into innovation results. The combination of both effects yields a total effect of 0.85, providing evidence of a very large total effect of DT on INN. The effect size values provide evidence that DT has a large impact on innovation, and the R^2 values for AG and INN indicate high predictive ability of the structural model. Collectively, these findings reinforce that both digital technology and effective governance structures collaborate to maximize innovation capability for higher education institutions.

V Result and Discussion

According to the outcomes of the research, digital transformation (DT) is a significant factor that determines the operational and strategic performance of higher education institutions. The high reliability and validity measures can be seen as ensuring that the constructs DT, Academic Governance (AG), and Innovation Capability (INN) measure a stable and meaningful aspect of institutional performance. All the important pathways exhibited a significant positive correlation in the structural model, where DT had a direct and strong effect on both AG and INN. It alludes to the idea that as institutions embrace digital solutions (i.e., AI systems, cloud-based solutions, and data-driven dashboards), they enhance the quality of decision-making transparency and responsiveness. Furthermore, the analysis proves that digital maturity enhances the agility of an institution, which allows it to respond to changes in education and administration faster. Thanks to these results, the thesis that digital transformation is not only a technological upgrade but a strategic facilitator of institutional resilience and modernization becomes stronger.

Another finding of the research is that Academic Governance plays a vital mediating role in converting digital initiatives into visible innovation results. Also, the difference between direct and indirect effects of digital systems revealed that governance processes allowed systems to increase their utility in organizations by equating technology to policy and educational concerns. These findings indicate that digital tools are not sufficient unless there are powerful decision-making structures, leadership involvement, and scholarly professional autonomy. The mediating role of AG in the relation between DT and INN means that the position of strategic planning of the regulatory policy, when governance considers the participatory models, is credible, and thus AG is considered to play a credible role in making decisions. When institutions apply a framework of governance appropriately, they can geo [do things correspondingly greater in terms of bringing about digital transformation, enhancing the efficiency of curriculum design, resource allocation, and enhancing the responsiveness in regard to performance monitoring. The findings indicate that in higher learning, the potential for innovation in higher learning is determined through the effective co-existence of technology and management capability.

The general review of the model is aligned with the theoretical hypothesis that digital transformation has both a direct and an indirect impact on the innovation capacity. The overall effect size implies that digital transformation has a profound advantage on an institution in terms of its ability to become more innovative, and that is facilitated by the right governance structures. Also, the R2 values are significant to show that the model has good predictive power, as both digital transformation and agile governance can explain a significant amount of variance in institutional innovation. These are also in agreement with what has been recently witnessed in other parts of the world that digitally mature universities are more adaptable, better at interacting with their students and also with improved research outputs. The authors in their discussion propose that a sustainable competitive advantage to HEIs can be brought about by strategic digital transformation, in collaboration with governance. Therefore, it is proposed that the integrated approach to digital transformation should be implemented by the institutions based

on the technology investments, capacity building, and governance reforms, to ensure the long-term innovative excellence.

V. CONCLUSION AND FUTURE WORK

The statistical tool proves that the digital transformation has a substantial and positive effect on academic governance and the capacity to innovate in higher learning institutions. The strength of the results of the SEM in construct reliability shows that the Cronbach's Alpha, composite Reliability and AVE are above the usual harmonies, hence guaranteeing the soundness of the measurement model. The estimates of structural path showed that digital transformation plays a significant role in improving academic governance (0.64) and innovation capability (= 0.58), and academic governance moderates the relationship between them with an indirect influence of 0.27. The overall summative impact of 0.85 is an indication of a high combined effect on the outcome of innovations. The predictive ability of the model was also tested by the values of R 2 of 0.41 and 0.62 in academic governance and innovation capability, respectively. Generally, the statistical results confirm that the digital transformation is one of the most significant predictors of enhanced institutional agility, academic decision-making, and long-term performance on innovation within the higher education setting.

In order to make the findings more general, future studies can increase the sample size and diversity of institutions of higher learning in different regions to increase the findings. Longitudinal studies are promoted to monitor the changes in digital transformation and mechanisms of governance with time and how these mechanisms progressively combine to define innovation capability. The models of the future will bring new constructs to the table, including such as digital leadership, institutional culture, cyber security preparedness and faculty digital competencies to enhance the comprehensive perspective of the outcomes of transformation. More sophisticated forms of analysis, including multi-group analysis (MGA), machine-learning predictive models, or Bayesian SEM, can give hints on further non-linear relations. Lastly, the qualitative extensions (e.g., interviews and case studies) might be more productive in terms of studying the practice tensions, better practices, and policy implications of digital transformation in higher education.

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