Cuadernos de Economía (2025) Volume 48, Issue 136, 45-56

Asociación Cuadernos de economía

Cuadernos de economía

www.cude.es

ARTÍCULO

Evaluation of the Impact of Success Factors for Adopting Digital Technologies of Information and Communications Technologies Firms in Vietnam

Hang T. M. Nguyen[1], Thanh Huong Tran[2], Mai T. Nguyen[3], V. P. Nguyen[4]*

[1] Faculty of Finance and Accounting, University of Finance - Marketing, Nguyen Kiem Street, Ward 3, Go Vap District, Ho Chi Minh City, Vietnam. Email: hangntm@ufm.edu.vn
[2] Department of Marketing, Posts and Telecommunications Institute of Technology, Km 10 Nguyen Trai, Ha Dong, Ha Noi, Vietnam. Email: huongtt@ptit.edu.vn
[3] Department of Marketing, Posts and Telecommunications Institute of Technology, Km 10 Nguyen Trai, Ha Dong, Ha Noi, Vietnam. Email: maint@ptit.edu.vn
[4] Faculty of Business Administration, Posts and Telecommunications Institute of Technology, Km 10 Nguyen Trai, Ha Dong, Ha Noi, Vietnam.
Email: phuocnv@ptit.edu.vn

Corresponding Author Email: phuocnv@ptit.edu.vn

Keywords:
Adoption of Digital Technologies, Information and Communications Technology, TOE, PLS-SEM.

Abstract: This study investigates the influence of critical success factors on the adoption of digital technologies by Information and Communications Technology (ICT) firms in Vietnam, employing the Technology-Organisation-Environment (TOE) framework and Partial Least Squares Structural Equation Modelling (PLS-SEM). The proposed model evaluates the impact of eleven key factors through thirteen hypotheses concerning digital technology adoption. The uptake of digital technologies is notably shaped by several variables, including technology utilisation (USDT), perceived relative advantages (READ), digital workforce (DIEM), organisational preparedness (ORRE), strategic orientation towards digital adoption (DIST), executive-level support (TOMS), and market competitiveness (COMP). Additionally, partner influence (PAPR) and governmental policy and support (POSU) emerge as pivotal elements in facilitating this transition. The findings yield valuable implications for both policymakers and industry professionals, highlighting actionable pathways to foster favourable conditions for digital adoption. Furthermore, this study lays a foundation for future research on digital technology implementation in emerging economies, with particular relevance to the evolving ICT landscape in Vietnam.

Author Correspondence: phuocnv@ptit.edu.vn

https://doi.org/10.32826/cude.v48i136.1005

Introduction

According to the International Telecommunication Union (ITU), nearly half of the global population—approximately 4 billion individuals—remains without Internet access (ITU, 2023). This digital divide presents a substantial opportunity for Vietnam's Information and Communication Technology (ICT) sector to expand its international footprint. Despite recent global macroeconomic uncertainties, the ICT segment in Vietnam demonstrated notable resilience and sustained growth throughout 2023, with positive projections extending into the future. As reported by the Ministry of Information and Communications (MIC), the ICT industry's revenue increased by 8.7% year-on-year, reaching USD 148 billion. In the same period, approximately 70,000 new firms were established, marking a 9.5% growth rate (MIC, 2024). The adoption of digital technologies is increasingly becoming a strategic necessity for the long-term, sustainable development of ICT firms in Vietnam. However, comprehensive research examining the digital adoption process within these organisations remains limited. Consequently, this study seeks to explore the complex causal relationships among multiple success factors influencing the adoption of digital technologies, aiming to facilitate their seamless integration across ICT enterprises. To achieve this, the research employs a statistical model grounded in the TOE framework, supplemented by a dual-effect perspective—encompassing both the net impact of individual influencing factors and the contextual effect arising from their combined influence (Tornatzky & Fleischer, 1990).

Amid the ongoing Fourth Industrial Revolution, the adoption of digital technologies is catalysing transformative change across numerous sectors (Wu et al., 2023; Zhu, Xie, & Chen, 2023). Governments worldwide increasingly recognise digital transformation as a critical driver for sustaining the competitiveness of traditional industries, including the ICT sector (Boratyńska, 2019; Savastano et al., 2019). ICT, representing the convergence of communication and information technologies, is at the forefront of this evolution. As interactions among people, systems, and devices intensify within an ever-more interconnected global environment, businesses are compelled to meet the dynamic demands of both employees and customers. Consistency in communication and information access is paramount. Cloud computing models are enabling firms to enhance operational efficiency by offering scalable infrastructure, thus providing intelligent and cost-effective access to technology and data. This hybrid model has contributed to heightened productivity and reduced operational costs within and beyond organisational boundaries (Cuevas-Vargas, Aguirre, & Parga-Montoya, 2022; Fan et al., 2023; Yang et al., 2023).

Consequently, ICT enterprises must embrace digital technologies promptly to tackle these critical issues and to position themselves as competitive leaders within the sector. The advancement and utilisation of digital innovations—such as artificial intelligence (AI) (Celik, 2023), the Internet of Things (IoT) (Wang et al., 2020), blockchain (BC) (Lumsden & Gutierrez, 2013), big data (BD) (Bilal et al., 2016), and cloud computing models (CM) (Wang et al., 2021)—have contributed significantly to resolving various challenges in the ICT domain (Ben Halima, Greenan, & Lanfranchi, 2023). These technologies provide essential tools and foundational platforms that support digital technology adoption and promote sustainable development within the ICT sector.

Most scholarly investigations examine the adoption of digital technologies in ICT enterprises from two primary perspectives. The first concerns the impact of these technologies on ICT management and operations (Nagy, Papp, & Szabó, 2021; You, 2022). Data-driven methods, particularly AI, have enabled predictive modelling, forecasting, and optimisation across the entire ICT value chain (Celik, 2023). The second perspective focuses on organisational change management (Bonanomi et al., 2019; Zhang, Fong, & Yamoah Agyemang, 2021). Digital technologies are expected to significantly influence both formal and informal organisational structures within large ICT firms (Bonanomi et al., 2019). Their adoption may also enhance organisational resilience (Zhang, Long, & von Schaewen, 2021). However, implementing multi-layered organisational transformations may lead to innovations that introduce both constructive and disruptive consequences during the digital adoption process (Zeng, Cai, & Ouyang, 2021a). Although numerous scholars have examined the adoption of digital technologies in ICT firms, notable gaps remain. Most prior studies have explored specific aspects from a singular perspective, despite the fact that adoption is a complex systems engineering task (Chen, Wang, & Wan, 2021) influenced by technological, environmental, and organisational factors (Wu et al., 2021). Thus, an integrated approach considering multiple contexts is essential. Moreover, adoption involves various stakeholders (Li et al., 2022) and is shaped by both internal and external dynamics, warranting further investigation (Chen & Tian, 2022). Existing research often isolates the impact of individual factors, failing to clarify their interrelationships or combined influence (Chen & Tian, 2022). Most studies are qualitative, with limited quantitative insights into the mechanisms at play. Therefore, understanding the cumulative and interactive effects of success factors is crucial for effective implementation.

This study aims to: (1) Determine, from a net effect standpoint, which key factors most strongly drive the adoption of digital technologies within ICT organisations; (2) Identify, through a configurational lens, the various pathways leading to effective adoption, and clarify which combinations are linked to lower adoption levels; (3) Explore, from a dual influence perspective, the most impactful factors shaping digital technology adoption in Vietnamese ICT firms. These objectives build upon prior research while integrating the practical insights gained through the research team's direct involvement in related projects, enhancing the study's anticipated effectiveness.

The paper is organised as follows: The introduction provides an overview of the study's context, highlights existing research gaps, and justifies its importance. Section 2 outlines the theoretical framework, conceptual model, and hypotheses. Section 3 explains the methodological approach and data collection strategy. Section 4 presents empirical results. Section 5 interprets the findings in relation to prior literature. The final section concludes with key outcomes, acknowledges study limitations, and suggests future research directions.

Literature Review

Overview of the Importance of Digital Technologies Adoption in ICT Firms

Despite actively promoting digital adoption, the ICT sector's overall digitisation level remains moderate

compared to other industries, largely due to its operational complexity, fragmentation, and diverse processes (Adywiratama et al., 2022; Lafioune et al., 2023). The sector also faces numerous challenges, including a shortage of digital talent, an ageing workforce, declining profitability, rising competition, limited appeal to younger professionals, and rapid industry expansion (Lafioune et al., 2023). Traditional models of production and operation no longer align with the needs of intelligent ICT systems in a digital era (Charfeddine & Umlai, 2023). Therefore, accelerating digital adoption is essential to improve project efficiency, strengthen competitiveness, optimise sectoral structure, and support sustainable, high-quality growth. In response, the Vietnamese Ministry of Information and Communications (MIC) has introduced strategic policies to support ICT development for 2024 and the 2024–2025 period, aiming for a 7% increase in ICT exports and a 6–6.5% contribution to GDP growth from digital firms (Cameron et al., 2019). The National Strategy for Digital Economy and Society to 2025, with a vision to 2030, further emphasises fast-tracking Vietnam's digital transformation, expanding the digital economy, and fostering the emergence of high-quality ICT enterprises and broader technology adoption (Cameron et al., 2019). Vial (2021) conceptualises digital technology adoption as the integration of digital tools aimed at improving business processes, which ultimately induces substantial organisational transformation. According to this view, the digital technology adoption process in ICT firms involves the restructuring of procedures through the implementation of digital technologies across key operational areas such as manufacturing, service operations, ICT systems, maintenance, and repair functions. This transformation leads to shifts in organisational practices to drive profitability and sustain competitive advantage. This perspective underscores that current scholarly discourse predominantly frames digitalisation in terms of organisational transformation and technological integration (Delin, Jiawei, & Taohua, 2021). Accordingly, digital technology adoption can be understood as a procedural mechanism in which both technological implementation and organisational change constitute core components.

Success Factors Influencing Digital Technologies of Information and Communications Technologies Firms Adoption

The TOE framework offers a comprehensive theoretical model for assessing the adoption of innovative technologies within firms, based on technological, organisational, and environmental dimensions (Qiu, 2017). It is widely applied to examine factors influencing technology adoption in organisational settings (Fernando, Rozuar, & Mergeresa, 2021). Its strength lies in identifying context-specific influencing variables, rather than relying solely on predetermined explanatory factors (Phuoc, 2022). Originally proposed by Tornatzky & Fleischer (1990). Diffusion of Innovations Theory, the framework is illustrated in Figure 1.

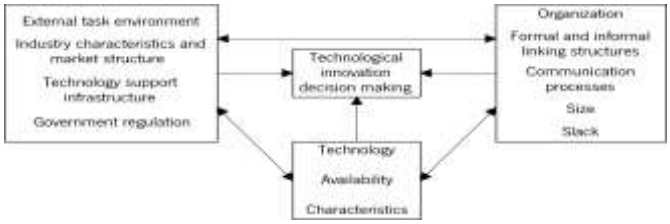

Figure 1: The Constructs Proposed in the Original TOE Theory Framework.

Numerous technological, organisational, and environmental elements have been found to affect digital technology adoption in businesses (Jović et al., 2022). However, since adoption in ICT enterprises is influenced by the interplay of both internal and external factors, it is inappropriate to assess success factors in isolation (Chen & Tian, 2022). Therefore, it is essential to examine their combined effects across diverse contexts. According to Li et al. (2022), ICT firms must urgently integrate technologies for effective data utilisation to foster digital development and enhance core profitability, thereby advancing digital adoption. Thus, the following hypotheses is proposed,

H1: The adoption of digital technologies of ICT firms is positively influenced by the adoption of digital technologies.

Relative competitive advantage refers to the benefits a firm gains through the implementation of technological innovations that enhance its current operations (Oliveira, Thomas, & Espadanal, 2014). Prior studies have shown that adopting digital technologies can transform business models (Pagani & Pardo, 2017), reduce costs, improve operational efficiency (Yin, 2022), and boost overall performance (Matarazzo et al., 2021), thereby strengthening a firm's competitive edge (Koseoglu, Keskin, & Ozorhon, 2019). Based on this, the following hypotheses are proposed in this study:

H2a: Top management support for ICT firms adopt digital technologies is positively influenced by the relative competitive advantages.

H2b: The adopt digital technologies of ICT firms is positively influenced by the relative competitive advantages.

Digital staff are considered to possess the requisite digital competencies essential for supporting a firm's adoption of digital technologies (Teng, Wu, & Yang, 2022). These individuals represent a critical element in driving the implementation of digital technologies within organisations. By enhancing their digital literacy and technical skills, digital employees play a pivotal role in facilitating the adoption process and advancing the overall digital transformation of businesses (Gabriel et al., 2020). Based on this understanding, the following hypothesis is proposed:

H3: The adoption of digital technologies of ICT firms is positively influenced by digital employees.

Digital costs refer to the expenditures incurred by firms when implementing digital technology initiatives, encompassing all related implementation expenses. Typically, higher costs tend to reduce the likelihood of adopting new technologies (Lin, 2014). As such, digital costs may act as a barrier, negatively impacting the adoption of digital technologies in organisations. Thus, the following hypotheses is proposed,

H4: The adoption of digital technologies of ICT firms is negatively influenced by digital costs.

Organisational readiness reflects the availability of infrastructure, skilled personnel, and financial resources within a firm to facilitate the adoption of digital

technologies (Chatterjee et al., 2021). Prior studies (Chatterjee et al., 2021; Pan & Pan, 2020) have shown that such preparedness positively influences the uptake of emerging technologies. For instance, firms are more inclined to adopt big data technologies when supported by strong organisational capabilities (Lutfi et al., 2022). Thus, the following hypotheses is proposed,

H5: Adopt digital technologies in ICT firms is positively influenced by organizational readiness.

As a guiding framework for firms undertaking digital transformation, a digital technology adoption strategy is considered vital to the success of such initiatives (Teng et al., 2022). A digital business strategy entails leveraging digital assets to create value and influence an organisation's operational planning and decision-making processes (Correani et al., 2020). The advancement of digital technologies within firms is often motivated by strategic objectives (Teng et al., 2022). Therefore, it is crucial to develop innovative procedures that align with the firm's overarching strategy in order to secure a sustainable competitive advantage (Correani et al., 2020). Thus, the following hypotheses is proposed,

H6: The adopted digital technologies of ICT firms is positively influenced by the adopted digital technologies strategy.

The extent to which a company's leadership endorses and promotes the adoption of digital technologies is referred to as top management support. While digital technology adoption offers potential benefits across various sectors and firms, the presence of effective and committed leadership is a critical determinant of its successful implementation (Luo & Yu, 2022; Wrede, Velamuri, & Dauth, 2020). Based on this premise, the following hypothesis is proposed:

H7: Adopt digital technologies in ICT firms is positively influenced by the top management support.

Competitive pressure refers to the degree to which firms are influenced by their competitors to adopt emerging technologies (Wong et al., 2020). In a competitive market, firms are often compelled to implement innovative strategies and optimise the use of production factors to gain a competitive edge (Wang et al., 2022), such as reducing costs and enhancing production efficiency and quality in response to competition. Based on this, the following hypotheses are proposed:

H8a: The competitive pressure has positively influenced top management support for adopting digital technologies of ICT firms.

H8b: The competitive pressure has positively influenced on adopt digital technologies of ICT firms.

Partner pressure can significantly influence an organisation's adoption of digital technologies. Through ICT projects, partners may encourage or mandate ICT firms to adopt emerging technologies such as BIM and other digital innovations. Previous studies have highlighted that partner pressure is a key factor in the adoption of new technologies by organisations (Wang, Wang, & Yang, 2010). This is often driven by enterprise leaders strengthening relationships with collaborators and promoting the use of mature technologies already adopted by their partners (Chen et al., 2019). Thus, the following hypotheses are proposed,

H9a: The partner pressure has positively influenced on top management support for adopt digital technologies of ICT firms.

H9b: The partner pressure has positively influenced on adopt digital technologies in ICT firms.

Policy and government support refer to the assistance provided by government bodies and regulatory organisations in promoting the adoption of digital technologies by businesses. These entities can either encourage or hinder the adoption of innovations by implementing relevant regulations (Lutfi et al., 2022). For example, Luo et al. (Luo & Yu, 2022) found that government policy support positively impacts digitisation and can aid in the adoption of digital technologies in pharmaceutical companies. As a result, this study proposes the following two hypotheses:

Figure 2: Proposed Research Model for Evaluation the Success Factors that Influence the Adopt Digital Technologies of ICT Firm.

H10a: Policy and government support have positively influenced top management support for the adoption of digital technologies of ICT firms.

H10b: Policy and government support have positively influenced the adoption of digital technologies of ICT firms.

The literature lacks clarity on the enabling factors that enable ICT firms to adopt digital technologies and the interrelationships and influences that shape digital technology implementation decision-making. To fill this gap, this study presents a TOE-based research approach, shown in Figure 2, to examine the essential success elements affecting digital technology adoption in ICT organisations.

Methodologies

Collecting Data and Sampling Techniques

Questionnaires have been widely utilised in the field of digital technology adoption due to their methodological rigour and ease of application (Kronblad, 2020). In this study, a survey-based questionnaire will serve as the primary instrument for data collection. The research variables and corresponding items will be derived from validated measurement scales established in the extant literature, thereby ensuring the alignment of the investigated constructs and evaluative items with the contextual framework of this study. To support this investigation, a preliminary version of the questionnaire was developed, grounded in the study's hypotheses and prior research on digital technology adoption within firms. The measurement items will undergo refinement based on expert feedback from professionals and scholars in the ICT sector. Prior to conducting the full-scale survey, a pilot test

will be administered to a limited sample in order to validate the clarity, reliability, and scientific robustness of the questionnaire. This preliminary step will inform necessary revisions, ensuring the instrument's suitability for formal data collection. For the purposes of this study, an online questionnaire will be distributed to relevant professionals in the ICT sector through appropriate platforms such as LinkedIn, forums, and industry conferences. Additionally, the questionnaire will be shared with a select group of subject matter experts. To encourage participant engagement, the research team will commit to providing a research report at the conclusion of the study, offering valuable insights into the digital technology adoption process within ICT firms. This initiative aims to enhance participants' interest and involvement. Given that both private and state-owned enterprises dominate the ICT market in Vietnam, a total of 250 questionnaires will be distributed to a diverse range of work units. These will include ICT company owners, firms involved in ICT project design and solutions, ICT consulting firms, and regulatory bodies overseeing the sector. This distribution ensures a comprehensive representation of the industry within the study.

Measurement Instruments

The questionnaire used to measure the variables within the TOE framework includes all relevant measurement questions. To facilitate the completion and evaluation of the study, a 5-point Likert scale (ranging from 1 for "strongly disagree" to 5 for "strongly agree") will be employed to assess the various factors. Prior to filling out the questionnaire, ICT sector practitioners will receive an explanation of what adopting digital technologies means for ICT businesses. Participants will be informed that they can make decisions based on their own abilities and experiences, with the understanding that there are no right or wrong answers. The responses will be used solely for academic research purposes.

Data Analysis

Data processing was performed using SPSS version 25.0 for initial tabulation and descriptive statistics, followed using SmartPLS 4.0 to assess the reliability and validity of the measurement scales and to test the proposed relationships. The research employed PLS-SEM methodology. To validate the proposed theoretical model, an empirical study was conducted, applying the method to a real-world case study. This study aims to analyse the key TOE factors influencing the adoption of digital technologies in leading Vietnamese enterprises. PLS-SEM, a modern technique for analysing multiple variables, offers several advantages over CB-SEM (Hair et al., 2018). These include better handling of non-normal distribution statistics, fewer sample requirements, and the ability to manage complex structural equations with numerous assessment variables, without needing large datasets (Henseler, Ringle, & Sinkovics, 2009; Vinzi et al., 2010). A total of 250 questionnaires were distributed, with 216 valid responses received after removing duplicates and questionnaires with excessive missing or inconsistent data, achieving an 86.4% success rate. The sample size adhered to the 10-times rule for the minimum number of samples in PLS-SEM, as outlined by Chin (1998). Specifically, this involves selecting the higher value between: (a) ten times the total number of items for the measurement constructs relative to the largest item count in the measurement model, and (b) ten times the number of external variables for the endogenous factor and the primary exogenous variables. The construct measuring the USDT in this study, which has five items, represents the measurement with the highest item count. The endogenous variable, adoption of DITR, is associated with ten external variables. Therefore, the 216 samples meet the minimum sample size requirement of 100 as recommended by Hair et al. (2017).

Findings

Descriptive Statistics of Respondents

Table 1: Participants' Key Information.

Item	Category	Frequency	Percentage (%)
Gender	Men	171	79.17
	Female	45	20.83
Age	<25 years	16	7.41
	25–30 years	33	15.28
	31–35 years	65	30.09
	36–40 years	80	37.04
	>40 years	22	10.19
Education	Undergraduate	81	37.50
	Master	114	52.78
	PhD	21	9.72
Experiences	<3 years	45	20.83
	4–5 years	85	39.35
	6–10 years	50	23.15
	11–15 years	16	7.41
	>15 years	20	9.26
Occupation or Sector	Owner	76	35.19
	ICT engineer	68	31.48
	Design and solution	33	15.28
	Consulting organization	25	11.57
	Supervision company	14	6.48
	Government and institutions	45	20.83
Types of Firms	State-owned firms	75	34.72
	Private firms	92	42.59
	Foreign-funded firms	4	1.85

The data collected from the survey in this study is summarised in Table 1. The overall sample distribution by gender revealed a clear male predominance, with 171 male respondents and 45 female respondents. This aligns with the well-established gender imbalance in the ICT sector, where males are typically the majority. Additionally, the survey highlights the practical experience prevalent in the sector. Less than 37% of respondents held a bachelor's degree or lower, while more than 62% had attained a master's degree or higher. Most respondents were aged between 36 and 40 years, and over 39% had less than five years of professional experience, reflecting the high turnover rate typical of the ICT sector. These respondents represented a broad range of ICT companies, surveying and design institutions, consulting firms, and regulatory organisations. The survey results further indicate the dominance of government-owned enterprises in Vietnam's ICT market. However, a key limitation of this study lies in the specificity of the sample, as it focuses exclusively on ICT firms in Vietnam.

Construct Validity

The outcomes indicated that the first's variables accounted for just 48.80% of the overall variation, a percentage that was not higher than 50%. Consequently, the CMB, which lacked a significant influence on this investigation (Hair, Ringle, & Sarstedt, 2014). Furthermore, the variance correlation coefficients of all variables were all below 0.90, further supporting the notion that CMB did not represent a significant issue (Hair, Howard, & Nitzl, 2020; Zeng et al., 2021b). Simultaneously, the VIF in the study was below the level of 5 suggested by Hair et al. (2018), suggesting that multicollinearity did not have an impact on this research. The convergent validity, reliability, and discriminating validity of the model for measurement are assessed in PLS-SEM to assess the integrity of the research modelling (Hair et al., 2019). Initially, all constructs in this study had higher Cronbach's alpha and composite reliability (CR) scores than 0.85, as demonstrated in Table 2, which satisfies the standard criteria proposed by Hair et al. (2020). It seems to suggest that the constructs utilised in this investigation are highly reliable. Secondly, the convergent validity of all constructs is demonstrated by the fact that the entire external models load values of factors of the measure categories included in the survey questionnaire are over 0.70, and the AVE (an average of variability extracted) of all items exceeds the suggested level of 0.50 (Hair et al., 2018).

Table 2: Validity Indicators for Reliability and Convergence.

Construct	Item	Loading	Cronbach's α	CR.	AVE.
Use of Digital Technologies (USDT)	USDT1	0.813	0.862	0.900	0.644
	USDT2	0.853			
	USDT3	0.860			
	USDT4	0.774			
	USDT5	0.703			
Relative Competitive Advantages (READ)	READ1	0.904	0.931	0.951	0.830
	READ2	0.916			
	READ3	0.930			
	READ4	0.890			
Digital Employees (DIEM)	DIEM1	0.870	0.903	0.932	0.775
	DIEM2	0.891			
	DIEM3	0.892			
	DIEM4	0.869			
Digital Costs (DICO)	DICO1	0.955	0.861	0.907	0.767
	DICO2	0.901			
	DICO3	0.761			
Organizational Readiness (ORRE)	ORRE1	0.895	0.925	0.947	0.817
	ORRE2	0.932			
	ORRE3	0.893			
	ORRE4	0.896			
Adopt Digital Technologies Strategy (DIST)	DIST1	0.930	0.917	0.947	0.857
	DIST2	0.923			
	DIST3	0.924			
Top Management Support (TOMS)	TOMS1	0.933	0.931	0.951	0.830
	TOMS2	0.848			
	TOMS3	0.932			
	TOMS4	0.928			
Competitive Pressure (COMP)	COMP1	0.891	0.851	0.893	0.678
	COMP2	0.889			
	COMP3	0.717			
	COMP4	0.784			
Partner Pressure (PAPR)	PAPR1	0.941	0.902	0.939	0.837
	PAPR2	0.913			
	PAPR3	0.889			
Policy and Government Support (POSU)	POSU1	0.827	0.868	0.910	0.717
	POSU2	0.880			
	POSU3	0.859			
	POSU4	0.819			
Adopt Digital Technologies (DITR)	DITR1	0.909	0.933	0.952	0.832
	DITR2	0.908			
	DITR3	0.917			
	DITR4	0.915			

Finally, the Fornell-Larcker criterion and cross-loadings examined discriminant reliability for each measurement model construct (Hair et al., 2020). As demonstrated in Table 3, Pearson's correlation shows that each construct's diagonal square root of the AVE exceeds its correlation coefficients with other constructs. The cross-loadings of all items are higher for their constructs than for any other construct, meeting the discriminant validity requirement (Hair et al., 2020). This shows discriminant reliability across all constructs.

Table 3: The Results of the Fornell-Larcker Measure for Discriminant Validity.

Constructs	COMP	DICO	DIEM	DITR	DIST	ORRE	PAPR	POSU	READ	TOMS	USDT
COMP	0.823										
DICO	0.213	0.876									
DIEM	0.559	0.175	0.880								
DITR	0.691	0.119	0.611	0.912							
DIST	0.663	0.155	0.693	0.751	0.926						
ORRE	0.587	0.125	0.780	0.680	0.769	0.904					
PAPR	0.711	0.112	0.524	0.625	0.548	0.534	0.915				
POSU	0.666	0.128	0.586	0.670	0.601	0.601	0.724	0.847			
READ	0.434	0.289	0.530	0.606	0.524	0.606	0.344	0.403	0.910		
TOMS	0.694	0.177	0.685	0.777	0.831	0.782	0.572	0.636	0.604	0.911	
USDT	0.511	0.295	0.543	0.652	0.557	0.577	0.436	0.451	0.762	0.639	0.803

Evaluation of PLS-SEM

The PLS-SEM model was assessed using Q^2, R^2, and f^2 (Hair et al., 2018). R^2 for DITR was 0.745 (adj. 0.735) and for TOMS, 0.636 (adj. 0.631), showing strong explanatory power (Vinzi et al., 2010). Q^2 values of 0.560 and 0.521 indicate high predictive relevance (Hair et al., 2018). All f^2 values for DITR were below 0.15 (small effects). For TOMS, COMP (0.172) and READ (0.254) had moderate effects, while POSU (0.073) showed a small but significant impact.

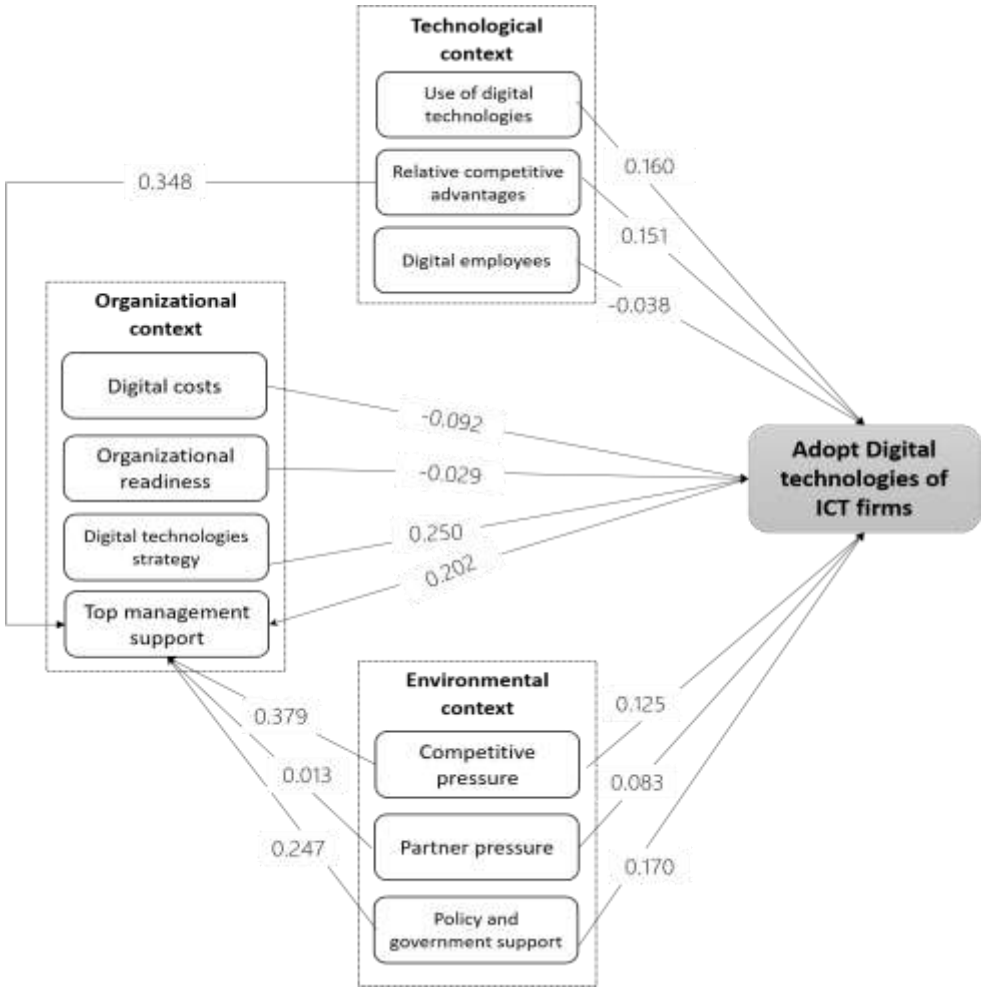

Figure 3: Examined and Results the Path of the Proposed Research Model.

Mediation Analysis

The Bootstrapping method is generally utilised to estimate the significance levels of paths through 5000 repeated samples, as performed by Smart-PLS software (Hair et al., 2018). Table 4 presents that digital personnel, organisational readiness, and partner pressure do not show any statistically significant difference at the p-value of 0.05. Digital tech adoption in ICT firms is driven by usage, relative advantage, strategies, top management support, competitive pressure, and policy support, as shown by 10

accepted hypotheses. Digital costs negatively impact adoption. Top management support is boosted by competitive pressure, relative advantage, and policy support. Table 5 shows it strengthens links between relative advantage, competitive pressure, and adoption, but no mediation is found for partner pressure or policy support.

Table 4: The Findings of the Research Hypothesis Test.

Research Hypothesis	The Relationships	The Coefficients of Path	*T* Statistics	*P* Values	Findings
H1	USDT → DITR	0.160	2.768	0.007	Supported
H2a	READ → TOMS	0.348	5.544	0.000	Supported
H2b	READ → DITR	0.151	2.211	0.034	Supported
H3	DIEM → DITR	−0.038	0.684	0.048	Supported
H4	DICO → DITR	−0.092	2.121	0.042	Supported
H5	ORRE → DITR	−0.029	0.414	0.046	Supported
H6	DIST → DITR	0.250	3.164	0.002	Supported
H7	TOMS → DITR	0.202	2.411	0.017	Supported
H8a	COMP→ TOMS	0.379	4.564	0.000	Supported
H8b	COMP → DITR	0.125	2.004	0.046	Supported
H9a	PAPR→ TOMS	0.013	0.173	0.049	Supported
H9b	PAPR → DITR	0.083	1.299	0.009	Supported
H10a	POSU → TOMS	0.247	2.473	0.011	Supported
H10b	POSU → DITR	0.170	2.299	0.030	Supported

Table 5: Specifically, Indirect Outcome.

The Relationships	Original Samples	*P* Values	*T* Statistics	Effect of Mediation
READ → TOMS → DITR	0.079	0.026	2.114	Partial Mediation
COMP → TOMS → DITR	0.085	0.027	2.086	Partial Mediation
PAPR → TOMS → DITR	0.004	0.045	0.182	Partial Mediation
POSU→ TOMS → DITR	0.057	0.002	1.758	Partial Mediation

Discussion

To explore the various "technological, organizational, and environmental" variables influencing the adoption of digital technologies in ICT firms, this study applied the TOE framework. The study design also incorporates the investigation of the two-way impacts of digital technology adoption. By employing PLS-SEM, the study provides valuable insights into the mechanisms underlying the numerous antecedents of digital technology adoption within ICT firms. The research findings are further elaborated in line with the dual effect perspective, which considers both the individual and combined impacts of various factors on the adoption process.

The Net Effect Discussion

The results indicate that the use of digital technologies (H1) facilitates the digital transformation of ICT firms. This aligns with previous research on digital technologies and corporate adoption of digital technologies (Lutfi et al., 2022). ICT firms must tailor their use of digital technologies to meet their specific needs, enhance integration with business operations and management, and recognise the value of these technologies. Relative competitive advantages (H2a/H2b) positively influence top-level support from leaders and the adoption of digital technologies in ICT firms, thereby further promoting digital adoption. This implies that encouraging the adoption of digital technologies within ICT firms using digital technologies can enhance senior management support and drive the adoption process. While prior studies have indicated that employees' digital capabilities positively affect digital adoption (Wong et al., 2020), this study found that digital staff (H3) also significantly influence ICT firms' digital transformation. Digital technologies have become fully integrated into ICT organisations' design and operations, with their utilisation primarily influenced by traditional business models. Celik (2023) agreed, noting that Vietnam's ICT sector largely employs digital technologies to address challenges in engineering IT projects. ICT organisations, including digital workers, experience higher employee turnover compared to traditional businesses. Due to their stability, digital workers are likely to embody the corporate identity and job continuity, which does not restrict their involvement in the digital transformation of ICT organisations.

The study reveals that digital costs (H4) have a negative impact on the adoption of digital technologies within ICT firms in an organisational context. High digital costs make the implementation of digital technologies financially burdensome, impeding their adoption. In the case of small and medium-sized enterprises, which often face stringent cash flow constraints, the substantial financial outlay required for digital adoption becomes a significant obstacle (Lutfi et al., 2022). Furthermore, ICT firms in Vietnam's intensely competitive market face challenges such as having to pay upfront for ICT investments, compounded by delayed payments from project owners, which places them at financial risk during the project lifecycle. In this context, ICT firms must carefully weigh the digital costs involved in the adoption of new technologies and their efforts to drive digital transformation. This research posits that organisational readiness (H5) facilitates the digital transition of ICT firms. Supporting evidence for this claim exists. While cognitive readiness has been previously associated with the adoption of digital technologies (Lutfi et al., 2022), ICT firms with an established and high level of adoption often lack the necessary organisational plans and adjustments for effective digital technology integration, due to a vague understanding of the process.

However, personnel with established work habits and behaviour patterns may find it easier to embrace the disruptive nature of digital technologies (Correani et al., 2020), and this organisational preparedness can positively influence the adoption of digital technologies. Additionally, the reluctance of employees to adopt disruptive technologies such as digital tools does not

appear to hinder the adoption process, as suggested by Wrede et al. (2020). The strategy for adopting digital technologies plays a crucial role in driving the adoption process, influencing all other independent factors. A well-crafted digital transformation strategy is a cornerstone for successful corporate adoption (Correani et al., 2020). Successful organisations integrate their digital transformation strategies with their overall business goals to ensure that digital technologies contribute value (Correani et al., 2020). The study also highlights that the adoption of digital technologies by ICT firms depends significantly on top management support (H7). This factor ranks third among the path coefficients affecting digital transformation within ICT businesses. Leadership is key to digital adoption (Gabriel et al., 2020). Relative advantage (H2a), competitive pressure (H8a), and regulatory support (H10a) boost top management support in ICT firms. This support partly mediates the effects of relative advantage and competitive pressure on adoption. Partner pressure (H9a) shows no significant impact. Thus, leadership should focus on tech benefits, competition, and regulation when driving innovation.

In the context of the environmental framework, competitor pressure (H8a/H8b) has a positive influence on top management support and the adoption of digital technologies within ICT firms, with top management support partially mediating this effect. Intense competition in the ICT sector compels senior management to adopt new technologies and reform business practices to foster growth. Despite the significant impact of partner pressure (H9a/H9b), top management support and the adoption of digital technologies within ICT firms remain unaffected. Two potential explanations for this exist. First, the ICT industry is integral to the broader ICT supply chain, with digital technology adoption being project centric. Consequently, partner demands regarding the adoption of digital technologies may play a role in shaping decisions. Second, most ICT partners adopting digital technologies are small to medium-sized enterprises, rather than large-scale technology-driven organisations such as design and consultancy firms.

Over 70% of these enterprises are undergoing large-scale adoption of digital technologies (Gabriel et al., 2020), indicating they have the necessary resources and incentives for digitalisation. Additionally, policy and government support (H10b and H10a) positively influence top management support and the adoption of digital technologies within ICT firms, representing key external environmental factors. In the Vietnamese market, government policies and administrative directives can shape organisational orientations, particularly in state-owned enterprises, which tend to be more influenced by these external factors. These findings provide further clarification. However, while policy and government support influence top management support and digital technology adoption, they do not appear to significantly impact the adoption process via top management support alone. Although government policies promote digital adoption, other factors—particularly the short-term benefits of adopting digital technologies—may need to be considered to determine whether top management is motivated to actively promote digitalisation.

The Configuration Effect Discussion

The examination of the configurational effects of various factors within the TOE framework revealed that, across all three high-level adoption settings in ICT firms, the core determining conditions for digital technology adoption are the internal use of technology and digital employees, organizational sub-factors, and government policy and support in the external environment. However, factors such as competitive pressure and partners were found to have a minor or ineffective influence. In order to achieve a high level of digital technology adoption, ICT firms must focus on internal initiatives (Gabriel et al., 2020). Furthermore, the lack of external environmental pressure and top management support in low-level adoption configurations indicates that ICT firms may struggle to pursue high-level adoption without these external incentives. Firms often become entrenched in their existing relationships, making it difficult to adapt without external motivation, particularly from top management (Wu et al., 2021). In conclusion, the "net effect" perspective reinforces that top management support, policy support, and government assistance are crucial factors in the adoption of digital technologies. The findings indicate that the organizational and environmental conditions for digital technology adoption in ICT firms are significantly influenced by top management support and external policy and governmental backing.

Conclusion, Implications and Future of Research

Traditional ICT firms must undergo digital transformation to navigate emerging industry challenges and secure long-term success in the ICT and innovation sectors in the digital era. Using the TOE framework, this study investigates the various drivers of digital technology adoption in ICT firms in Vietnam and develops a research model to explore the success factors impacting digital adoption from a dual impact perspective. The PLS-SEM technique was employed to examine the dual influence of success factors on digital adoption in ICT organisations. From an overall impact perspective, seven key success factors significantly influence digital adoption in ICT firms in Vietnam: the adoption of digital technologies, their relative technical advantages, digital costs, top management support, the firm's digital adoption strategy, competitive pressure, and environmental policy support. Additionally, three other success factors—digital workforce capabilities, organisational readiness, and partner pressure—were found to have considerable statistical significance. Furthermore, competitive advantage, competitive pressure, and policy and government support positively influenced senior management's attitudes toward digital technology adoption, whereas partner pressure had notable implications.

From a configurational perspective, ICT firms may achieve high levels of digital adoption through three strategies that are primarily influenced by internal organisational characteristics. Nations such as Vietnam, with a growing understanding of the digital adoption process, can use these insights as a benchmark for successful digital transformation. Despite these significant contributions, the study has several limitations. First, it used the TOE framework to examine the success factors driving digital adoption in ICT organisations. Future research could incorporate additional theories, such as the Push-Pull-Mooring theory, to extend the scope of digital adoption in ICT firms and assess the success factors within a more integrated framework. Future research could incorporate advanced algorithms, such as deep learning models, to better predict the recognition of emerging success factors in digital adoption. Finally, this study did not consider

variables such as business size, which could influence the digital adoption process.

Declarations Statement

Ethical Approval

This article does not contain any studies with human participants performed by any of the authors.

Informed Consent

This article does not contain any studies with human participants performed by any of the authors.

Funding Details

This research received support from Posts and Telecommunications Institute of Technology, affiliated with the Ministry of Science and Technology, for the submitted work.

Disclosure Statement

No potential conflict of interest was reported by the authors.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, [V.P. Nguyen], upon reasonable request.

Acknowledgments

This work was supported by Posts and Telecommunications Institute of Technology, Vietnam (PTIT) and University of Finance - Marketing (UFM).

Authors' Contributions Statement

The authors, H. T. M. Nguyen, T. H. Tran, M. T. Nguyen, and V. P. Nguyen, contributed to the conception, design, analysis, and interpretation of the data, drafted the paper, critically revised it for intellectual content, and approved the final version for publication. They all agreed to take responsibility for all aspects of the work.

References

Adywiratama, A. D., Ko, C., Raharjo, T., & Wahbi, A. (2022). Critical success factors for ICT project: A case study in project colocation government data center. *Procedia Computer Science, 197*, 385-392. doi: https://doi.org/10.1016/j.procs.2021.12.154

Ben Halima, M. A., Greenan, N., & Lanfranchi, J. (2023). Getting sick for profit? The impact of cumulative ICT and management changes on long term sickness absence. *Journal of Economic Behavior & Organization, 212*, 659-688. doi: https://doi.org/10.1016/j.jebo.2023.06.008

Bilal, M., Oyedele, L. O., Qadir, J., Munir, K., Ajayi, S. O., Akinade, O. O., et al. (2016). Big Data in the construction industry: A review of present status, opportunities, and future trends. *Advanced Engineering Informatics, 30*(3), 500-521. doi: https://doi.org/10.1016/j.aei.2016.07.001

Bonanomi, M. M., Hall, D. M., Staub-French, S., Tucker, A., & Talamo, C. M. L. (2019). The impact of digital transformation on formal and informal organizational structures of large architecture and engineering firms. *Engineering, Construction and Architectural Management, 27*(4), 872-892. doi: https://doi.org/10.1108/ECAM-03-2019-0119

Boratyńska, K. (2019). Impact of Digital Transformation on Value Creation in Fintech Services: An Innovative Approach. *Journal of Promotion Management, 25*(5), 631-639. doi: https://doi.org/10.1080/10496491.2019.1585543

Cameron, A., Pham, T. H., Atherton, J., Nguyen, D. H., Nguyen, T. P., Tran, S. T., et al. (2019). *Vietnam's Future Digital Economy–Towards 2030 and 2045*. Brisbane: Commonwealth Scientific and Industrial Research Organisation. Retrieved from https://research.csiro.au/aus4innovation-phase1/foresight

Celik, I. (2023). Exploring the Determinants of Artificial Intelligence (AI) Literacy: Digital Divide, Computational Thinking, Cognitive Absorption. *Telematics and Informatics, 83*, 102026. doi: https://doi.org/10.1016/j.tele.2023.102026

Charfeddine, L., & Umlai, M. (2023). ICT sector, digitization and environmental sustainability: A systematic review of the literature from 2000 to 2022. *Renewable and Sustainable Energy Reviews, 184*, 113482. doi: https://doi.org/10.1016/j.rser.2023.113482

Chatterjee, S., Rana, N. P., Dwivedi, Y. K., & Baabdullah, A. M. (2021). Understanding AI adoption in manufacturing and production firms using an integrated TAM-TOE model. *Technological Forecasting and Social Change, 170*, 120880. doi: https://doi.org/10.1016/j.techfore.2021.120880

Chen, H., & Tian, Z. (2022). Environmental uncertainty, resource orchestration and digital transformation: A fuzzy-set QCA approach. *Journal of Business Research, 139*, 184-193. doi: https://doi.org/10.1016/j.jbusres.2021.09.048

Chen, Q. J., Wang, Y. M., & Wan, M. F. (2021). Research on Peer Effect of Enterprise Digital Transformation and Influencing Factors. *Chinese Journal of Management, 18*(5), 653-663. Retrieved from http://manu68.magtech.com.cn/Jwk_glxb/CN/abstract/abstract11967.shtml

Chen, Y., Yin, Y., Browne, G. J., & Li, D. (2019). Adoption of building information modeling in Chinese construction industry. *Engineering, Construction and Architectural Management, 26*(9), 1878-1898. doi: https://doi.org/10.1108/ECAM-11-2017-0246

Chin, W. W. (1998). Commentary: Issues and Opinion on Structural Equation Modeling. *MIS Quarterly, 22*(1), vii-xvi. Retrieved from http://www.jstor.org/stable/249674

Correani, A., De Massis, A., Frattini, F., Petruzzelli, A. M., & Natalicchio, A. (2020). Implementing a Digital Strategy: Learning from the Experience of Three Digital Transformation Projects. *California Management Review, 62*(4), 37-56. doi: https://doi.org/10.1177/0008125620934864

Cuevas-Vargas, H., Aguirre, J., & Parga-Montoya, N. (2022). Impact of ICT adoption on absorptive capacity and open innovation for greater firm performance. The mediating role of ACAP. *Journal of Business Research, 140*, 11-24. doi: https://doi.org/10.1016/j.jbusres.2021.11.058

Delin, Z., Jiawei, C., & Taohua, O. (2021). A Research on Digital Transformation: Integration Framework and Prospects. *Foreign Economics & Management, 43*(5), 63-76. doi: https://doi.org/10.16538/j.cnki.fem.20210406.101

Fan, X., Zhao, S., Zhang, B., Wang, S., & Shao, D. (2023). The Impact of Corporate Digital Strategic Orientation on Innovation Output. *Heliyon, 9*(5), e16371. doi: https://doi.org/10.1016/j.heliyon.2023.e16371

Fernando, Y., Rozuar, N. H. M., & Mergeresa, F. (2021). The blockchain-enabled technology and carbon performance: Insights from early adopters. *Technology in Society, 64*, 101507. doi: https://doi.org/10.1016/j.techsoc.2020.101507

Gabriel, J., Mayzira, A., Aditya, J., Itsari, M., Satrio, S., & Ruldeviyani, Y. (2020). Critical Success Factors of Data Integration on Digital Human Capital Information System to Support Digital Transformation - A Case Study at PTXYZ. In *2020 8th International Conference on Cyber and IT Service Management (CITSM)* (pp. 1-7). IEEE. doi: https://doi.org/10.1109/CITSM50537.2020.9268793

Hair, J. F., Howard, M. C., & Nitzl, C. (2020). Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. *Journal of Business Research, 109*, 101-110. doi: https://doi.org/10.1016/j.jbusres.2019.11.069

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)* (2nd ed.). Thousand Oaks: Sage.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2014). PLS-SEM: Indeed a Silver Bullet. *Journal of Marketing theory and Practice, 19*(2), 139-152. doi: https://doi.org/10.2753/MTP1069-6679190202

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review, 31*(1), 2-24. doi: https://doi.org/10.1108/EBR-11-2018-0203

Hair, J. F., Sarstedt, M., Ringle, C. M., & Gudergan, S. P. (2018). *Advanced Issues in Partial Least Squares Structural Equation Modeling (PLS-SEM)*. Thousand Oaks, CA: Sage. doi: https://doi.org/10.3926/oss.37

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. In R. R. Sinkovics & P. N. Ghauri (Eds.), *New Challenges to International Marketing* (Vol. 20, pp. 277-319). Emerald Group Publishing Limited. doi: https://doi.org/10.1108/S1474-7979(2009)0000020014

ITU. (2023). *Facts and Figures 2023*. Retrieved from https://www.itu.int/itu-d/reports/statistics/facts-figures-2023

Jović, M., Tijan, E., Vidmar, D., & Pucihar, A. (2022). Factors of Digital Transformation in the Maritime Transport Sector. *Sustainability, 14*(15), 9776. doi: https://doi.org/10.3390/su14159776

Koseoglu, O., Keskin, B., & Ozorhon, B. (2019). Challenges and Enablers in BIM-Enabled Digital Transformation in Mega Projects: The Istanbul New Airport Project Case Study. *Buildings, 9*(5), 115. doi: https://doi.org/10.3390/buildings9050115

Kronblad, C. (2020). How Digitalization Changes our Understanding of Professional Service Firms. *Academy of Management Discoveries, 6*(3), 436-454. doi: https://doi.org/10.5465/amd.2019.0027

Lafioune, N., Desmarest, A., Poirier, É. A., & St-Jacques, M. (2023). Digital transformation in municipalities for the planning, delivery, use and management of infrastructure assets: Strategic and organizational framework. *Sustainable Futures, 6*, 100119. doi: https://doi.org/10.1016/j.sftr.2023.100119

Li, Y., Sun, H., Li, D., Song, J., & Ding, R. (2022). Effects of Digital Technology Adoption on Sustainability Performance in Construction Projects: The Mediating Role of Stakeholder Collaboration. *Journal of Management in Engineering, 38*(3), 04022016. doi: https://doi.org/10.1061/(ASCE)ME.1943-5479.0001040

Lin, H.-F. (2014). Understanding the determinants of electronic supply chain management system adoption: Using the technology–organization–environment framework. *Technological Forecasting and Social Change, 86*, 80-92. doi: https://doi.org/10.1016/j.techfore.2013.09.001

Lumsden, J. R., & Gutierrez, A. (2013). Understanding the Determinants of Cloud Computing Adoption within the UK. In *Conference Proceedings - EMCIS 2013*. Retrieved from https://kar.kent.ac.uk/72980/1/emcis2013_submission_37.pdf

Luo, X., & Yu, S.-C. (2022). Relationship between External Environment, Internal Conditions, and Digital Transformation from the Perspective of Synergetics. *Discrete Dynamics in Nature and Society, 2022*(1), 6756548. doi: https://doi.org/10.1155/2022/6756548

Lutfi, A., Alsyouf, A., Almaiah, M. A., Alrawad, M., Abdo, A. A. K., Al-Khasawneh, A. L., et al. (2022). Factors Influencing the Adoption of Big Data Analytics in the Digital Transformation Era: Case Study of Jordanian SMEs. *Sustainability, 14*(3), 1802. doi: https://doi.org/10.3390/su14031802

Matarazzo, M., Penco, L., Profumo, G., & Quaglia, R. (2021). Digital transformation and customer value creation in Made in Italy SMEs: A dynamic capabilities perspective. *Journal of Business Research, 123*, 642-656. doi: https://doi.org/10.1016/j.jbusres.2020.10.033

MIC. (2024, September 27). *Report on National Digital Transformation*. Ministry of Science and Technology (MST). Retrieved from https://english.mic.gov.vn/report-on-national-digital-transformation-august-2024-197240927161814412.htm

Nagy, O., Papp, I., & Szabó, R. Z. (2021). Construction 4.0 Organisational Level Challenges and Solutions. *Sustainability, 13*(21), 12321. doi: https://doi.org/10.3390/su132112321

Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors. *Information & Management, 51*(5), 497-510. doi: https://doi.org/10.1016/j.im.2014.03.006

Pagani, M., & Pardo, C. (2017). The impact of digital technology on relationships in a business network. *Industrial Marketing Management, 67*, 185-192. doi: https://doi.org/10.1016/j.indmarman.2017.08.009

Pan, M., & Pan, W. (2020). Understanding the Determinants of Construction Robot Adoption: Perspective of Building Contractors. *Journal of Construction Engineering and Management, 146*(5), 04020040. doi: https://doi.org/10.1061/(ASCE)CO.1943-7862.0001821

Phuoc, N. V. (2022). The Critical Factors Impacting Artificial Intelligence Applications Adoption in Vietnam: A Structural Equation Modeling Analysis. *Economies, 10*(6), 129. doi: https://doi.org/10.3390/economies10060129

Qiu, Z. (2017). Technology and Organization: Multidisciplinary Research Patterns and Sociological Concerns. *Sociological Study, 32*(4), 167-192. Retrieved from http://www.shehui.pku.edu.cn/upload/editor/file/20170907/20170907142537_8969.pdf

Savastano, M., Amendola, C., Bellini, F., & D'Ascenzo, F. (2019). Contextual Impacts on Industrial Processes Brought by the Digital Transformation of Manufacturing: A Systematic Review. *Sustainability, 11*(3), 891. doi: https://doi.org/10.3390/su11030891

Teng, X., Wu, Z., & Yang, F. (2022). Research on the Relationship between Digital Transformation and Performance of SMEs. *Sustainability, 14*(10), 6012. doi: https://doi.org/10.3390/su14106012

Tornatzky, L., & Fleischer, M. (1990). *The Process of Technology Innovation*. Lexington, MA: Lexington Books.

Vial, G. (2021). Understanding Digital Transformation: A Review and a Research Agenda. In A. Hinterhuber, T. Vescovi, & F. Checchinato (Eds.), *Managing Digital Transformation* (pp. 13-66). Routledge. doi: https://doi.org/10.4324/9781003008637-4

Vinzi, V. E., Chin, W. W., Henseler, J., & Wang, H. (2010). *Handbook of Partial Least Squares: Concepts, Methods and Applications*. Springer-Verlag Berlin Heidelberg. doi: https://doi.org/10.1007/978-3-540-32827-8

Wang, T., Wang, X., Wang, L., Au-Yong, C. P., & Ali, A. S. (2021). Assessment of the development level of regional industrialized building based on cloud model: A case study in Guangzhou, China. *Journal of Building Engineering, 44*, 102547. doi: https://doi.org/10.1016/j.jobe.2021.102547

Wang, X., Liu, L., Liu, J., & Huang, X. (2022). Understanding the Determinants of Blockchain Technology Adoption in the Construction Industry. *Buildings, 12*(10), 1709. doi: https://doi.org/10.3390/buildings12101709

Wang, X., Wang, S., Song, X., & Han, Y. (2020). IoT-Based Intelligent Construction System for Prefabricated Buildings: Study of Operating Mechanism and Implementation in China. *Applied Sciences, 10*(18), 6311. doi: https://doi.org/10.3390/app10186311

Wang, Y.-M., Wang, Y.-S., & Yang, Y.-F. (2010). Understanding the determinants of RFID adoption in the manufacturing industry. *Technological Forecasting and Social Change, 77*(5), 803-815. doi: https://doi.org/10.1016/j.techfore.2010.03.006

Wong, L.-W., Leong, L.-Y., Hew, J.-J., Tan, G. W.-H., & Ooi, K.-B. (2020). Time to seize the digital evolution: Adoption of blockchain in operations and supply chain management among Malaysian SMEs. *International Journal of Information Management, 52*, 101997. doi: https://doi.org/10.1016/j.ijinfomgt.2019.08.005

Wrede, M., Velamuri, V. K., & Dauth, T. (2020). Top managers in the digital age: Exploring the role and practices of top managers in firms' digital transformation. *Managerial and Decision Economics, 41*(8), 1549-1567. doi: https://doi.org/10.1002/mde.3202

Wu, J., Chen, T., Gong, Y., & Yang, Y. (2021). Digital Transformation of Firms: Theoretical Framework and Research Prospects. *Chinese Journal of Management, 18*(12), 1871-1880. Retrieved from http://manu68.magtech.com.cn/Jwk_glxb/EN/abstract/abstract12096.shtml

Wu, K., Chen, Y., Zhang, H. o., Liu, Y., Wang, M., Ye, Y., et al. (2023). ICTs capability and strategic emerging technologies: Evidence from Pearl River Delta. *Applied Geography, 157*, 103019. doi: https://doi.org/10.1016/j.apgeog.2023.103019

Yang, L., Zou, H., Shang, C., Ye, X., & Rani, P. (2023). Adoption of information and digital technologies for sustainable smart manufacturing systems for industry 4.0 in small, medium, and micro enterprises (SMMEs). *Technological Forecasting and Social Change, 188*, 122308. doi: https://doi.org/10.1016/j.techfore.2022.122308

Yin, W. (2022). Identifying the pathways through digital transformation to achieve supply chain resilience: an fsQCA approach. *Environmental Science and Pollution Research, 30*(4), 10867-10879. doi: https://doi.org/10.1007/s11356-022-22917-w

You, Z. (2022). Intelligent construction: unlocking opportunities for the digital transformation of China's construction industry. *Engineering, Construction and Architectural Management, 31*(4), 1429-1453. doi: https://doi.org/10.1108/ECAM-08-2022-0706

Zeng, D. L., Cai, J. W., & Ouyang, T. H. (2021a). A Research on Digital Transformation: Integration Framework and Prospects. *Foreign Economics & Management, 43*(5), 63-76. doi: https://doi.org/10.16538/j.cnki.fem.20210406.101

Zeng, N., Liu, Y., Gong, P., Hertogh, M., & König, M. (2021b). Do right PLS and do PLS right: A critical review of the application of PLS-SEM in construction management research. *Frontiers of Engineering Management, 8*(3), 356-369. doi: https://doi.org/10.1007/s42524-021-0153-5

Zhang, J., Long, J., & von Schaewen, A. M. E. (2021). How Does Digital Transformation Improve Organizational Resilience?—Findings from PLS-SEM and fsQCA. *Sustainability, 13*(20), 11487. doi: https://doi.org/10.3390/su132011487

Zhang, Y., Fong, P. S.-W., & Yamoah Agyemang, D. (2021). What Should Be Focused on When Digital Transformation Hits Industries? Literature Review of Business Management Adaptability. *Sustainability, 13*(23), 13447. doi: https://doi.org/10.3390/su132313447

Zhu, Z.-Y., Xie, H.-M., & Chen, L. (2023). ICT industry innovation: Knowledge structure and research agenda. *Technological Forecasting and Social Change, 189*, 122361. doi: https://doi.org/10.1016/j.techfore.2023.122361