Digital transformation and sustainable business growth: Evidence from SMEs in Vietnam's Mekong Delta

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A R T I C L E I N F O

A B S T R A C T

Digital transformation is increasingly recognized as a key driver of sustainable business development and effective change management in today's economy. This study examines the factors influencing digital transformation decisions among trade and service firms in Can Tho City, a major economic hub in Vietnam's Mekong Delta. By combining the Technology-Organization-Environment (TOE) framework and the Diffusion of Innovations (DOI) theory with principles of sustainable business, the study adopts a quantitative approach using survey data from 187 enterprises. The results identify seven key factors affecting digital transformation: relative advantage, organizational readiness, competitive pressure, government support, compatibility, managerial support, and pressure from partners and consumers. Among these, relative advantage is the most influential driver, while partner and consumer pressure have a negative impact, reflecting the challenges small and medium-sized enterprises (SMEs) face in adapting to change with limited resources. This study contributes to both theory and practice by offering a comprehensive framework for understanding digital transformation in the context of sustainable development. It provides valuable insights for policymakers and business leaders in emerging economies, emphasizing the importance of aligning technological change with sustainable business practices through effective change management strategies.

1. Introduction

The rapid evolution of digital technology has fundamentally transformed business environments globally, making digital transformation a critical component of sustainable business development and organizational change management (Vial, 2021; Al Haziazi, 2023). Digital transformation, characterized by the integration of digital technology across all business operations, has become essential for sustainable growth, competitive advantage, and long-term survival in the contemporary economy (Verhoef et al., 2021). However, while extensive research has examined this phenomenon in developed economies, a significant knowledge gap exists regarding its implementation within emerging economies, particularly in regions with unique socioeconomic characteristics.

The Mekong Delta of Vietnam represents such a distinctive context, where traditional agricultural practices intersect with emerging digital needs. In this region, small and medium-sized enterprises (SMEs) in the trade and service sectors constitute a vital component of Vietnam's economic framework (Minh et al., 2024), but face unique challenges in their digital journey. These firms struggle to implement digital transformation while maintaining sustainable business practices (Li et al., 2018) due to their limited resources, inadequate technological infrastructure, and insufficient change management capabilities (Ifinedo, 2011; Purwanto et al., 2022).

While established frameworks like the Technology-Organization-Environment (TOE) paradigm provide a foundation for examining digital transformation (Tornatzky et al., 1990), their application to sustainable business development in developing contexts remains insufficiently explored. This knowledge gap is particularly evident when considering how resource-constrained SMEs

integrate sustainability principles with digital transformation strategies (Martínez-Peláez et al., 2024). Furthermore, the unique interplay between governmental support, competitive pressures, and organizational readiness in emerging economies requires examination through a sustainability lens to address their distinctive dynamics effectively (Malik and Abdallah, 2019; Nayak and Pillai, 2024). Additionally, the interaction between external pressures from partners and consumers and the internal capabilities of SMEs frequently produces unexpected outcomes, highlighting the complexities of managing digital transformation in resource-limited environments while maintaining sustainable business practices (Matt et al., 2015).

This study addresses these gaps by empirically investigating the factors influencing digital transformation decisions among trade and service SMEs in Vietnam's Mekong Delta, with Can Tho City as a central case study. Can Tho's position as an economic and educational hub provides it with advantages in infrastructure, business networks, and technological readiness that may not be present in rural districts. Using data from 187 firms, the research examines technological, organizational, and environmental elements affecting digital transformation adoption, including relative advantage, compatibility, organizational readiness, government assistance, and competitive pressures.

The research makes significant theoretical and practical contributions. Theoretically, it enhances understanding of digital transformation in SMEs within sustainability contexts, extending the TOE framework's applicability to developing economies. Practically, it provides actionable insights for SMEs seeking to improve digital readiness while maintaining sustainable practices, and assists policymakers in developing targeted strategies for sustainable digital adoption in resource-limited environments. Additionally, the study highlights the often-overlooked dynamics of mid-tier cities like Can Tho, which serve as critical hubs for sustainable economic development in emerging economies. The findings emphasize the need for comprehensive approaches that integrate technological, organizational, and environmental factors with sustainable business practices to facilitate successful digital transformation in similar developing regions worldwide.

2. Theoretical framework

2.1. Digital transformation definition

Digital transformation has recently become one of the most prevalent terms on the World Wide Web due to its significance. Many researchers have attempted to define and discuss the precise meaning of this term, reaffirming the importance of conceptualizing digital transformation. Currently, there is no universally accepted definition in academic literature, and the boundaries of these concepts remain ambiguous. However, through a literature review, several fundamental aspects of digital transformation have been synthesized, as outlined below.

Stolterman and Fors (2004) described digital transformation as the changes induced or influenced by digital technologies in every aspect of human life. Martin (2008) emphasized the application of information and communication technologies in an era where automation processes are significantly implemented, fundamentally creating new capacities in business, government, and social life. Fitzgerald et al. (2014) extended the definition by framing digital transformation as leveraging new digital technologies to improve business operations, such as enhancing customer experiences or developing new business models. Consequently, digital transformation is not merely about digitizing resources to generate value or revenue but encompasses broader operational improvements.

Solis et al. (2014) proposed a more comprehensive view, considering digital transformation as restructuring or reinvesting in technologies and business models to effectively engage customers at every touchpoint in the digital age. Meanwhile, Kane et al. (2015) pointed out that while digitization involves converting information into digital formats, the terms "digital transformation" and "digitization" are often used interchangeably to describe a broader concept that impacts politics, business, and societal issues.

From prior research, several key elements of digital transformation emerge. First, technology plays a central role, relying on the use of innovative technologies such as social media, mobile devices, analytics, or embedded systems. Second, organizational change is essential, requiring alterations in organizational processes or the creation of new business models. Finally, societal impact is a significant factor, as digital transformation influences all aspects of human life, such as enhancing customer experiences.

2.2. TOE framework

The TOE framework (Fig. 1) is a widely utilized model for studying the adoption of new technologies by enterprises. Developed by Tornatzky et al. (1990), the framework is extensively applied to analyze technology adoption. It posits that the acceptance of a new technology by an organization is influenced by three main categories of factors:

- Technological factors: These factors include the availability and characteristics of the technology, such as its compatibility, complexity, and relative advantage. Incremental innovations are considered as new features added to existing technologies, while synthetic innovations involve applying or combining existing technologies in novel ways. Disruptive innovations, on the other hand, represent entirely new technologies that mark a significant departure from previous solutions. Incremental and synthetic innovations allow for

gradual adoption, while disruptive technologies often require swift, decisive, and irreversible adoption decisions (Ifinedo, 2011). Another important aspect of technological context is the technological competence required of employees responsible for implementation. The interaction between competence and innovation can be dual-faceted: adoption can either "enhance competence" by building on existing capabilities or "destroy competence" by requiring entirely new skill sets, rendering old ones obsolete.

- Organizational factors: Organizational characteristics such as structure, size, type of business, and communication processes play a crucial role in determining readiness for technology adoption. Larger organizations are often viewed as more innovative due to their greater financial resources, advanced infrastructure, diverse workforce, and technical capabilities, as well as their ability to mobilize funds when necessary. Conversely, smaller organizations may demonstrate greater innovation potential due to their flexibility, faster decision-making processes, lower bureaucracy, and higher levels of individual engagement from managers and employees. Research indicates that the positive effects of size, through increased financial

and human resources, influence all stages of adoption, while negative effects, such as rigidity and bureaucracy, mainly impact implementation. This insight helps organizations of various sizes identify which stages of the adoption process require improvement.

- Environmental factors: These factors consider the external conditions that influence an organization's readiness to adopt new technologies. Examples include ownership type (public or private), competition or cooperation with other companies, government regulations and policies, and the availability of technological support and infrastructure. Among these, competition has been widely studied as a driver of technology adoption, with intense competition often encouraging innovation adoption as a means of survival and gaining a competitive advantage.

The TOE framework provides a holistic perspective on technology adoption by integrating the technological, organizational, and environmental dimensions, offering valuable insights for researchers and practitioners aiming to understand the dynamics of innovation adoption across different organizational contexts.
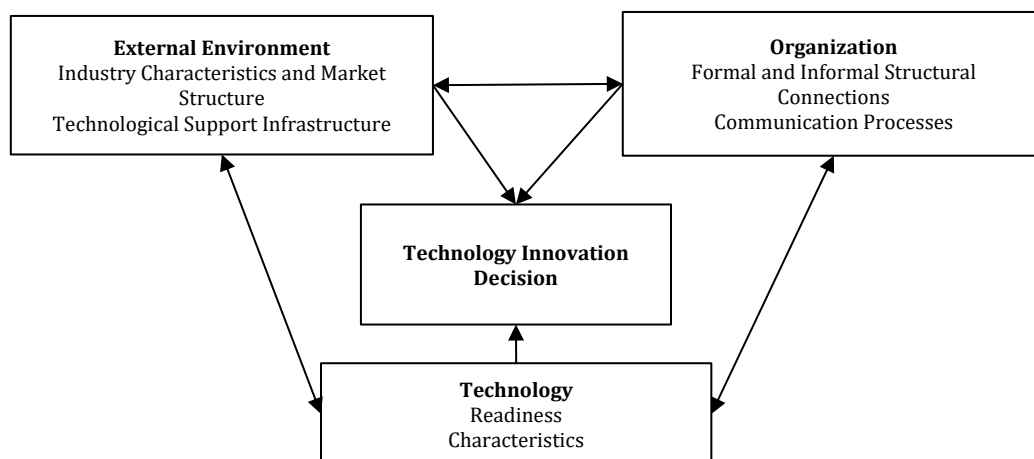

Fig. 1: TOE framework

2.3. Diffusion of innovations theory

The Diffusion of Innovations Theory, developed by Rogers (1962), outlines how new technological advancements and other innovations spread across societies and cultures, from their initial introduction to widespread adoption. This theory aims to explain how and why new ideas and practices are adopted, often over extended periods. By integrating previous sociological theories on behavior change, it illustrates how an idea is transmitted through various stages, adopted by different actors over time.

The way innovations are communicated to different segments of society and the subjective opinions about these innovations are critical factors influencing how quickly diffusion—or spread—occurs. This theory is particularly significant in

understanding market development and is frequently referenced in the marketing of new products.

The theory describes the patterns and speed at which new ideas, practices, or products are disseminated within a population. The key adopters in this theory are categorized into innovators, early adopters, early majority, late majority, and laggards. In marketing, this innovation diffusion theory is often applied to understand and accelerate the adoption of new products. Its application frequently involves identifying and recruiting influential early adopters to expedite consumer acceptance.

Five key factors influence the adoption of an innovation. Relative advantage refers to the degree to which the innovation is perceived as superior to existing solutions, offering significant improvements

or benefits. Compatibility measures how well the innovation aligns with the values, experiences, and needs of potential adopters, making it easier for them to integrate it into their current practices. Complexity examines the perceived difficulty in understanding or using the innovation, with simpler solutions generally being more readily adopted. Trialability highlights the extent to which an innovation can be tested or experimented with on a limited basis, allowing potential adopters to evaluate its effectiveness without significant commitment. Lastly, observability pertains to how visible and apparent the results or benefits of the innovation are to others, which can encourage further adoption by showcasing its impact. Together, these factors shape the rate and extent of innovation diffusion.

3. Methodology

3.1. Research hypothesis and proposed research model

To comprehend the dynamics of digital transformation in trade and service organizations, it is crucial to examine the fundamental elements affecting decision-making processes. This research, based on existing theories like the Diffusion of Innovations (DOI) and the TOE framework, reveals key factors that may influence the acceptance of digital transformation. The constructs encompass three principal dimensions: Technological factors, including relative advantage, complexity, and compatibility; organizational elements such as management support and readiness; and environmental pressures comprising competitive forces, partner and customer demands, and government support.

The DOI hypothesis posits that the relative advantage of a technology serves as a criterion for assessing its benefits in comparison to a similar conventional approach or technology. Relative advantage refers to the extent to which an innovation is regarded as superior to the concept it supersedes. Consequently, if the advantages of a technical breakthrough are deemed superior to current systems and practices, its adoption will be vigorously promoted. The increased recognition of innovation's benefits correlates with a heightened probability of its acceptance (Ifinedo, 2011). Perceptions of digital technology as useful, convenient, dependable, and superior to traditional technology represent its relative advantage. A bigger relative advantage of a technology correlates with increased acceptance of digital technologies (Hussein and Baharudin, 2017; Oh et al., 2022). Consequently, the proposed theory is:

H₁: Relative advantage positively influences digital transformation decisions.

Rogers (1962) defined complexity as the extent to which an invention is regarded as particularly challenging to comprehend and utilize. The adoption of an invention by an organization is impeded when adopters regard it as difficult (Ifinedo, 2011). Numerous studies have identified a substantial correlation between complexity and the adoption of e-commerce. Small and medium-sized enterprises may regard e-commerce as intricate and inappropriate for their existing operational capacity (Ahmad et al., 2015). While complexity is perceived to negatively impact IT adoption, it is acknowledged as a critical component affecting the digital transformation of SMEs (Ramdani et al., 2013). Consequently, the proposed theory is:

H₂: Complexity negatively influences digital transformation decisions.

The compatibility of an invention with an enterprise is described as the extent to which the innovation is regarded as aligned with current values, prior experiences, and the requirements of prospective adopters (Rogers, 1962). Premkumar and King (1994) recognized compatibility as a crucial determinant of IT adoption. For SMEs, modifications must correspond with the organization's infrastructure, values, and principles (Ramdani et al., 2013). Technological innovations are more freely and easily diffused when they align with the adopter's processes (Ifinedo, 2011). Consequently, the proposed theory is:

H₃: Compatibility positively influences digital transformation decisions.

Management support refers to the active involvement of leadership in implementing digital technologies (Ifinedo, 2011). Senior management support is considered one of the best predictors of an organization's IT adoption. Ramdani et al. (2013) argued that senior leaders can drive change by communicating and reinforcing values through a clear vision for the organization. In SMEs, decision-makers are often senior managers, and their support is crucial for IT adoption. A positive attitude of senior managers toward change is vital to creating an organizational environment receptive to innovation. Management support is a critical factor in the success of digital transformation. Thus, the proposed hypothesis is:

H₄: Management support positively influences digital transformation decisions.

Organizational readiness refers to the availability of the necessary resources for adoption, encompassing not only physical assets but also human capital and knowledge of digital technology (Ifinedo, 2011). Ramdani et al. (2013) argued that organizational readiness assesses whether a company has sufficient IT sophistication and financial resources; economic costs and lack of technical knowledge are identified as two major barriers to IT development in small organizations. IT sophistication evaluates whether a company is

technologically prepared, while financial resources reflect the organization's available capital to invest in IT. Thus, the proposed hypothesis is:

H₅: Organizational readiness positively influences digital transformation decisions.

Michael Porter's Five Forces Model identifies five competitive pressures businesses face: current competitors, potential competitors, suppliers, customers, and substitute products. Intense competition can compel a business to explore new ways of operating, including leveraging technological innovations to survive. Malhotra and Grover (1998) asserted that business partner pressure drives the implementation of e-commerce and related technologies to improve trade transactions and relationships. Hart and Saunders (1997) found that business partner influence significantly predicts the adoption of technological innovations. Ifinedo (2011) stated that the primary driver for businesses to innovate is customer feedback and demand. Thus, the proposed hypotheses are:

H₆: Competitive pressure positively influences digital transformation decisions.
H₇: Partner and customer pressure positively influence digital transformation decisions.

Digital transformation offers opportunities for all nations, with developing countries potentially leveraging these opportunities for rapid digital transformation. Government support is essential for encouraging the dissemination of digital innovations among businesses. If SMEs overlook external support, successful digital transformation cannot be achieved, aligning with the DOI theory and the TOE model. Recognizing the vitality of SMEs, governments have implemented policies, funding programs, and consultations within their national economic plans to support and improve conditions for SMEs, helping them achieve sustainable growth, which is key to successful digital transformation. Zhang et al. (2022) found that government support increases SMEs' positive perceptions of digital transformation and its success. Governments can enhance policies, initiatives, training programs, and ecosystems to support SMEs' digital transformation. Thus, the proposed hypothesis is:

H₈: Government support positively influences digital transformation decisions.

3.2. Proposed research model

Drawing on established theoretical frameworks and empirical studies, along with the traits and features of the research subjects, the authors present a research model (Fig. 2) to examine the determinants affecting the digital transformation choices of trade and service firms in the city. The model incorporates insights from recognized frameworks, like as the Technology Acceptance Model (TAM) and the TOE framework, while also accounting for the distinct dynamics of local enterprises.

3.3. Research scale

The measurement scale utilized in this study is based on established frameworks and comprises 34 items categorized under three primary dimensions: Technology, Organization, and Environment. Each variable is measured using a 5-point Likert scale, where 1 represents "strongly disagree" and 5 represents "strongly agree."

The Technology dimension includes three constructs: Complexity, Compatibility, and Relative Advantage. Complexity examines the intricacy of digital transformation activities, such as the requirement for advanced skills, significant investment in talent training, and the extensive time needed for implementation. These items are adapted from Fu and Lee (2021). Compatibility evaluates the alignment of digital transformation with the existing hardware and software of the company, its business scope, strategy, and culture. These variables are also based on Fu and Lee (2021). Relative Advantage measures the benefits of digital technologies, such as enhanced operational efficiency, improved operational quality, and better control over activities. This construct draws on the work of Ifinedo (2011).

The Organizational dimension consists of two constructs: Organizational Readiness and Management Support. Organizational Readiness assesses the company's preparedness for digital transformation, considering the adequacy of financial resources, personnel, IT infrastructure, and employee capabilities. Management Support examines senior managers' belief in the importance of digital transformation, their knowledge of its future implications, their active support for digitization efforts, and their ability to allocate necessary resources. These variables are informed by Fu and Lee (2021) and Ramdani et al. (2013).

The Environmental dimension incorporates three constructs: Government Support, Competitive Pressure, and Partner and Customer Pressure. Government Support evaluates the government's role in promoting digitization through strategies, funding, and incentive policies. Competitive Pressure measures the influence of industry competitors on digital transformation adoption, including efforts to strengthen customer relationships and gain competitive advantages. Similarly, Partner and Customer Pressure captures the impact of partners and suppliers who have adopted digital technologies, assessing how their actions influence the broader industry. These items are also derived from Fu and Lee (2021).

Finally, the construct of digital transformation examines the company's inclination, intention, and commitment to continuously adopt digital transformation practices. These variables are again supported by Fu and Lee (2021). Collectively, this

measurement scale ensures a comprehensive assessment of the factors influencing digital

transformation, integrating insights from prior research to maintain academic rigor.
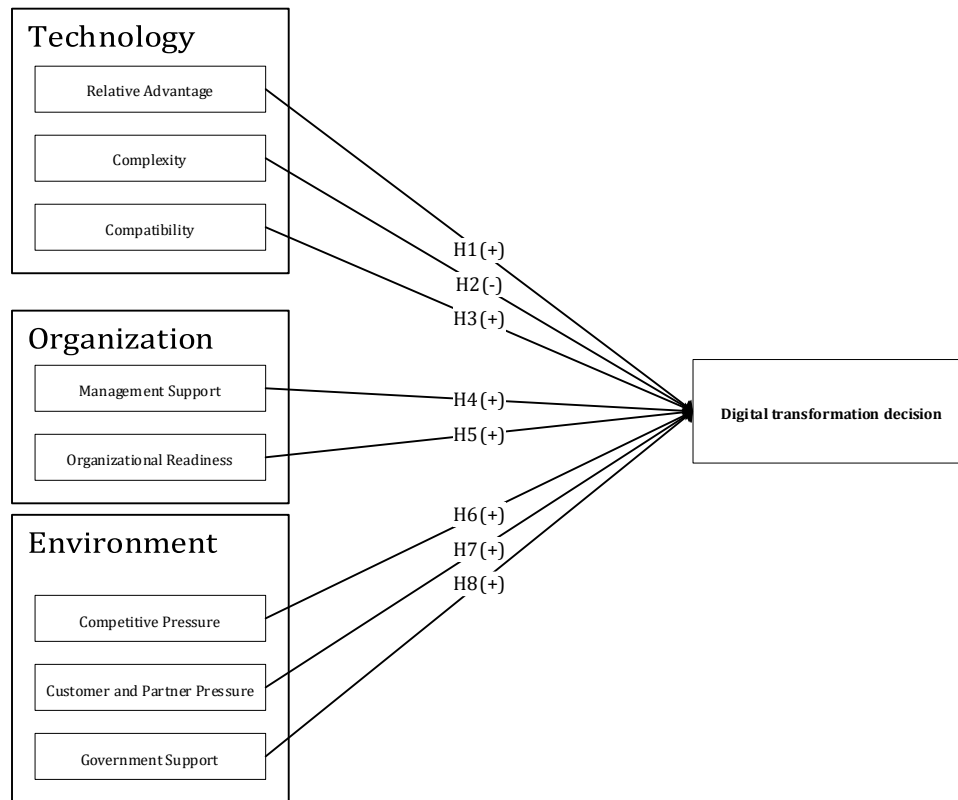

Fig. 2: Proposed research model

3.4. Data collection

This study addresses critical gaps by empirically investigating the factors influencing digital transformation decisions among trade and service SMEs in the Mekong Delta region, with Can Tho City serving as a central case study due to its role as the region's economic and educational hub. With particular attention to sustainable business development and change management processes, the research examines the roles of technological, organizational, and environmental elements, including relative advantage, compatibility, organizational readiness, government assistance, and competitive pressures, while considering the unique contextual characteristics of sustainable development in this agriculturally driven region. To ensure methodological rigor, the sampling approach was carefully considered. While larger sample sizes generally yield better results, they require more cost and time, resources often limited in regional studies. Following established research practices, this study determined sample size through empirical formulas based on the chosen quantitative method. For the exploratory factor analysis model employed, Hair et al. (2006) recommended a minimum level of 50 observations, with an observation-to-variable ratio of 5:1 or 10:1.

Given the constructed model's 8 scales with 34 measurement variables and applying the 5:1 ratio, a sample size of 170 observations was calculated (n=5×34). To enhance research accuracy and

account for potentially invalid responses, 190 businesses were surveyed. After eliminating 3 invalid questionnaires, data from 187 firms were analyzed using SPSS software. This methodologically sound approach enabled the study to both validate existing theoretical frameworks and challenge conventional wisdom, particularly regarding the surprising negative impact of external pressures from partners and customers on sustainable transformation initiatives in this unique regional context.

4. Results

4.1. Description of the research sample

The survey results from 187 respondents, as presented in Table 1, indicate that the majority of respondents (52.9%) were between the ages of 31 and 45. Male respondents constituted a higher proportion (52.4%) than females, as managerial roles from mid-level upward were more often held by men. Approximately 11% of the respondents were members of the board of directors, while the remaining respondents held roles such as department heads or deputies in areas like accounting, human resources, marketing and sales, and operations. A significant majority (83%) of the respondents had over six years of work experience, suggesting adequate competence and knowledge about digital transformation in their respective companies.

Table 1: Summary of research sample

Criterion	Frequency	Percent (%)
Gender		
Male	98	52.4
Female	89	47.6
Age		
20–30 years	44	23.5
31–45 years	99	52.9
46–60 years	44	23.5
20–30 years	44	23.5
Position		
Board of directors	21	11.3
Department heads/deputies	166	88.7
Work areas		
Accounting	53	28.3
Human resources	34	18.2
Marketing and sales	40	21.4
Operations	60	32.1
Working experience (years)		
1–5	31	16.6
6–10	61	32.6
11–15	46	24.6
>15	49	26.2
Company age		
≤5 years	31	16.6
6–15 years	98	52.4
>15 years	58	31.0
Business type		
Trade	127	67.9
Services	60	32.1
Enterprise type		
Joint-stock	39	20.9
Limited liability company	93	49.7
Partnership	15	8.0
Private	29	15.5
Others	11	5.8
Number of employees		
≤50	106	56.7
51–100	53	28.3
>100	28	14.9
Duration of digital transformation		
1–2 years	109	58.3
3–4 years	57	30.5
>5 years	21	11.2

This study examined several company kinds, emphasizing trade firms (two-thirds) and service enterprises (one-third). Enterprises with operational lengths of 6 to 15 years included 52.4%, while those exceeding 15 years represented 31%, suggesting that more established enterprises exhibit a heightened interest in digital transformation. Most of the questioned enterprises (57%) were small businesses, followed by medium-sized enterprises (28%) and large enterprises (15%). Small and medium-sized enterprises (SMEs) comprised 85% of the overall sample, highlighting the dominance of this sector in Vietnam. Of these, 41.7% had been engaged in digital transformation for over three years, and the remainder had initiated their efforts during the past one or two years.

4.2. Analysis of factors influencing digital transformation decisions

The study utilized Cronbach's alpha for reliability assessment, exploratory factor analysis (EFA), and ordinary least squares (OLS) regression analysis. The Cronbach's alpha analysis of the 34 observed variables indicated that only variable TT1 was excluded; the remaining 33 variables satisfied the criterion with alpha values exceeding 0.6 and overall correlation coefficients surpassing 0.3, thus qualifying for EFA. As shown in Table 2, following two rounds of Exploratory Factor Analysis for independent variables, the variables CP3 and CT1 were eliminated. The Kaiser-Meyer-Olkin (KMO) value was 0.828 (>0.5), and Bartlett's test of sphericity produced a Chi-square with a significance level of Sig.=0.000, validating the data's adequacy. All factor loadings exceeded 0.5, and the analysis identified 8 factors that accounted for 67.02% of the variance in the data. The dependent variable had analogous validation and satisfied EFA criteria.

Table 2: Regression model results

Factor	Standardized beta	S.E.	Sig.	VIF
Organizational readiness	0.425	0.040	0.000	1.000
Complexity	0.040	0.040	0.321	1.000
Partner and customer pressure	-0.072	0.040	0.076	1.000
Competitive pressure	0.332	0.040	0.000	1.000
Management support	0.239	0.040	0.000	1.000
Relative advantage	0.455	0.040	0.000	1.000
Compatibility	0.255	0.040	0.000	1.000
Government support	0.285	0.040	0.000	1.000

Adjusted R^2: 70.9%; F-test sig.: 0.000; Durbin-Watson: 1.886; S.E.: Standard error; VIF: Variance inflation factor

The research findings offer a comprehensive insight into the factors affecting digital transformation in SMEs throughout the commercial and service sectors in Vietnam's Mekong Delta. The study utilized rigorous methodologies, such as reliability testing, EFA, and OLS regression, to identify key factors influencing the decision to embrace digital transformation, thus providing valuable theoretical and practical insights.

5. Discussion

This study presents a comprehensive analysis of factors influencing digital transformation among SMEs in Vietnam's Mekong Delta region, yielding several significant insights that both confirm and challenge existing theoretical frameworks. By examining technological, organizational, and environmental dimensions simultaneously, our findings reveal complex interactions that contribute to a more nuanced understanding of digital transformation in emerging economies. The results not only enhance theoretical understanding but also provide actionable insights for practitioners and policymakers seeking to promote sustainable digital adoption. Our regression model explains 70.9% of the variance in digital transformation decisions (adjusted R^2=0.709), indicating strong explanatory power that can guide practical interventions in this resource-constrained context.

The data indicate that relative advantage stands as the most influential factor driving digital transformation decisions (β=0.455, p<0.001), aligning with previous studies by Ifinedo (2011) and Ramdani et al. (2013). This substantial effect size suggests that a one standard deviation improvement in demonstrating tangible benefits would increase digital transformation adoption by nearly half a standard deviation, representing a considerable practical impact for SMEs. Our results suggest that in the resource-constrained context of Mekong Delta SMEs, the threshold for demonstrating value may be significantly higher than in developed economies. Unlike findings from advanced economies where competitive positioning often drives adoption (Verhoef et al., 2021), our data indicates that Mekong Delta SMEs require concrete evidence of immediate operational improvements and cost reductions before committing to digital initiatives. This finding extends the applicability of Rogers' (1962) innovation diffusion theory by highlighting how economic context modifies the relative advantage threshold necessary to trigger adoption.

Building on the importance of foundational capabilities, organizational readiness (β=0.425, p<0.001) emerged as the second most influential factor, underscoring internal capability as a prerequisite for transformation efforts. This large effect size underscores internal capability as a prerequisite for transformation efforts and suggests that investments in basic technological infrastructure and personnel skills would yield substantial returns. In practical terms, for SMEs with limited resources, allocating budget to improve organizational readiness would generate approximately 85% of the impact of relative advantage initiatives while potentially requiring less investment. This finding aligns with Ramdani et al. (2013) but differs from studies in other contexts where different organizational aspects take precedence. Our findings suggest that in emerging economies, the foundational elements of readiness—financial resources, skilled personnel, and basic technological infrastructure—represent more fundamental barriers than the cultural and process challenges that dominate discussions in developed markets. This indicates a hierarchical relationship between transformation factors that is not adequately captured in existing TOE applications as described by Tornatzky et al. (1990).

The external business environment also plays a crucial role, as competitive pressure (β=0.332, p<0.001) functions as a significant catalyst with a moderate to large effect size on digital transformation. In practical terms, increased competitive intensity in a market would drive digital transformation adoption at about 73% of the rate of relative advantage, making it an important but secondary factor. Unlike studies from more industrialized regions (Zhang et al., 2022), our results suggest that competitive influences in the Mekong Delta operate more as accelerators than initiators of digital transformation. This distinction highlights how market structure and competitive intensity in regional economic hubs like Can Tho shape adoption patterns differently than in major metropolitan centers or rural areas, supporting observations by Li et al. (2018) about contextual influences on digital transformation.

Similarly, government support (β=0.285, p<0.001) demonstrates substantial influence on transformation decisions, with an effect size approximately 63% as strong as relative advantage, confirming the findings of Zhang et al. (2022) on policy impact in SME contexts. This moderate effect size suggests that government initiatives can meaningfully impact adoption rates, though perhaps not as dramatically as improving perceived benefits or organizational readiness. The findings show the government support's positive impact on digital transformation in Ho Chi Minh City, while our study extends this understanding to the Mekong Delta region. From a practical perspective, a well-designed government support program could potentially increase digital transformation adoption by approximately 2.9% for every 10% increase in support quality or availability.

Technological alignment also proves significant, as compatibility (β=0.255, p<0.001) considerably impacts digital transformation decisions, supporting conclusions of Ahmad et al. (2015) while revealing important contextual nuances specific to the Mekong Delta. Our data indicates that for Mekong Delta SMEs, compatibility extends beyond technical integration concerns to encompass broader alignment with traditional business practices and established relationship networks that characterize this region. This finding supports Matt et al.'s (2015) observation that digital transformation strategies must align with existing organizational structures and processes. The result highlights how digital transformation in regions transitioning from traditional to digital economies must navigate not only technical compatibility challenges but also deep-rooted cultural and operational considerations.

The human element remains essential, as management support (β=0.239, p<0.001) plays a vital role in driving digital transformation, as emphasized by Ramdani et al. (2013). Our findings confirm that leadership commitment remains crucial in the Mekong Delta context, though its relative importance compared to other factors suggests interesting contextual variations in how management influence operates in different economic environments.

Perhaps most significantly, our finding that partner and customer pressure exhibits a negative relationship with digital transformation decisions (β=-0.072, p=0.076) directly contradicts theoretical expectations derived from the TOE framework. This counterintuitive result reveals a critical limitation in applying standard theoretical assumptions to emerging economies. Unlike in developed markets where customer and partner demands typically drive innovation, in the Mekong Delta context, external pressures appear to overwhelm SMEs'

capabilities, creating resistance rather than motivation. This finding aligns with observations by Purwanto et al. (2022) about the challenges SMEs face in resource-constrained environments and highlights how resource limitations can fundamentally alter response patterns to external pressures.

The interrelationships between factors and their varying effect sizes reveal important theoretical and practical implications. Our findings suggest a hierarchical structure among adoption factors, with relative advantage ($\beta=0.455$) and organizational readiness ($\beta=0.425$) functioning as necessary conditions with the largest effects, while compatibility ($\beta=0.255$) and management support ($\beta=0.239$) serve as enabling factors with moderate effects that facilitate implementation once the fundamental conditions are met. For practitioners, this suggests a sequential approach to digital transformation, focusing first on building basic capabilities and demonstrating clear benefits before addressing alignment and leadership issues.

Furthermore, the significant variation in factor influence challenges the universal applicability of standard TOE framework weightings. While the framework's three dimensions remain relevant, their internal dynamics and relative importance appear to be contingent on regional economic development stages. Our findings suggest that in emerging economies like Vietnam's Mekong Delta, technological and organizational factors carry more weight than typically observed in studies from developed economies, where environmental factors often predominate.

In conclusion, this study provides a nuanced understanding of digital transformation drivers in the Mekong Delta context, not only identifying which factors matter but quantifying their relative importance through effect sizes. Our findings reveal how theoretical models require contextual adaptation when applied to emerging economies and provide practical guidance on where limited resources should be allocated to maximize digital transformation outcomes. The substantial variance explained by our model (70.9%) suggests that focusing on these key factors can significantly impact adoption success in resource-constrained environments. By identifying both the primary drivers and potential barriers to transformation, along with their relative magnitudes, this research contributes to developing more effective strategies for sustainable digital adoption in similar developing regions worldwide

6. Conclusions

This study constructed a comprehensive research model, based on known theoretical frameworks, to analyze the determinants affecting digital transformation decisions in trade and service firms in Can Tho City. Based on data from 187 enterprises, the results identified seven critical factors: Relative advantage, organizational readiness, competitive pressure, government assistance, compatibility, management support, and partner and customer pressure. Relative advantage emerged as the predominant factor, underscoring the significance of perceived technological gains in facilitating adoption. Organizational readiness, competitive pressure, and government support highlighted the essential importance of internal capabilities and external assistance in facilitating transition, while compatibility and management support stressed the necessity for technology alignment and leadership dedication. Notably, pressure from partners and customers adversely affected adoption, highlighting the difficulties encountered by small and medium firms (SMEs) in fulfilling external expectations with constrained resources.

These findings have significant practical implications for multiple stakeholders. For SME managers in the Mekong Delta, our results suggest prioritizing investments in foundational readiness and focusing on immediate operational benefits when evaluating digital technologies. Rather than responding reactively to external pressures, managers should develop staged implementation plans that align with their organizational capabilities and resources. The negative impact of partner-customer pressure indicates that SMEs should carefully evaluate external demands and potentially develop buffering strategies when these demands exceed current capabilities. For policymakers, our results highlight the effectiveness of government support ($\beta=0.285$) while suggesting that the highest return on public investment would come from programs that help SMEs understand and quantify potential benefits from digital technologies (addressing relative advantage) and build basic technological capabilities (addressing organizational readiness). Support programs should be differentiated based on SME readiness levels rather than applying one-size-fits-all approaches. The small negative effect of partner-customer pressure ($\beta=-0.072$) suggests that policies encouraging large businesses to impose digital requirements on SME suppliers should be accompanied by appropriate support mechanisms to prevent resistance.

This research makes significant theoretical contributions by expanding both the TOE framework and DOI theory beyond their conventional applications. The expanded models we propose better capture the complex realities of digital transformation in emerging economies, where resource limitations fundamentally alter how organizations respond to technological opportunities and environmental pressures. This study goes beyond merely applying the TOE framework and DOI theory by revealing significant extensions to both models in the context of emerging economies. Our findings expand the TOE framework in three fundamental ways. First, we demonstrate that the relative weights of the technological, organizational, and environmental dimensions vary substantially in resource-constrained contexts, with technological and organizational factors carrying significantly

more influence than in developed economies. This challenges the implicit assumption in many TOE applications that the three dimensions have relatively balanced importance across contexts.

Second, rather than operating as parallel influences, our findings show that certain factors (relative advantage and organizational readiness) function as necessary foundational conditions, while others (compatibility and management support) serve as enabling factors that become influential only after the foundational conditions are met. This expands the TOE framework from a flat, concurrent model to a multi-stage, hierarchical one that better captures the complex reality of digital transformation in emerging economies.

Third, our unexpected finding regarding the negative impact of partner and customer pressure substantially reconfigures the environmental dimension of the TOE framework. Traditional applications universally position external business pressures as adoption drivers, but our results necessitate a more nuanced division of environmental influences into competitive pressures (which drive adoption) and relational pressures (which may inhibit adoption in resource-constrained contexts). This important distinction expands the TOE framework's applicability to environments where resource limitations fundamentally alter response patterns to external influences.

Similarly, our findings extend Rogers's (1962) DOI theory by demonstrating that the threshold for 'relative advantage' varies significantly between developed and emerging economies. While DOI theory posits relative advantage as a universal adoption driver, our research shows that in resource-constrained environments, the perceived benefits must be substantially more concrete, immediate, and significant to trigger adoption than in resource-rich contexts. This contextual calibration of innovation attributes expands DOI theory beyond its implicit assumptions of relatively consistent thresholds across different economic environments. This finding suggests that the TOE framework's environmental dimension may need to distinguish between competitive pressures (which drive adoption) and relational pressures (which may inhibit adoption in resource-constrained environments). This nuanced distinction is absent from current theoretical formulations but appears critical for understanding adoption dynamics in developing regions.

While our findings provide valuable insights for theory and practice, it is important to acknowledge several methodological limitations that contextualize these results. First, the survey methodology may have introduced response biases that could influence the findings. Self-selection bias may be present, as firms more actively engaged in digital transformation might have been more willing to participate in the study, potentially skewing the sample toward organizations with higher digital readiness.

The sample characteristics also present limitations for generalizability. The distribution of respondents across sectors—with trade firms (67.9%) significantly outnumbering service enterprises (32.1%)—may not perfectly represent the broader economic landscape of the Mekong Delta region. Furthermore, the focus on Can Tho City as an urban center means our findings might not fully capture the experiences of businesses in more rural areas of the Mekong Delta, where infrastructure challenges, resource constraints, and business practices might differ considerably.

Our sample size of 187 firms, while sufficient for the statistical analyses performed, represents a relatively small proportion of the total SME population in the region. This limitation becomes particularly relevant when considering the diversity of business types, sizes, and digital maturity levels across the Mekong Delta. Additionally, the cross-sectional design of the study captures digital transformation at a specific point in time, which limits our ability to observe how these factors influence adoption processes over time or how relationships between factors might evolve as businesses progress through different stages of digital maturity.

Despite these limitations, the strong explanatory power of our model and the consistency of many findings with previous research suggest that the key insights remain valid and valuable for understanding digital transformation in emerging economy contexts.

Compliance with ethical standards

Ethical considerations

This study was conducted in accordance with ethical standards applicable to research involving human participants. All respondents were informed of the purpose of the study and participated voluntarily. Anonymity and confidentiality were guaranteed, and no personally identifiable information was collected or disclosed.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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