SCIENTIFIC CULTURE

www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 11, No. 3.1, (2025), pp. 321-332
Open Access. Online & Print

DOI: 10.5281/zenodo.11032527

DIGITAL TRANSFORMATION IN HIGHER EDUCATION: A TOE FRAMEWORK ANALYSIS OF TECHNOLOGY ADOPTION, DYNAMIC CAPABILITIES, AND UNIVERSITY PERFORMANCE

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Received: 28/05/2025
Accepted: 28/08/2025

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ABSTRACT

As digital transformation accelerates in higher education, universities are integrating technological innovations to enhance teaching, research, and administration. However, technological innovation adoption (TIA) remains complex, particularly in Henan Province, China, where institutions face challenges related to infrastructure, organizational readiness, and external pressures. This study examines the key factors influencing TIA using the Technology-Organization-Environment (TOE) framework and explores its impact on dynamic capability (DC) and organizational performance (OP). A mixed-methods approach was employed, involving structured surveys and semi-structured interviews with senior administrators, IT staff, and faculty members from 174 universities in Henan Province. Structural Equation Modeling (SEM) was used for hypothesis testing. The results show that TOE factors significantly influence TIA, which strengthens DC and subsequently enhances OP. Additionally, TIA mediates the relationship between TOE components and DC, while DC further mediates the link between TIA and OP. This study extends the TOE framework by integrating TIA, DC, and OP into a structured model, contributing to the theoretical understanding of digital transformation in higher education. Practically, the findings provide empirical insights for policymakers and university leaders to refine technology adoption strategies, enhance dynamic capabilities, and improve institutional performance. Addressing key challenges in digitalization, this research offers valuable guidance for the sustainable development of higher education in China and beyond.

KEYWORDS: TOE Framework, Technological Innovation Adoption, Dynamic Capability, Organizational Performance, Higher Education Digitalization, China.

1. INTRODUCTION

The digital transformation of higher education is reshaping the way universities operate, making technological innovation adoption a key driver in improving teaching, research, and administrative functions. Despite global advancements in education technology, the pace and extent of adoption vary across regions, with some institutions facing considerable challenges (Qi & Rattanapun et al., 2024; Williamson et al., 2023; Pettersson, 2021). In China, particularly in Henan Province, universities encounter obstacles such as insufficient technological infrastructure, organizational preparedness issues, and external policy constraints. (Mhlanga, 2023). This study explores the factors influencing TIA in higher education institutions in Henan, employing the Technology-Organization-Environment framework as an analytical foundation. Additionally, it examines how TIA contributes to enhancing dynamic capability and its subsequent effects on organizational performance. Globally, universities are leveraging digital tools such as online learning platforms, artificial intelligence (AI), big data analytics, and smart campus solutions to modernize education. While these technologies have been widely adopted in developed regions, universities in China's central and western areas still experience disparities in implementation.

Henan Province, which hosts 174 universities, serves as a significant case for studying digital transformation efforts in a developing context. Some institutions have successfully integrated AI-driven teaching management and online learning platforms, yet progress remains uneven due to financial constraints, inconsistent digital literacy among faculty, and a lack of policy incentives.

To gain deeper insights into these challenges, this study employs a mixed-methods research approach, combining quantitative and qualitative methodologies. Structured surveys and semi-structured interviews were conducted with university administrators, IT staff, and faculty members across Henan's higher education institutions. The collected data were analyzed using Structural Equation Modeling (SEM) to explore the interplay between TOE factors, TIA, DC, and OP. The findings reveal that technological, organizational, and environmental factors significantly influence TIA, which in turn strengthens universities' dynamic capabilities and leads to enhanced organizational performance. Additionally, the study highlights the mediating role of TIA between TOE components and DC, as well as the mediating effect of DC between TIA and OP. This research offers both theoretical and practical contributions. From a theoretical perspective, it extends the TOE framework by incorporating TIA, DC, and OP into a comprehensive model for understanding digital transformation in higher education institutions. Practically, the study provides empirical insights for policymakers, university leaders, and decision-makers to optimize technology adoption strategies, improve institutional performance, and foster sustainable digital development. Given the regional disparities in digitalization efforts, the study underscores the importance of targeted policies and increased investment to bridge the technological divide in higher education.

By identifying the core determinants influencing TIA and organizational outcomes in Henan's universities, this study offers valuable recommendations for accelerating digital transformation in Chinese higher education. As China continues to advance its education informatization agenda, understanding the complexities of technology adoption in regional institutions will be crucial to ensuring balanced and effective digitalization efforts across the country.

1.1. Research Questions

1. How do technological, organizational, and environmental factors influence the technological innovation adoption of universities in Henan province?
2. How does technological innovation adoption affect universities' dynamic capability?
3. How does universities' dynamic capability influence their organizational performance?
4. Does technological innovation adoption mediate the relationship between technological, organizational and environmental factors and dynamic capability?
5. Does dynamic capability mediate the relationship between technological innovation adoption and organizational performance?

1.2. Research Objectives

1. To analyze how TOE factors influence the technological innovation adoption of universities in Henan Province, clarifying the role of technological, organizational, and environmental factors in the digitalization process of higher education institutions.
2. To examine the impact of technological innovation adoption on universities' dynamic capability, investigating how universities enhance their adaptability to change and resource integration capabilities after adopting

new technologies.
3. To assess the effect of universities' dynamic capability on organizational performance, exploring DC's role in improving operational efficiency, teaching quality, and institutional competitiveness.
4. To verify the mediating role of technological innovation adoption between TOE factors and dynamic capability, evaluating whether TIA serves as the key mechanism through which TOE factors influence DC.
5. To examine the mediating effect of dynamic capability between technological innovation adoption and organizational performance, clarifying whether DC acts as the transmission pathway for TIA's impact on OP.

2. LITERATURE REVIEW

This research is based on TOE framework, technological innovation adoption, dynamic capability theory, and organizational performance.

2.1. Organizational Performance

Organizational Performance (OP) is a central concept in management studies, initially assessed through financial indicators like profitability, return on investment (ROI), and market share (March & Sutton, 1997). Over time, scholars incorporated non-financial metrics such as customer satisfaction, innovation, and sustainability (Kaplan & Norton, 1996). This led to the development of frameworks like the Balanced Scorecard (BSC), which integrates financial and non-financial performance measures across multiple dimensions (Kaplan & Norton, 1992). The BSC has since been widely applied in corporate and higher education settings to evaluate institutional effectiveness (Umashankar & Dutta, 2007). In corporate management, OP is categorized into financial, market, and innovation performance (Venkatraman & Ramanujam, 1986).

Financial performance reflects profitability and growth, market performance assesses customer satisfaction and brand value (Hult et al., 2008), while innovation performance measures R&D efficiency and technological advancement (Jiménez-Jiménez & Sanz-Valle, 2011). Measuring OP in higher education is more complex due to universities' non-profit nature and diverse objectives. Key indicators include teaching quality, research output, student success, international collaborations, and social contributions (Hughes, 2017). Some researchers focus on quantitative metrics, such as research publications and graduate employment rates (Azis et al., 2017), while others emphasize qualitative aspects, like faculty engagement and institutional reputation (Abbaspour et al., 2017). Two main perspectives dominate OP assessment in universities. The BSC approach promotes a balanced evaluation integrating financial and societal metrics (Kaplan & Norton, 1996). In contrast, the dynamic capability perspective emphasizes adaptability, innovation, and digital transformation (Wang et al., 2021; Almaiah & Almulhem, 2022). Despite advancements, challenges remain in aligning OP evaluation with institutional goals and balancing quantitative and qualitative measures. Future research should refine data-driven performance assessment models and tailor them to different university types (Cao, Duan, & Gan, 2023).

2.2. TOE Framework

The Technology-Organization-Environment (TOE) framework, introduced by Tornatzky and Fleischer (1990), provides a comprehensive model for analyzing factors influencing Technological Innovation Adoption (TIA) within organizations. **It categorizes these factors into three dimensions** technological readiness, organizational structure, and external environmental conditions. Unlike individual adoption models such as the Technology Acceptance Model (TAM), TOE focuses on how institutional characteristics and external forces shape technology adoption at the organizational level. Originally developed for corporate IT adoption, TOE has since been applied to various sectors, including government, healthcare, and education (Oliveira & Martins, 2011; Dwivedi et al., 2020). In higher education, the TOE framework has become a critical tool for understanding digital transformation. Universities face unique challenges in TIA, including technological infrastructure gaps, faculty digital readiness, financial constraints, and regulatory barriers. Studies have applied TOE to explore the adoption of online learning systems, smart campus technologies, artificial intelligence (AI) tools, and digital research platforms (Almaiah & Almulhem, 2022; Rana et al., 2022). The framework has also been used to assess how digital transformation enhances Organizational Performance (OP) in universities, improving teaching quality, research productivity, administrative efficiency, and student engagement (Wang, Chen, & Wang, 2021).

Several key studies illustrate the impact of TOE on both TIA and OP in higher education. Almaiah & Almulhem (2022) found that robust technological infrastructure and faculty training programs significantly enhance TIA, leading to greater teaching effectiveness and student learning outcomes. Hiran & Henten (2020) demonstrated that organizational

leadership and policy support are crucial for the successful adoption of smart campus solutions, positively affecting operational efficiency. Wang, Chen, & Wang (2021) integrated TOE with Dynamic Capability (DC) theory, revealing that universities with strong adaptability and digital innovation strategies achieve higher research productivity and institutional competitiveness. Sahin & Thompson (2023) combined TOE with the Technology Acceptance Model (TAM), showing that faculty digital acceptance and institutional support systems play a dual role in influencing both technology adoption and long-term OP improvements. Based on this review, it is evident that technological, organizational, and environmental factors play a pivotal role in technological innovation adoption and organizational performance. **In summary, the following hypotheses are proposed**

H1: Technological factors have a significant positive impact on technological innovation adoption.

H2: Organizational factors have a significant positive impact on technological innovation adoption.

H3: Environmental factors have a significant positive impact on technological innovation adoption.

H6: Technological factors have a significant positive impact on organizational performance.

H7: Organizational factors have a significant positive impact on organizational performance.

H8: Environmental factors have a significant positive impact on organizational performance.

2.3. Technological Innovation Adoption

Technological Innovation Adoption (TIA) refers to the process by which organizations accept, integrate, and utilize new technologies to improve operational efficiency, optimize management, and gain competitive advantages. TIA encompasses the stages of initial adoption, full implementation, and broader diffusion within an organization (Venkatesh et al., 2003). The adoption process is influenced by multiple factors, including technology characteristics, organizational resources, external environment, and user attitudes (Oliveira & Martins, 2011). Over the years, TIA has been widely studied in fields such as enterprise IT adoption, e-commerce, artificial intelligence, cloud computing, and smart education (Zhu & Kraemer, 2005; Dwivedi et al., 2020). In higher education, the role of TIA has expanded significantly, particularly with the rise of digital learning platforms, AI-driven educational tools, and smart campus initiatives. Universities increasingly integrate big data analytics, e-learning systems, and cloud computing to enhance teaching, research, and administrative functions (Sahin & Thompson, 2023). The widespread shift to online education post-COVID-19 has further accelerated higher education's digital transformation, emphasizing the importance of technological readiness, faculty training, and institutional policy support in ensuring effective TIA (Li & Chan, 2019). Several authoritative studies have examined the impact of TIA on Dynamic Capability (DC) and its mediating role in organizational performance. By integrating TIA with DC theory, one research demonstrated that IT resource allocation and managerial support are key drivers of successful digital transformation in organizations (Dwivedi et al., 2020). Liang et al. (2023) found that TIA enhances universities' ability to manage digital assets, strengthening organizational adaptability and research innovation through cloud computing and AI applications. Patel & Robinson (2021) revealed that TIA plays a mediating role in the relationship between organizational culture and AI adoption, showing that effective TIA strategies accelerate knowledge transfer and innovation capability in higher education. Having studied smart education platforms, Huang et al. (2023) concluded that faculty training and IT infrastructure are crucial for leveraging TIA to enhance institutional dynamic capability and long-term competitiveness. Based on this review, it is evident that technological innovation adoption plays a pivotal role in dynamic capability and organizational performance.

In summary, the following hypotheses are proposed

H4: Technological innovation adoption has a significant positive impact on dynamic capability.

H9a: Technological innovation adoption mediates the relationship between relative competence and dynamic capability.

H9b: Technological innovation adoption mediates the relationship between technology maturity and dynamic capability.

H9c: Technological innovation adoption mediates the relationship between compatibility and dynamic capability.

H10a: Technological innovation adoption mediates the relationship between top management support and dynamic capability.

H10b: Technological innovation adoption mediates the relationship between financial resources and dynamic capability.

H11a: Technological innovation adoption mediates the relationship between competitive pressure and dynamic capability.

H11b: Technological innovation adoption mediates the relationship between government policies and dynamic capability.

2.4. Dynamic Capability Theory

Dynamic Capabilities (DC) refer to an organization's ability to adapt to external changes, optimize resource utilization, and foster continuous innovation to maintain a competitive advantage (Teece, Pisano, & Shuen, 1997). Unlike static capabilities, which primarily focus on maintaining operational efficiency, DC emphasizes the restructuring of internal processes, the development of new expertise, and the ability to respond effectively to market fluctuations (Eisenhardt & Martin, 2000). Initially applied in corporate strategy and resource management, DC has evolved into a critical framework for examining how organizations navigate technological advancements and digital transformation (Helfat & Winter, 2011). In the field of higher education, DC has gained increasing significance as universities integrate digital technologies, artificial intelligence (AI), and smart education systems to enhance institutional performance. Universities with strong DC can quickly adapt to evolving educational models, adopt emerging technologies, and drive innovation in research and teaching (Bharadwaj et al., 2013).

The widespread adoption of e-learning platforms, big data analytics, and cloud-based education tools has demonstrated that institutions with greater technological flexibility and strategic responsiveness achieve stronger organizational performance (OP) (Westerman et al., 2014). Furthermore, DC enables universities to stay competitive in a globalized education landscape, ensuring they effectively respond to shifting student and industry demands while maintaining academic excellence (Rojas & Perez, 2020). Several key studies have explored the impact of DC on OP and its mediating role between Technological Innovation Adoption (TIA) and OP. Teece (2007) emphasized that DC is essential for institutional competitiveness, directly influencing long-term OP through strategic resource allocation and operational enhancements.

Ambrosini & Bowman (2009) found that universities with strong DC experience higher research productivity, faculty engagement, and overall innovation output, leading to improved academic and administrative performance. Similarly, Bharadwaj et al. (2013) highlighted the role of IT-driven DC, demonstrating that institutions leveraging digital capabilities achieve greater research efficiency and administrative effectiveness. Further studies have examined the role of DC as a mediator between TIA and OP. Sahin & Thompson (2023) confirmed that DC plays a critical mediating role, ensuring that technological adoption efforts translate into measurable improvements in teaching quality and institutional governance. Additionally, Parise et al. (2016) investigated how universities using big data and AI technologies optimize strategic decision-making, ultimately enhancing OP. These findings collectively reinforce the importance of DC in ensuring that TIA leads to sustained improvements in institutional effectiveness. Based on this review, it is evident that dynamic capability plays a pivotal role in technological innovation adoption and organizational performance. **In summary, the following hypotheses are proposed**

H5: Dynamic capability has a significant positive impact on organizational performance.

H12: Dynamic capability mediates the relationship between technological innovation adoption and organizational performance.

3. RESEARCH METHODOLOGY

This research used both quantitative and qualitative methods, which allow for a comprehensive analysis, combining statistical validation of hypotheses with in-depth qualitative insights to enhance explanatory power and applicability. The quantitative research component employs a structured survey questionnaire targeting administrators, IT personnel, and faculty members from 174 universities in Henan. Four participants from each institution are randomly selected, resulting in an expected sample size of over 600 respondents. The study uses Structural Equation Modeling, a statistical technique that enables simultaneous examination of complex relationships among multiple variables. Compared to traditional regression analysis, SEM reduces measurement error and evaluates model fit indices (e.g., CFI, TLI, RMSEA) to enhance analytical precision. The qualitative research component consists of semi-structured interviews with 20 university administrators, allowing for deeper exploration of key barriers, facilitators, and decision-making processes influencing technology adoption.

3.1. Validity and Reliability

The credibility and accuracy of qualitative research largely depend on the authenticity of the findings and the objectivity of data interpretation. To ensure the robustness of this study, multiple validation methods were employed, including questionnaire assessments, reliability tests, and factor

analysis.

Internal consistency reliability was examined using Cronbach's alpha coefficient (Cronbach, 1951), which is widely recognized for measuring scale reliability. The analysis revealed that all dimensions of the questionnaire had Cronbach's alpha values exceeding 0.7, indicating strong reliability and stability. Additionally, expert evaluation was conducted to enhance the validity of the questionnaire. Five specialists in the field reviewed its content and confirmed its alignment with the research objectives.

They unanimously recognized the theoretical and practical importance of examining the factors influencing organizational performance in Henan, China. Additionally, they confirmed that the questionnaire successfully incorporated key components from established scales, ensuring its relevance and alignment with the study's framework.

3.2. Descriptive Statistics

Descriptive statistical analysis is a technique employed to systematically arrange, summarize, and interpret data (Field, 2018). In this study, demographic variables such as gender, age, job role, years of experience in higher education, educational qualification, type of university, and field of study or work were examined using descriptive statistics. Data processing and analysis were conducted utilizing SPSS and AMOS to ensure comprehensive statistical evaluation.

4. RESULTS

After analyzing the descriptive statistics of the respondents' demographic characteristics, this study proceeded with a descriptive analysis of key research variables. This involved calculating the minimum and maximum values, mean scores, standard errors, and standard deviations using a dataset of 592 valid responses. The results of these computations are presented in the following table.

Table 1: Demographic Statistics of Respondents (n=592).

		Count	%
Gender	Male	353	59.60%
	Female	239	40.40%
Age	18-24 yrs	7	1.20%
	25-34 yrs	158	26.70%
	35-44 yrs	167	28.20%
	45-54 yrs	182	30.70%
	55 yrs and above	78	13.20%
Job role	teacher	152	25.70%
	IT staff	171	28.90%
	Senior administrator	144	24.30%
	others	125	21.10%
Years of Experience in Higher Education	Less than 3 yrs	41	6.90%
	3-5 yrs	101	17.10%
	6-10 yrs	128	21.60%
	11-15 yrs	206	34.80%
	More than 15 yrs	116	19.60%
Educational Qualification	Bachelor	48	8.10%
	Master	436	73.60%
	Ph.D.	108	18.20%
Type of University	Public	310	52.40%
	Private	282	47.60%
Field of Study or Work	Natural Sciences	87	14.70%
	Engineering & Technology	82	13.90%
	Social Sciences	117	19.80%
	Humanities	183	30.90%
	Medical & Health Sciences	58	9.80%
	other	65	11.00%

Table 2: Reliability of Each Dimension in the Final Questionnaire.

Dimension	Items	Cronbach's Alpha
RC	5	0.902
CO	5	0.914
TM	5	0.901
TMS	5	0.924
FR	5	0.919
CP	5	0.92
GP	5	0.909
TIA	5	0.917
DC	5	0.921
OP	5	0.914
Total	50	0.941

4.1. Confirmatory Factor Analysis (CFA)

This study employed AMOS 26.0 software to perform a confirmatory factor analysis (CFA), validating the measurement model for multiple variables, including relative competence, compatibility, technology maturity, top management support, financial resources, government policies, competitive pressure, technological innovation adoption, dynamic capability, and organizational performance. To evaluate the convergent validity of the constructs within each variable, Composite Reliability (CR) and Average Variance Extracted (AVE) were utilized, ensuring the reliability and consistency of the measurement model.

The model fit of the validated factor analysis scale was first assessed. The questionnaire data were imported into AMOS software, and the CMIN/DF value was 2.237, which meets the evaluation criterion of being less than 3, indicating a satisfactory fit. Additionally, IFI, CFI, NFI, and TLI all exceeded 0.9, while the RMSEA value was 0.046, remaining below 0.05, confirming that the overall model fit was good.

4.2. Structure Equation Analysis (SEM)

Structural equation modeling (SEM) is a widely used statistical method for analyzing causal relationships across disciplines such as social sciences, psychology, and economics. In this study, SEM was employed to identify factors influencing organizational performance by constructing a theoretical model, collecting data, and evaluating model fit. This approach provides empirical insights into the interconnections among variables, contributing to a deeper understanding of factors that impact performance of universities in Henan.

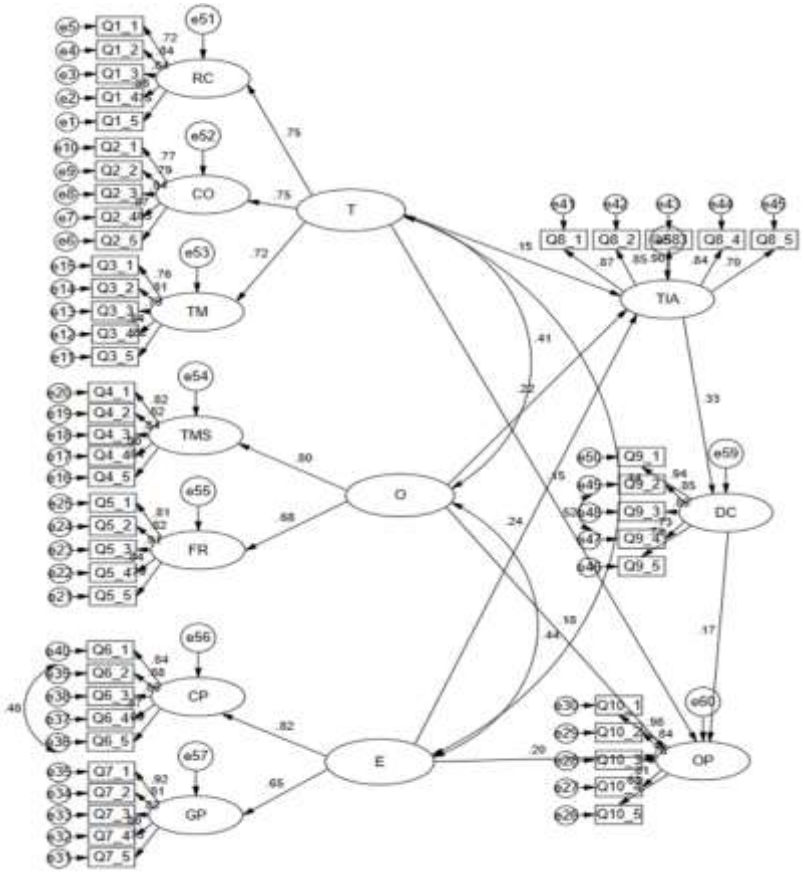

Figure 1: Validation Analysis Model.

Table 3: Model Fitting for Validation Factor Analysis.

Model Fit	CMIN/DF	NFI	IFI	TLI	CFI	RMSEA
	<3	>0.9	>0.9	>0.9	>0.9	<0.05
Model Score	2.08	0.9	0.946	0.942	0.945	0.043

From the table, it can be observed that the Chi-square to degrees of freedom ratio (CMIN/DF) for the structural equation model is 2.08, and the evaluation criterion is less than 3, so the CMIN/DF for the model meets the standard. IFI, CFI, NFI, and TLI are all greater than 0.9, and the RMSEA is 0.043, which is less

than 0.05, indicating that the overall fit of the model is good.

4.3. Hypothesis Testing Results

Structural equation modeling (SEM) was used to analyze the relationships among the research variables. The AMOS output showed that all standardized factor loadings exceeded 0.7, meeting the required criteria. Additionally, all parameter estimates were statistically significant, confirming the validity of the model. The study tested the proposed hypotheses by evaluating the assumed relationships within the theoretical framework. The results indicated that all hypotheses reached a significant level, leading to their acceptance, with P-values for each hypothesis also meeting the significance threshold.

Table 4: Hypothesis Result for Structural Equation Modelling.

Hypothesis	Path	Estimate	S.E.	C.R.	P	Result
H1	T→TIA	0.15	0.066	2.619	0.009	Accepted
H2	O→TIA	0.222	0.047	3.543	***	Accepted
H3	E→TIA	0.242	0.06	3.714	***	Accepted
H4	TIA→DC	0.329	0.049	7.417	***	Accepted
H5	DC→OP	0.165	0.044	4.044	***	Accepted
H6	T→OP	0.147	0.077	2.627	0.009	Accepted
H7	O→OP	0.18	0.053	2.973	0.003	Accepted
H8	E→OP	0.198	0.068	3.172	0.002	Accepted

4.4. Mediating Effects

To further verify the mediating role of Technological Innovation as a mediator between the independent variables Technology Factors, Environmental Factors, and Organizational Factors on Dynamic Capability, this study used the SPSS plugin PROCESS for mediation testing. The Bootstrap mediation test method was used for mediation effect analysis.

The hypothesis testing results confirm that Technological Innovation Adoption (TIA) plays a significant mediating role between various factors and Dynamic Capability (DC), while DC further mediates the relationship between TIA and Organizational Performance (OP). All total, direct, and indirect effects reached statistical significance (BootLLCI & BootULCI did not include zero), confirming the proposed mediation effects and supporting all hypotheses.

Table 5: Path Coefficients for the Mediated Effects Model.

Hypothesis	Effect	Path	Efficiency Value	BootSE	BootLLCI	BootULCI	Result
H9a	Total	RC→DC	0.202	0.04	0.124	0.279	Accepted
	Direct	RC→DC	0.148	0.039	0.071	0.224	
	Indirect	RC→TIA→DC	0.054	0.013	0.03	0.082	
H9b	Total	CO→DC	0.21	0.03	0.152	0.268	Accepted
	Direct	CO→DC	0.16	0.03	0.102	0.219	
	Indirect	CO→TIA→DC	0.05	0.01	0.031	0.071	
H9c	Total	TM→DC	0.328	0.046	0.239	0.418	Accepted
	Direct	TM→DC	0.262	0.045	0.173	0.351	
	Indirect	TM→TIA→DC	0.067	0.015	0.04	0.099	
H10a	Total	TMS→DC	0.206	0.03	0.148	0.264	Accepted
	Direct	TMS→DC	0.153	0.03	0.094	0.212	
	Indirect	TMS→TIA→DC	0.053	0.011	0.033	0.074	
H10b	Total	FR→DC	0.214	0.034	0.148	0.28	Accepted
	Direct	FR→DC	0.162	0.033	0.096	0.228	
	Indirect	FR→TIA→DC	0.052	0.012	0.031	0.075	
H11a	Total	CP→DC	0.24	0.03	0.181	0.3	Accepted
	Direct	CP→DC	0.186	0.031	0.125	0.247	
	Indirect	CP→TIA→DC	0.054	0.012	0.033	0.079	
H11b	Total	GP→DC	0.268	0.042	0.186	0.35	Accepted
	Direct	GP→DC	0.202	0.042	0.119	0.284	
	Indirect	GP→TIA→DC	0.066	0.014	0.04	0.096	
H12	Total	TIA→OP	0.466	0.059	0.351	0.581	Accepted
	Direct	TIA→OP	0.358	0.06	0.24	0.475	
	Indirect	TIA→DC→OP	0.108	0.024	0.064	0.158	

5. DISCUSSION

This study examines the relationship between technological, organizational, and environmental factors and their influence on technological innovation adoption, dynamic capability, and organizational performance in universities in Henan, China. Through quantitative analysis and qualitative interviews, the research highlights the significance of TOE factors in driving digital transformation in higher education.

The findings emphasize the need for institutions to develop a comprehensive approach that integrates leadership support, faculty training, infrastructure modernization, and external collaboration.

Technological factors significantly influence the adoption of innovation in universities. The study found that modern technological tools such as AI-driven grading systems and online learning platforms enhance efficiency but face compatibility and stability challenges. Legacy systems often hinder seamless integration, making it necessary for institutions to conduct compatibility assessments before adopting new technologies. Continuous faculty training is also crucial, particularly for senior professors who may struggle with digital adaptation.

Organizational factors, including leadership support, resource allocation, and institutional culture, play a crucial role in technology adoption. Universities with strong leadership commitment tend to implement technology-driven strategies more effectively. However, faculty resistance and budget constraints remain obstacles. The study recommends involving faculty advisory committees in decision-making and offering incentives such as research grants and career advancement opportunities to encourage digital engagement.

Environmental factors such as government policies, industry trends, and competitive pressures also shape the digital transformation landscape. While government support provides funding for digital initiatives, bureaucratic inefficiencies and ambiguous regulations slow down adoption. Universities should actively collaborate with policymakers to streamline regulatory frameworks and negotiate sustainable partnerships with ed-tech providers. Ensuring adaptability in vendor collaborations can help institutions avoid dependence on proprietary solutions that may limit customization.

The study confirms that TIA serves as a mediator between TOE factors and DC, indicating that the successful adoption of technology enhances universities' ability to develop and sustain dynamic capabilities. Factors such as compatibility, technology maturity, and leadership support are essential for a smooth transition. Interview findings reveal that younger faculty members are generally more open to digital adoption, while senior faculty often face difficulties due to steep learning curves.

To address this gap, institutions should introduce peer mentorship programs that facilitate knowledge transfer between experienced educators and tech-savvy faculty members. Additionally, universities should ensure financial resources are allocated not just for acquiring technology but also for maintaining and optimizing its integration into academic operations.

Dynamic capability plays a critical mediating role between TIA and OP. Universities with strong adaptive learning mechanisms and strategic flexibility are better positioned to sustain long-term competitiveness. The study highlights that rigid administrative structures and bureaucratic delays slow down the adoption of emerging technologies. To improve institutional agility, universities should decentralize decision-making, allowing departments to pilot test and refine digital solutions before full-scale implementation. Additionally, data-driven governance should be institutionalized to enable real-time assessment of technology adoption and its impact on performance.

5.1. Recommendation Agenda

Based on the findings of the research, the following recommendations are purposed.

To enhance technological innovation adoption (TIA), faculty should actively participate in training programs to improve digital literacy and adapt to new tools. Senior professors should engage in peer mentorship programs, while all educators should integrate AI-driven teaching tools and digital platforms into their pedagogy to optimize student engagement and learning outcomes.

Institutional leaders must upgrade technological infrastructure, ensure compatibility with existing systems, and allocate resources effectively. Establishing faculty advisory committees and providing incentives such as research grants and career promotions can encourage faculty to embrace digital transformation. Decentralized decision-making can improve institutional agility in adopting emerging technologies.

Government agencies should streamline regulations on data security, digital rights, and privacy protection to facilitate seamless digital transformation. Policies should provide financial incentives for technology investments and foster public-private partnerships to ensure long-term sustainability and scalability of digital initiatives in higher education.

Further studies should explore the long-term impact of TIA on organizational performance, investigate moderating factors like government incentives and industry collaboration, and examine how universities can bridge digital inequalities. Integrating TOE with other theoretical models can provide deeper insights into technology-driven innovation in higher education.

5.2. Contribution

At the individual level, this study provides insights for faculty members and administrators, highlighting how technological innovation adoption enhances professional development, digital literacy, and efficiency. Faculty can use technology for personalized teaching, student engagement, and streamlined assessment, while administrators benefit from data-driven decision-making and process automation. The findings emphasize the need for continuous professional development programs to help faculty adapt to digital advancements.

At the institutional level, the study offers a strategic framework for universities to optimize technology adoption and organizational performance. By identifying key technological, organizational, and environmental factors, universities can overcome digital transformation barriers and align technology integration with long-term goals. The research stresses the importance of cross-departmental collaboration, resilient leadership, and dynamic capabilities in ensuring competitiveness in higher education.

From a policy-making perspective, the study supports government efforts to advance digitalization in universities. Findings indicate that bureaucratic inefficiencies and inconsistent policies hinder progress. Future policies should focus on standardized digital frameworks, financial incentives, and data security guidelines. Public-private partnerships should also be encouraged to enhance technological capacity across institutions and promote equitable access to digital resources.

This research supports SDG 4 (Quality Education) and SDG 9 (Industry, Innovation, and Infrastructure) by fostering inclusive, technology-driven learning environments and enhancing university infrastructure. It promotes AI-driven teaching tools, adaptive learning, and digital collaboration, ensuring broader access to quality education. Additionally, technology adoption enhances university resilience, sustainability, and economic development, reinforcing China's role in global educational technology innovation. Collaboration between universities, industries, and policymakers will be crucial for sustaining long-term higher education digitalization.

5.3. Future Research

Future research could expand beyond Henan Province to examine whether regional differences in economic development, technological infrastructure, and policy frameworks influence TOE factors in higher education institutions nationwide. Additionally, longitudinal studies would provide a deeper understanding of how universities evolve their dynamic capabilities over time in response to technological advancements.

Exploring individual and cultural factors, such as faculty digital literacy, leadership attitudes, and institutional innovation culture, could offer new perspectives on technology adoption. Further investigation into emerging technologies like AI, blockchain, and big data analytics would help assess their impact on TOE-TIA-DC relationships.

This study identified TIA as a mediator between TOE factors and DC, and DC as a mediator between TIA and OP. Future research should examine moderating variables such as government incentives, industry-academic collaboration, and institutional autonomy to refine these relationships. Comparative studies between public and private universities could reveal how different governance and funding structures affect technology adoption strategies.

A policy-oriented approach is also necessary to evaluate the effectiveness of government regulations, digital transformation grants, and research funding in fostering dynamic capabilities. Integrating TOE with other theoretical models, such as the Resource-Based View (RBV) and institutional theory, could provide a more comprehensive analytical framework.

Finally, addressing digital inequality by studying disparities in technological infrastructure, funding, and digital literacy could help policymakers develop inclusive technology adoption strategies. By pursuing these research directions, scholars can contribute to the development of more adaptable, data-driven, and policy-relevant strategies for advancing digital transformation in higher education institutions.

Acknowledgments: The authors gratefully acknowledge the supervisor, lecturers, participants, and students for their significant assistance and participation in this research.

Conflict of Interest: The authors have no financial or personal interests that may have influenced their work in

this study.

Contributions: Include conceptualization, methodology, original writing, editing by He Wang, Supot Rattanapun, and review by Tikhamporn Taweedech. All authors reviewed and approved the final version of the text.

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