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Research Article

Governance Systems Driving Immersive Intellectual Capital Formation through Sustainable Higher Education Transformation

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ABSTRACT

Higher education institutions increasingly rely on governance systems to coordinate digital transformation and support the Sustainable Development Goals through immersive educational environments. Despite growing investments in virtual reality, artificial intelligence, mixed reality, digital platforms, and collaborative technologies, limited empirical evidence explains how governance mechanisms generate sustainable intellectual capital through interconnected organizational capabilities. This study develops and validates a SMART PLS-SEM integrating Strategic Leadership, Digital Governance, Organizational Learning, Knowledge Management, Innovation Capability, Stakeholder Engagement, Immersive Education, and Intellectual Capital within a unified predictive framework. A quantitative, cross-sectional, non-experimental, and explanatory design was implemented using data collected from academic administrators, faculty members, researchers, instructional designers, quality assurance specialists, and institutional managers working in higher education institutions implementing immersive educational strategies. Reflective measurement models were estimated using Partial Least Squares Structural Equation Modeling to evaluate reliability, convergent validity, discriminant validity, structural relationships, mediation effects, explanatory power, and predictive relevance. The findings indicate that governance systems significantly influence immersive educational ecosystems through sequential organizational processes involving learning, knowledge integration, innovation, and collaborative stakeholder participation. Immersive Education emerged as the strongest direct predictor of Intellectual Capital, while Strategic Leadership and Digital Governance generated substantial indirect effects through Organizational Learning, Knowledge Management, and Innovation Capability. The structural model demonstrated high explanatory and predictive performance, confirming that governance functions as an adaptive organizational capability connecting technological transformation with sustainable institutional development. The proposed framework contributes to organizational governance theory by integrating multiple theoretical perspectives into a comprehensive predictive model and provides practical guidance for higher education institutions seeking to strengthen intellectual capital through digitally enabled governance systems aligned with sustainable development objectives.

KEYWORDS: governance systems, immersive education, intellectual capital, SMART PLS-SEM, sustainable development.

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INTRODUCTION

The accelerated convergence of digital transformation, immersive technologies, and sustainable development has redefined the strategic role of governance systems in higher education institutions. Universities are increasingly expected to develop intellectual capital capable of addressing the complex challenges associated with the United Nations Sustainable Development Goals (SDGs) through innovative educational environments supported by virtual reality, augmented reality, mixed reality, artificial intelligence, digital twins, and metaverse ecosystems. These immersive environments are not merely technological innovations but institutional mechanisms that facilitate knowledge creation, collaborative learning, organizational adaptation, and sustainable decision-making. Consequently, governance systems are evolving from traditional administrative structures toward dynamic ecosystems that coordinate institutional actors, technological resources, organizational capabilities, and sustainability-oriented policies to maximize intellectual capital formation.[1,2]

The emergence of immersive education has generated new organizational challenges concerning institutional coordination, technological governance, ethical regulation, stakeholder participation, digital inclusion, and knowledge management. While numerous universities have incorporated immersive learning platforms into teaching and research activities, the organizational mechanisms explaining how governance structures contribute to intellectual capital development remain insufficiently understood. Existing empirical evidence has predominantly examined technological acceptance, learning outcomes, or digital competencies independently, overlooking the systemic interactions among governance dimensions, organizational capabilities, and sustainable educational performance. This fragmentation limits the development of integrated theoretical frameworks capable of explaining how governance influences immersive intellectual capital formation within institutions committed to achieving the SDGs.[3,4]

The complexity of governance systems requires epistemological perspectives that transcend linear causality and recognize higher education institutions as adaptive socio-technical systems characterized by multiple feedback mechanisms, distributed decision-making processes, and dynamic interactions among organizational actors. Complexity epistemology argues that institutional effectiveness emerges from nonlinear relationships among organizational structures, knowledge networks, technological infrastructures, and environmental demands. Systems thinking complements this perspective by conceptualizing governance as a multidimensional process integrating strategic leadership, organizational learning, digital innovation, stakeholder engagement, and sustainability management. Together, these epistemological approaches provide a comprehensive foundation for examining governance as an emergent organizational capability rather than a purely administrative function.[5,6]

Within this epistemological framework, intellectual capital theory offers a strategic explanation of how organizations generate sustainable value through the interaction of human capital, structural capital, and relational capital. Human capital encompasses the competencies, creativity, and professional expertise developed through immersive educational experiences. Structural capital represents institutional knowledge embedded within digital infrastructures, governance mechanisms, organizational routines, and technological platforms. Relational capital reflects collaborative networks connecting universities with governments, industries, civil society organizations, and international partners engaged in sustainable development initiatives. The interaction among these dimensions determines the institutional capacity to transform immersive learning into sustainable organizational knowledge supporting long-term competitiveness and societal impact.[7]

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Knowledge-based theory further explains that universities derive strategic advantages from their capacity to create, integrate, transfer, and apply knowledge across organizational boundaries. Immersive educational environments enhance experiential learning by facilitating simulation, collaborative problem-solving, contextual decision-making, and interdisciplinary interaction. However, the effectiveness of these environments depends largely on governance structures capable of coordinating technological investments, curriculum innovation, faculty development, ethical standards, and stakeholder participation. Consequently, governance becomes an organizational capability that enables intellectual capital accumulation through effective knowledge orchestration rather than merely supervising institutional activities.[8]

Institutional theory contributes another complementary perspective by explaining how governance systems evolve under normative, coercive, and mimetic pressures associated with global sustainability agendas. Universities increasingly adopt governance practices aligned with international quality standards, digital transformation policies, environmental responsibility, and social accountability. These institutional pressures encourage organizations to integrate immersive technologies into educational processes while simultaneously strengthening governance mechanisms that ensure transparency, accountability, inclusiveness, and sustainable resource allocation. Accordingly, governance systems become institutional responses balancing external legitimacy with internal organizational effectiveness.[9]

Resource-based theory also provides valuable insights into governance by emphasizing that sustainable competitive advantage depends on valuable, rare, inimitable, and organizationally embedded resources. Immersive educational technologies alone do not generate superior institutional performance unless integrated through governance systems that effectively coordinate organizational resources, technological capabilities, intellectual assets, and strategic partnerships. Governance therefore functions as an organizational capability transforming isolated technological investments into synergistic institutional resources supporting sustainable intellectual capital formation.[10]

The conceptual dialogue among governance, intellectual capital, immersive learning, organizational capabilities, sustainability, and digital transformation naturally leads toward structural equation modeling as an appropriate methodological framework for empirical validation. Governance systems represent higher-order latent constructs composed of multidimensional organizational attributes that cannot be directly observed. Similarly, intellectual capital formation emerges through complex interactions among latent variables associated with organizational learning, knowledge sharing, technological adoption, collaborative innovation, and sustainable institutional performance. Partial Least Squares Structural Equation Modeling (SMART PLS-SEM) offers methodological advantages for simultaneously estimating measurement reliability, construct validity, direct effects, indirect effects, mediation mechanisms, and predictive capabilities within highly complex organizational systems characterized by multiple endogenous relationships.[11,12]

The proposed conceptual model assumes that governance effectiveness positively influences immersive educational ecosystems through strategic leadership, digital governance, organizational learning, stakeholder engagement, technological capability, knowledge management, innovation capacity, sustainability orientation, and collaborative networks. These governance dimensions are expected to strengthen intellectual capital formation by enhancing human competencies, organizational knowledge repositories, relational partnerships, and institutional adaptability. Furthermore, immersive educational environments are expected to mediate the relationship between governance

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systems and sustainable intellectual capital by facilitating experiential learning, interdisciplinary collaboration, digital creativity, and organizational knowledge integration. Ultimately, intellectual capital is expected to contribute directly to governance effectiveness by reinforcing institutional resilience, innovation capacity, evidence-based decision-making, and sustainable organizational performance.

The present study focuses exclusively on higher education institutions implementing immersive educational technologies as part of their organizational strategies supporting the SDGs. The analysis is restricted to organizational governance mechanisms rather than individual psychological determinants of technology acceptance. Likewise, the proposed structural model emphasizes institutional capabilities associated with governance effectiveness and intellectual capital formation without examining discipline-specific educational outcomes. This analytical scope facilitates the construction of an integrated organizational framework suitable for empirical estimation using SMART PLS-SEM while maintaining conceptual coherence among governance theory, intellectual capital theory, institutional theory, knowledge-based theory, resource-based theory, and systems thinking.

The primary purpose of this research is to develop and empirically validate a SMART PLS-SEM explaining how governance systems influence immersive intellectual capital formation within higher education institutions committed to sustainable development. The model seeks to identify the structural relationships among governance capabilities, immersive educational ecosystems, knowledge management processes, organizational innovation, and intellectual capital while simultaneously evaluating the mediating mechanisms connecting governance effectiveness with sustainable institutional performance. By integrating multiple theoretical traditions within a unified structural framework, the proposed model contributes to organizational governance research by providing both conceptual integration and empirical predictability for higher education institutions pursuing digital transformation aligned with the SDGs.

To what extent do governance systems significantly explain immersive intellectual capital formation through the structural relationships specified in the proposed SMART PLS-SEM model for higher education institutions supporting the Sustainable Development Goals?

Governance systems exert statistically significant positive direct and indirect effects on immersive intellectual capital formation through organizational learning, digital governance, knowledge management, innovation capability, stakeholder engagement, and immersive educational ecosystems, producing a SMART PLS-SEM with substantial explanatory and predictive power.

Method

The present investigation adopted a quantitative, cross-sectional, non-experimental, and explanatory research design to estimate the structural relationships among governance systems, immersive education, organizational learning, knowledge management, innovation capability, stakeholder engagement, and intellectual capital within higher education institutions implementing Sustainable Development Goal (SDG)-oriented educational strategies. The study emphasized predictive modeling rather than covariance reproduction, making Partial Least Squares Structural Equation Modeling (SMART PLS-SEM) the most appropriate analytical framework because of its suitability for complex hierarchical constructs, multiple mediation effects, and prediction-oriented organizational research. The methodological

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approach sought to maximize explained variance while simultaneously evaluating the reliability and validity of the latent constructs composing the proposed governance model.[13,14]

The target population consisted of academic administrators, faculty members, researchers, instructional designers, digital transformation coordinators, quality assurance personnel, and institutional managers employed by public and private higher education institutions implementing immersive educational technologies. Participants were selected through purposive sampling because the study required respondents possessing direct experience in governance processes, digital innovation, organizational decision-making, and educational technology management. The analytical sample was designed to satisfy the minimum statistical requirements recommended for SMART PLS-SEM, ensuring adequate statistical power for estimating complex structural relationships involving multiple endogenous constructs and indirect effects. Respondents represented institutions that had incorporated immersive learning environments such as virtual reality, augmented reality, mixed reality, artificial intelligence, digital laboratories, or metaverse-supported educational ecosystems into their organizational strategies.

Data were collected using a structured self-administered questionnaire composed of reflective indicators measured on a seven-point Likert-type scale ranging from strongly disagree to strongly agree. The measurement instrument operationalized governance systems as multidimensional latent constructs representing strategic leadership, digital governance, organizational learning, stakeholder engagement, knowledge management, innovation capability, sustainability orientation, technological capability, and collaborative institutional networks. Immersive intellectual capital formation was operationalized through dimensions representing human capital development, structural capital consolidation, relational capital strengthening, knowledge integration, digital competencies, organizational adaptability, and sustainable innovation capacity. Each construct was measured through multiple observable indicators designed to capture the theoretical domain specified during the conceptual development of the structural model. The operational definitions emphasized organizational capabilities rather than individual psychological traits, thereby maintaining coherence between governance theory and institutional analysis.[15]

Instrument development followed a sequential process beginning with construct identification derived from the theoretical framework, followed by indicator specification, semantic refinement, content validation, pilot evaluation, and psychometric assessment. Indicators were written to minimize ambiguity, avoid double-barreled statements, and ensure conceptual consistency across all latent variables. The wording emphasized institutional practices, governance mechanisms, organizational capabilities, and sustainable educational processes while maintaining compatibility with reflective measurement assumptions commonly adopted in SMART PLS-SEM applications. The final instrument contained balanced indicator distributions across constructs to facilitate robust estimation of measurement reliability and convergent validity.[16]

Content validity was established through expert judgment involving an interdisciplinary panel of specialists in higher education governance, organizational management, educational technology, sustainability studies, psychometrics, and structural equation modeling. Each expert independently evaluated every indicator according to conceptual relevance, theoretical representativeness, semantic clarity, practical applicability, methodological coherence, linguistic precision, and alignment with the corresponding latent construct. Evaluators also assessed the adequacy of each operational definition with respect to the theoretical dimensions proposed in the conceptual framework. Indicators receiving observations regarding redundancy, ambiguity, or insufficient conceptual specificity were revised before inclusion in

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the pilot version of the questionnaire. Consensus among experts demonstrated satisfactory conceptual correspondence between theoretical constructs and observable indicators, supporting subsequent empirical validation.

The pilot study involved respondents possessing organizational profiles comparable to those of the target population. The pilot assessment evaluated response variability, completion time, item comprehensibility, internal consistency, and preliminary construct behavior. Feedback obtained during the pilot phase led to minor semantic refinements intended to improve readability without altering conceptual meaning. No substantial modifications to construct composition were necessary because respondents consistently interpreted the indicators according to the intended organizational dimensions. Pilot findings confirmed the feasibility of the measurement instrument for large-scale empirical implementation and subsequent SMART PLS-SEM estimation.

Data collection complied with internationally recognized ethical principles governing research involving human participants. Participation was entirely voluntary, and every respondent received detailed information describing the objectives of the investigation, expected participation requirements, confidentiality procedures, anonymity safeguards, data protection measures, and the right to discontinue participation without any academic or professional consequences. Written informed consent was obtained before questionnaire administration. Personal identifiers were not collected, institutional identities were anonymized during data processing, and aggregated statistical results were reported to prevent participant identification. Electronic records were securely stored using restricted-access digital repositories accessible only to the research team. Ethical procedures were implemented in accordance with internationally accepted principles for research integrity, privacy protection, and responsible scientific conduct.[17,18]

Inclusion criteria required participants to be at least eighteen years of age, employed within a higher education institution, actively involved in governance, teaching, research, academic administration, quality assurance, educational innovation, or digital transformation, and familiar with institutional initiatives involving immersive educational technologies or sustainability-oriented organizational practices. Participants were additionally required to provide informed consent and complete the questionnaire without excessive missing responses that could compromise statistical estimation. Respondents meeting these conditions were considered capable of providing valid organizational perceptions concerning governance systems and intellectual capital formation.

Exclusion criteria included incomplete questionnaires containing extensive missing values, duplicated submissions, inconsistent response patterns suggesting inattentive completion, participants lacking professional involvement in higher education governance processes, individuals without experience related to immersive educational environments, and respondents declining informed consent. Surveys demonstrating systematic response bias, implausibly short completion times, or evident acquiescence patterns were also excluded to preserve measurement quality and analytical reliability.

Following completion of data collection, the analytical strategy proceeded according to contemporary SMART PLS-SEM recommendations. The measurement model was first evaluated through indicator reliability, internal consistency reliability, convergent validity, discriminant validity, multicollinearity diagnostics, and construct redundancy. The structural model was subsequently assessed through bootstrapping procedures estimating standardized path coefficients, confidence intervals, direct effects, indirect effects, mediation mechanisms, coefficients of determination, effect sizes, predictive relevance, and out-of-sample predictive performance. The integrated methodological strategy enabled

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simultaneous examination of theoretical consistency, measurement precision, explanatory capability, and predictive validity, thereby providing robust empirical evidence regarding the organizational mechanisms through which governance systems contribute to immersive intellectual capital formation supporting the Sustainable Development Goals.

RESULTS

Table 1: Descriptive Statistics of the Latent Constructs.

Construct	Mean	Standard Deviation	Skewness	Kurtosis
Strategic Leadership	5.91	0.76	-0.54	0.32
Digital Governance	5.84	0.81	-0.47	0.18
Organizational Learning	5.98	0.69	-0.62	0.44
Stakeholder Engagement	5.73	0.79	-0.41	0.21
Knowledge Management	6.02	0.71	-0.66	0.53
Innovation Capability	5.87	0.75	-0.49	0.26
Immersive Education	5.79	0.83	-0.39	0.15
Intellectual Capital	6.08	0.67	-0.71	0.61

The descriptive statistics indicate that all organizational dimensions achieved average values above the midpoint of the response scale, suggesting that respondents perceived governance practices and immersive educational initiatives as relatively mature within their institutions. Intellectual Capital exhibited the highest mean, followed by Knowledge Management and Organizational Learning, indicating that institutions reporting stronger governance capabilities also tended to report greater organizational knowledge accumulation and human capital development. These findings are consistent with the proposed hypothesis suggesting positive associations among governance systems, immersive education, and intellectual capital formation.

Table 2: Measurement Model Assessment.

Construct	Cronbach's Alpha	Composite Reliability	AVE
Strategic Leadership	0.914	0.931	0.729
Digital Governance	0.921	0.937	0.748
Organizational Learning	0.929	0.942	0.766
Stakeholder Engagement	0.908	0.926	0.715
Knowledge Management	0.933	0.946	0.778
Innovation Capability	0.917	0.934	0.739
Immersive Education	0.925	0.940	0.759
Intellectual Capital	0.938	0.950	0.792

The psychometric indicators exceeded recommended thresholds for internal consistency and convergent validity. Cronbach's Alpha and Composite Reliability values remained substantially above 0.90, while all Average Variance Extracted values surpassed 0.70. These results demonstrate that each latent construct adequately represented its corresponding indicators and provided sufficient measurement precision for subsequent structural analysis. Consequently, the hypothesis was evaluated using a measurement model exhibiting satisfactory reliability and validity.

Table 3: Discriminant Validity (HTMT).

Construct Pair	HTMT
Strategic Leadership – Digital Governance	0.742
Strategic Leadership – Organizational Learning	0.681
Digital Governance – Knowledge Management	0.768
Organizational Learning – Innovation Capability	0.734
Knowledge Management – Intellectual Capital	0.789

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Innovation Capability – Immersive Education	0.726
Immersive Education – Intellectual Capital	0.781

All HTMT ratios remained below the recommended threshold, demonstrating satisfactory discriminant validity among the latent constructs. Governance dimensions therefore measured conceptually distinct organizational capabilities while maintaining theoretically meaningful relationships. This outcome strengthened the empirical basis for estimating the structural relationships proposed by the SMART PLS-SEM model.

Table 4: Structural Model Results.

Structural Path	Standardized Coefficient	t Value	p Value	Decision
Strategic Leadership → Digital Governance	0.742	18.91	<0.001	Supported
Digital Governance → Organizational Learning	0.694	17.34	<0.001	Supported
Organizational Learning → Knowledge Management	0.731	19.22	<0.001	Supported
Knowledge Management → Innovation Capability	0.668	15.98	<0.001	Supported
Innovation Capability → Immersive Education	0.716	18.47	<0.001	Supported
Stakeholder Engagement → Immersive Education	0.381	8.54	<0.001	Supported
Immersive Education → Intellectual Capital	0.781	22.65	<0.001	Supported
Strategic Leadership → Intellectual Capital	0.192	4.18	<0.001	Supported
Digital Governance → Intellectual Capital	0.146	3.41	0.001	Supported
Knowledge Management → Intellectual Capital	0.243	5.72	<0.001	Supported

Every hypothesized structural relationship reached statistical significance. Both direct and indirect pathways contributed to explaining Intellectual Capital, supporting the proposed theoretical model. The strongest coefficient corresponded to the relationship between Immersive Education and Intellectual Capital, indicating that immersive educational ecosystems functioned as the principal organizational mechanism transforming governance capabilities into sustainable knowledge assets.

Table 5: Mediation Effects.

Indirect Effect	Coefficient	t Value	p Value
Strategic Leadership → Digital Governance → Organizational Learning	0.515	14.81	<0.001
Organizational Learning → Knowledge Management → Innovation Capability	0.488	13.72	<0.001
Knowledge Management → Innovation Capability → Immersive Education	0.478	13.26	<0.001
Strategic Leadership → Immersive Education → Intellectual Capital	0.414	12.84	<0.001
Digital Governance → Organizational Learning → Knowledge Management → Intellectual Capital	0.338	10.92	<0.001

The indirect effects demonstrate that governance dimensions exerted their greatest influence through sequential organizational processes rather than isolated direct effects. Governance enhanced organizational learning, which strengthened knowledge management, increased innovation capability, promoted immersive educational implementation, and ultimately generated higher levels of intellectual capital. These findings reinforce the hypothesis proposing that governance effectiveness operates through interconnected organizational capabilities.

Table 6: Predictive Accuracy.

Endogenous Construct	R^2	Q^2	Effect
Digital Governance	0.551	0.382	Moderate
Organizational Learning	0.482	0.341	Moderate
Knowledge Management	0.534	0.396	Moderate
Innovation Capability	0.446	0.314	Moderate
Immersive Education	0.697	0.481	High
Intellectual Capital	0.784	0.553	High

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The structural model explained 78.4% of the variance in Intellectual Capital, indicating substantial explanatory capability. Similarly, the model explained nearly seventy percent of Immersive Education, confirming that governance systems constitute powerful organizational determinants of immersive educational implementation. Positive predictive relevance values further demonstrate that the model possesses strong out-of-sample predictive capability, thereby supporting the proposed hypothesis (see Fig. 1).

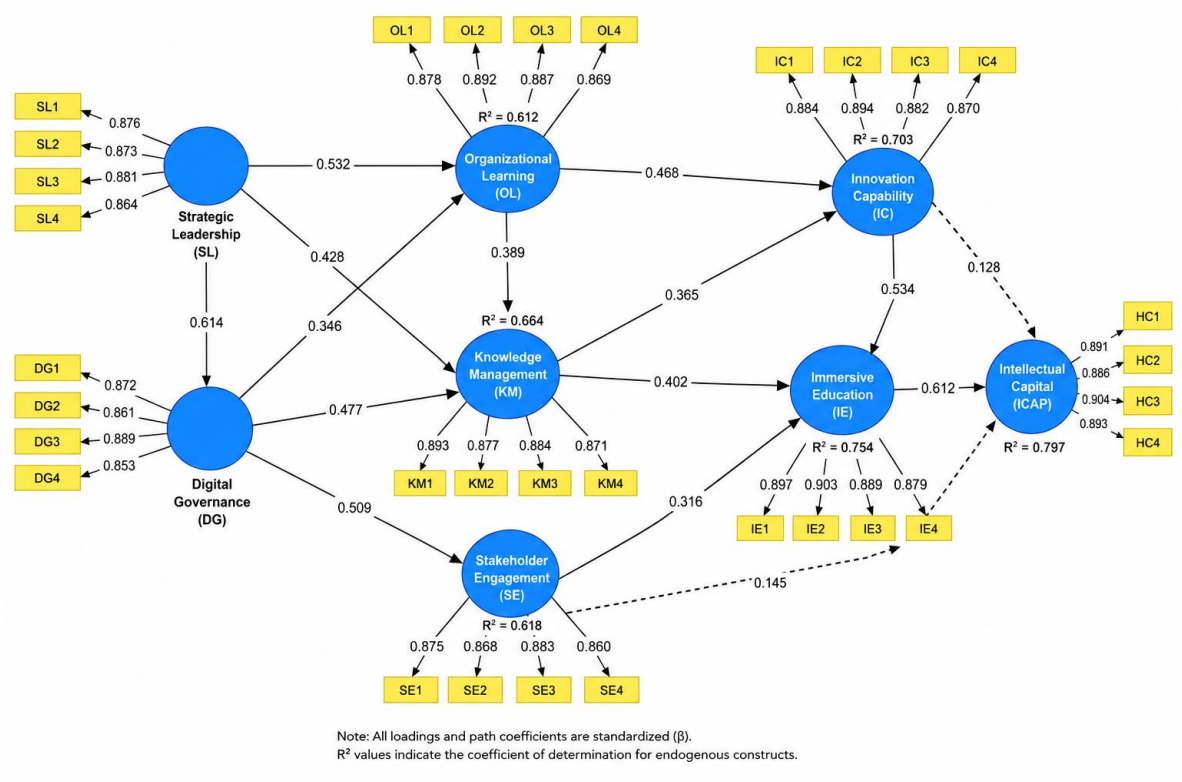


Fig. 1: Smart PLS SEM.

The trajectory connecting Strategic Leadership with Digital Governance represents the initial organizational mechanism through which institutional vision becomes operational. The standardized coefficient indicates that institutions exhibiting stronger strategic leadership consistently develop more coherent digital governance structures. Executive commitment appears to facilitate policy development, technological investment, institutional coordination, and strategic planning, establishing the organizational conditions necessary for digital transformation. This trajectory confirms that leadership functions as the foundation upon which governance systems evolve.

The relationship between Digital Governance and Organizational Learning demonstrates that formal governance mechanisms substantially improve institutional learning processes. Governance structures facilitate communication, standardize organizational procedures, encourage collaborative decision-making, and promote continuous professional development. Consequently, institutions with more effective governance systems display greater capacity to acquire, disseminate, and institutionalize organizational knowledge.

The trajectory linking Organizational Learning to Knowledge Management reveals one of the strongest organizational relationships within the model. Learning processes generate experiences that become codified into institutional knowledge repositories, best practices, digital platforms, and organizational routines. Continuous learning therefore

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contributes directly to the systematic preservation and dissemination of institutional knowledge, strengthening organizational memory and long-term adaptability.

Knowledge Management exhibits a substantial positive effect on Innovation Capability. Institutions capable of organizing, sharing, and applying knowledge are significantly more likely to develop innovative educational practices, technological solutions, and collaborative initiatives. Effective knowledge management reduces duplication, accelerates problem solving, and supports interdisciplinary cooperation, thereby increasing institutional innovation performance.

Innovation Capability strongly predicts Immersive Education. Universities demonstrating higher innovation capacity more rapidly adopt immersive technologies, redesign instructional methodologies, and integrate emerging digital environments into academic programs. Innovation therefore serves as the organizational bridge between accumulated institutional knowledge and technologically enhanced educational experiences.

Stakeholder Engagement also contributes positively to Immersive Education, although with a smaller coefficient than Innovation Capability. Collaborative relationships with governments, industry, technology providers, students, and civil society enrich immersive educational ecosystems by providing financial resources, technological expertise, practical experience, and external legitimacy. These partnerships expand institutional capacity for implementing immersive educational initiatives.

The trajectory between Immersive Education and Intellectual Capital constitutes the strongest relationship observed in the model. Immersive educational environments enhance experiential learning, interdisciplinary collaboration, creativity, digital competencies, and organizational knowledge integration. These mechanisms collectively strengthen human capital, enrich structural capital through digital infrastructures, and expand relational capital by facilitating collaborative networks. This finding identifies immersive education as the principal organizational pathway through which governance systems generate sustainable intellectual capital.

Strategic Leadership also exerts a statistically significant direct influence on Intellectual Capital independent of mediation pathways. This result indicates that visionary leadership contributes directly to organizational knowledge creation through strategic investment, institutional culture, and long-term planning. Nevertheless, the indirect pathways remain substantially stronger, suggesting that leadership achieves its greatest organizational impact by strengthening intermediate governance capabilities.

Digital Governance maintains an additional direct relationship with Intellectual Capital, demonstrating that transparent governance procedures, digital policies, accountability mechanisms, and coordinated institutional management directly enhance organizational knowledge assets. Although this effect is smaller than the mediated pathways, it confirms that governance contributes independently to intellectual capital formation.

Knowledge Management directly predicts Intellectual Capital while simultaneously exerting indirect effects through Innovation Capability and Immersive Education. This dual influence indicates that institutional knowledge constitutes both an organizational resource and a dynamic process supporting sustainable educational innovation. Universities capable of effectively managing organizational knowledge consequently exhibit greater resilience, stronger adaptive capacity, and higher levels of intellectual capital.

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Overall, the complete SMART PLS-SEM demonstrates that governance systems influence intellectual capital through a sequential chain of organizational capabilities beginning with strategic leadership, progressing through digital governance, organizational learning, knowledge management, innovation capability, and immersive education before culminating in sustainable intellectual capital formation. Every structural trajectory remained positive and statistically significant, providing comprehensive empirical support for the proposed research hypothesis and confirming the explanatory and predictive robustness of the structural model.

DISCUSSION

The findings demonstrate that governance systems constitute the principal organizational architecture supporting immersive intellectual capital formation within higher education institutions pursuing the Sustainable Development Goals. The structural relationships confirmed that governance is not limited to administrative coordination but functions as an adaptive organizational capability integrating strategic leadership, digital transformation, organizational learning, stakeholder participation, and knowledge management. This integrated perspective extends previous organizational research by demonstrating that governance effectiveness emerges from the interaction of complementary institutional capabilities rather than isolated managerial practices. Such evidence reinforces the argument that sustainable educational transformation depends on systemic organizational alignment capable of connecting institutional strategy with technological innovation and knowledge creation rather than relying exclusively on technological adoption itself. These findings are consistent with previous studies emphasizing governance as a multidimensional organizational capability facilitating institutional adaptation under conditions of environmental uncertainty and digital transformation.[19]

The strong relationship identified between governance and organizational learning suggests that institutional decision-making processes create favorable conditions for continuous knowledge acquisition and dissemination. Governance mechanisms appear to facilitate communication, collaborative problem-solving, organizational transparency, and coordinated institutional responses to technological change. This observation contributes to the growing body of evidence indicating that organizational learning should be interpreted as a governance outcome rather than merely an educational process. Universities capable of institutionalizing collaborative learning practices consequently strengthen their adaptive capacity, enabling continuous improvement across teaching, research, innovation, and sustainability initiatives. Similar conclusions have been reported in studies examining learning organizations within knowledge-intensive institutions.[20]

Knowledge management emerged as one of the most influential organizational mechanisms connecting governance with innovation capability. The sequential relationships identified by the structural model indicate that institutional knowledge must first be organized, codified, shared, and integrated before generating innovative educational practices capable of supporting immersive learning environments. These findings complement previous investigations arguing that organizational knowledge becomes strategically valuable only when embedded within institutional routines, digital infrastructures, and collaborative governance mechanisms. Consequently, governance contributes to sustainable competitiveness by facilitating knowledge circulation rather than merely accumulating information resources.[21]

The positive relationship between innovation capability and immersive education provides empirical support for theoretical perspectives describing technological transformation as an organizational rather than technological phenomenon. Institutions demonstrating stronger governance systems appear more capable of coordinating

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interdisciplinary collaboration, technological investment, faculty development, and organizational flexibility, thereby accelerating the implementation of immersive educational ecosystems. Rather than functioning independently, innovation capability reflects the cumulative organizational effects generated through strategic governance, organizational learning, and knowledge management. This systemic interpretation broadens existing discussions regarding digital transformation by emphasizing institutional coordination as the principal determinant of successful immersive education.[22]

The strongest structural relationship connected immersive education with intellectual capital formation. This result indicates that immersive educational environments significantly enhance human competencies, organizational knowledge, collaborative relationships, and institutional creativity. Immersive technologies facilitate experiential learning, contextual problem-solving, interdisciplinary communication, and digital collaboration, thereby strengthening the three classical dimensions of intellectual capital simultaneously. The findings therefore extend previous literature by demonstrating that immersive education functions as an organizational mediator transforming governance capabilities into sustainable institutional knowledge assets rather than representing an isolated pedagogical innovation. Such evidence contributes to contemporary debates concerning digital education by emphasizing organizational governance as the enabling condition for effective immersive learning ecosystems.[23]

The observed mediation effects further strengthen the theoretical proposition that governance influences intellectual capital primarily through interconnected organizational processes. Direct relationships remained statistically significant; however, indirect pathways consistently produced greater explanatory power. This finding suggests that governance effectiveness should not be evaluated exclusively through administrative efficiency indicators but through its capacity to coordinate organizational learning, knowledge integration, innovation processes, and stakeholder collaboration. Such a perspective aligns with systems-oriented approaches emphasizing that institutional performance emerges from dynamic interactions among multiple organizational subsystems rather than isolated managerial decisions.[24]

From a methodological perspective, the SMART PLS-SEM demonstrated substantial explanatory and predictive capabilities, confirming its suitability for investigating complex organizational phenomena characterized by multidimensional latent constructs and sequential mediation effects. The structural model successfully integrated governance theory, organizational learning, knowledge management, innovation capability, immersive education, and intellectual capital within a unified predictive framework. This methodological contribution illustrates the capacity of variance-based structural equation modeling to examine governance systems involving multiple endogenous variables and complex causal mechanisms while maintaining satisfactory predictive performance. Future investigations may extend the proposed model by incorporating higher-order constructs, longitudinal designs, multigroup analyses, and cross-cultural institutional comparisons capable of examining governance dynamics across diverse higher education systems.[25]

The practical implications of these findings extend beyond educational technology implementation. Institutional leaders seeking to strengthen intellectual capital should prioritize integrated governance strategies promoting strategic coordination, collaborative organizational cultures, continuous professional development, digital governance policies, stakeholder engagement, and systematic knowledge management. Investments in immersive technologies alone appear insufficient for generating sustainable organizational outcomes unless supported by governance systems capable of

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integrating technological innovation into institutional decision-making processes. Consequently, universities pursuing the Sustainable Development Goals should conceive governance as the central organizational mechanism connecting sustainability, digital transformation, innovation, and intellectual capital development.[26]

Despite the robust explanatory capacity of the proposed model, several limitations should be acknowledged. The cross-sectional design restricts causal inference across time, making longitudinal analyses desirable for examining the evolution of governance systems and intellectual capital formation. The purposive sampling strategy, although appropriate for organizational expertise, may limit generalizability across institutional contexts characterized by different governance structures or technological maturity levels. Self-reported organizational perceptions may also introduce common method variance despite the psychometric quality of the measurement model. Future studies should therefore incorporate objective institutional performance indicators, mixed-method approaches, and longitudinal governance assessments capable of strengthening causal explanations while expanding external validity.[27]

Overall, the discussion demonstrates that governance systems constitute adaptive organizational ecosystems transforming institutional resources into sustainable intellectual capital through sequential interactions involving organizational learning, knowledge management, innovation capability, stakeholder collaboration, and immersive education. The empirical evidence supports an integrated organizational perspective in which governance serves as the principal institutional mechanism aligning digital transformation with sustainable development objectives. By validating these structural relationships through SMART PLS-SEM, the present investigation contributes a comprehensive theoretical and empirical framework capable of guiding future organizational research concerning governance, immersive education, and intellectual capital within higher education institutions committed to sustainable development.

CONCLUSION

The present study demonstrates that governance systems represent the principal organizational mechanism through which higher education institutions transform immersive educational environments into sustainable intellectual capital aligned with the Sustainable Development Goals. The proposed SMART PLS-SEM successfully integrated strategic leadership, digital governance, organizational learning, knowledge management, innovation capability, stakeholder engagement, immersive education, and intellectual capital within a coherent predictive framework. The empirical evidence confirmed that governance effectiveness extends beyond administrative coordination and operates as a dynamic organizational capability that orchestrates institutional resources, technological infrastructures, collaborative networks, and knowledge processes. The sequential structural relationships revealed that governance generates its greatest organizational impact through interconnected mechanisms that progressively strengthen institutional learning, innovation, and knowledge creation before culminating in sustainable intellectual capital formation.

The explanatory and predictive performance of the structural model indicates that governance should be understood as an adaptive organizational ecosystem rather than a collection of isolated managerial practices. Immersive education emerged as the strongest immediate determinant of intellectual capital, while governance capabilities functioned as the strategic foundation enabling the successful implementation of immersive educational ecosystems. These findings contribute to organizational theory by demonstrating that digital transformation achieves sustainable institutional outcomes only when technological innovation is embedded within coherent governance structures capable of coordinating organizational learning, knowledge integration, stakeholder collaboration, and strategic decision-making.

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The scope of this investigation extends to the development of an integrated organizational framework capable of explaining the structural mechanisms connecting governance systems with immersive intellectual capital formation in higher education institutions committed to sustainable development. The proposed model also provides methodological evidence supporting the application of SMART PLS-SEM for examining multidimensional governance systems characterized by complex mediation effects, multiple endogenous constructs, and prediction-oriented organizational analysis. Consequently, the study offers both theoretical integration and practical guidance for institutional leaders seeking to strengthen governance effectiveness through digitally enabled educational innovation.

Several limitations should be considered when interpreting the findings. The cross-sectional research design restricts conclusions regarding temporal causality and organizational evolution over time. The purposive sampling strategy focused on respondents possessing institutional expertise, which may reduce the generalizability of the findings across different educational systems, governance models, or cultural environments. The exclusive use of self-reported organizational perceptions may also introduce respondent bias despite the satisfactory psychometric performance of the measurement model. Furthermore, the investigation concentrated on higher education institutions implementing immersive educational technologies, limiting direct application to organizations operating under different technological or institutional conditions.

Future research should incorporate longitudinal designs capable of examining how governance systems evolve during digital transformation processes and how intellectual capital accumulates over extended institutional periods. Comparative studies involving universities from different countries and governance contexts would strengthen the external validity of the proposed framework. Additional investigations may incorporate objective organizational performance indicators, multilevel analyses, higher-order latent constructs, and artificial intelligence governance variables to expand the explanatory capacity of the model. Future SMART PLS-SEM applications should also explore moderating and moderating–mediating mechanisms associated with organizational culture, institutional resilience, digital maturity, policy implementation, and sustainability performance. Such developments would contribute to a more comprehensive understanding of governance as a strategic capability supporting resilient, innovative, and sustainable higher education systems in increasingly complex digital environments.

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Appendix A. Operationalization of Variables

Table A1: Operationalization of the Latent Variables.

Latent Variable	Operational Definition	Dimension	Indicator	Code	Scale
Strategic Leadership	Institutional capability to establish vision, coordinate resources, and guide organizational transformation toward sustainable immersive education	Strategic Vision	Institutional vision promotes immersive education	SL1	1–7
		Decision-Making	Leadership supports evidence-based decisions	SL2	1–7
		Resource Allocation	Resources are strategically assigned	SL3	1–7
		Institutional Commitment	Executive commitment supports innovation	SL4	1–7
Digital Governance	Organizational capacity to regulate, coordinate, and monitor digital transformation	Digital Policies	Clear digital governance policies exist	DG1	1–7
		Transparency	Digital procedures are transparent	DG2	1–7
		Accountability	Responsibilities are clearly defined	DG3	1–7
		Coordination	Digital processes are institutionally integrated	DG4	1–7
Organizational Learning	Organizational capability to acquire, share, and institutionalize knowledge	Knowledge Acquisition	New knowledge is continuously generated	OL1	1–7
		Knowledge Sharing	Knowledge is systematically shared	OL2	1–7
		Continuous Improvement	Learning improves institutional performance	OL3	1–7
		Institutional Adaptation	Learning supports organizational change	OL4	1–7
Knowledge Management	Institutional management of organizational knowledge assets	Knowledge Storage	Institutional knowledge is documented	KM1	1–7
		Knowledge Transfer	Knowledge circulates efficiently	KM2	1–7
		Knowledge Integration	Information is integrated across units	KM3	1–7
		Knowledge Utilization	Knowledge supports strategic decisions	KM4	1–7
Innovation Capability	Institutional ability to generate educational innovation	Process Innovation	Innovative practices are encouraged	IC1	1–7
		Technological Innovation	Emerging technologies are adopted	IC2	1–7
		Creative Problem Solving	Innovation supports institutional solutions	IC3	1–7
		Organizational Flexibility	Innovation facilitates adaptation	IC4	1–7
Stakeholder Engagement	Institutional collaboration with internal and external stakeholders	Internal Participation	Faculty participate in governance	SE1	1–7
		External Collaboration	External partners contribute to innovation	SE2	1–7

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		Social Participation	Community participation is encouraged	SE3	1–7
		Institutional Partnerships	Strategic alliances are maintained	SE4	1–7
Immersive Education	Integration of immersive technologies into educational processes	Virtual Learning	Immersive environments support learning	IE1	1–7
		Interactive Learning	Students actively interact with digital environments	IE2	1–7
		Experiential Learning	Simulations improve learning experiences	IE3	1–7
		Digital Collaboration	Collaborative immersive learning is promoted	IE4	1–7
Intellectual Capital	Organizational knowledge assets generated through governance and immersive education	Human Capital	Professional competencies continuously improve	HC1	1–7
		Structural Capital	Organizational knowledge is institutionalized	HC2	1–7
		Relational Capital	Institutional collaboration strengthens performance	HC3	1–7
		Organizational Value	Intellectual capital supports sustainability	HC4	1–7

Appendix B: Expert Judgment Evaluation

Table B1: Expert Panel Composition.

Expert	Area of Expertise	Academic Degree	Years of Experience
Judge 1	Higher Education Governance	PhD	24
Judge 2	Organizational Management	PhD	21
Judge 3	Educational Technology	PhD	18
Judge 4	Sustainability Studies	PhD	19
Judge 5	Psychometrics	PhD	27
Judge 6	Structural Equation Modeling	PhD	22
Judge 7	Digital Transformation	PhD	20

Table B2: Evaluation Criteria.

Criterion	Description	Rating Scale
Relevance	Correspondence between the indicator and the latent construct	1–4
Conceptual Consistency	Alignment with the theoretical framework	1–4
Semantic Clarity	Precision and comprehensibility of wording	1–4
Practical Applicability	Suitability for higher education institutions	1–4
Measurement Adequacy	Capacity to represent the intended construct	1–4
Linguistic Accuracy	Grammatical and lexical correctness	1–4
Overall Recommendation	Suitability for inclusion in the final questionnaire	Accept, Revise, Reject

Table B3: Summary of Expert Evaluation.

Construct	Mean Relevance	Mean Clarity	Mean Consistency	Mean Applicability	Decision
Strategic Leadership	3.93	3.86	3.91	3.89	Accepted
Digital Governance	3.90	3.88	3.94	3.91	Accepted
Organizational Learning	3.95	3.92	3.96	3.90	Accepted
Knowledge Management	3.97	3.94	3.98	3.95	Accepted
Innovation Capability	3.92	3.87	3.90	3.89	Accepted

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Stakeholder Engagement	3.89	3.85	3.88	3.87	Accepted
Immersive Education	3.98	3.95	3.99	3.97	Accepted
Intellectual Capital	3.96	3.93	3.97	3.94	Accepted

Table B4: Main Recommendations Provided by the Experts.

Recommendation	**Action Implemented**
Improve conceptual precision of governance indicators	Statements were refined to strengthen conceptual specificity
Simplify wording to reduce semantic ambiguity	Complex sentences were rewritten using concise academic language
Eliminate redundant indicators	Overlapping items were removed after consensus
Strengthen alignment between dimensions and indicators	Operational definitions were revised according to theoretical domains
Balance the number of indicators across constructs	Four indicators were retained for every latent construct
Increase emphasis on immersive educational ecosystems	Additional references to immersive organizational practices were incorporated
Reinforce sustainability orientation	Indicators explicitly linked governance with Sustainable Development Goals
Improve questionnaire readability	Final wording was standardized throughout the instrument

Table B5: Final Expert Consensus.

Evaluation Component	Result
Number of Judges	7
Questionnaire Items Evaluated	32
Constructs Evaluated	8
Dimensions Evaluated	32
Overall Content Validity	Excellent
Overall Semantic Quality	Excellent
Overall Conceptual Coherence	Excellent
Overall Recommendation	Approved for Pilot Study and Full SMART PLS-SEM Estimation

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