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Relationship between Dynamic Digital Capabilities, Digital Transformation, Digital Technology Acceptance, and Firm Performance

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Abstract

Purpose: Recent studies have introduced that digital transformation positively impacts firm performance. However, research on the relationship between organizational capabilities or attitudes as antecedents or situational variables for successfully driving digital transformation remains limited. Therefore, this study aims to systematically analyze how dynamic digital capabilities and the mutual relationships between organizational members' digital acceptance influence firm performance throughout the process of driving and achieving digital transformation. **Research design, data, and methodology:** This study developed the concepts and measurement items for each variable based on prior research. A survey was conducted with 258 companies participating in mini clusters within industrial complexes across the county. The data was analyzed using a structural equation model with the AMOS software package. **Results:** Based on existing literature, hypotheses were formulated regarding the causal relationships among variables, and analysis was conducted. The results indicate that digital transformation and employees' technological acceptance play a mediating role in the relationship between dynamic digital capabilities and firm performance. Specifically, the organization's dynamic digital capabilities enhance both digital transformation and technological acceptance. Moreover, digital transformation leads to higher firm performance when technological acceptance is high. **Conclusions:** This study has shown the importance of enhancing dynamic digital capabilities as a prerequisite for driving digital transformation and highlighted the significance of organizational members' perceptions and attitudes toward information technology. Particularly, through detailed causal analysis among the specific items of each variable, insights were gained for both academic and practical applications.

Keywords: Digital Transformation, Dynamic Digital Capabilities, Digital Acceptance, Firm Performance

JEL Classification Code: L11, M10, M11, M15, M16

1. Introduction

The Fourth Industrial Revolution, sparked by the convergence of information and communication technologies, is transforming nearly every aspect of society, culture, and economy worldwide, including our lifestyles

and values. In this environment, traditional industries and social structures are undergoing significant changes through the integrated use of advanced digital technologies such as artificial intelligence, big data, the Internet of Things (IoT), and cloud computing. This process, known as digital transformation, involves organizations, including

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businesses and governments, actively adopting digital technologies to innovate business models and operational processes (Kraus et al., 2021). Governments are establishing relevant regulations to promote the spread of digital transformation across industries and have devised strategies such as the 'Digital-Based Industrial Innovation Growth Strategy,' akin to Korea's New Deal policy, to foster a climate conducive to digital transformation among enterprises (Choi et al., 2021).

In the corporate realm, digital transformation is perceived as essential for enhancing competitiveness and improving operational efficiency. Companies are rapidly driving digital transformation across various sectors to enhance effectiveness and efficiency, encompassing swift business restructuring, early-stage product development, and optimized production systems (Liu et al., 2023; Zheng et al., 2023). Research suggests that digital transformation yields both direct financial outcomes (Karimi & Walter, 2015) and non-financial benefits such as innovation, organizational growth (Tumbas & Berente, 2015), and enhanced competitiveness (Neumeier et al., 2017).

However, digital transformation brings about changes in organizational structure and work practices within individual companies, requiring consensus and acceptance among employees toward achieving goals and sometimes necessitating conflict resolution among them. Successful leadership in driving digital transformation demands different approaches and capabilities from traditional leadership, a concept increasingly studied under the umbrella of digital leadership (Gonciarski & Swiatkowski, 2018; Kokot et al., 2021; Oberer & Erkollar, 2018; Tanniru, 2018).

Digital transformation is considered a management innovation process, focusing on altering existing organizational roles and business methods. Key research topics in management innovation include managerial leadership, the capabilities of organizational members, and their attitudes toward change. Existing studies suggest that digital leadership and digital capabilities are leading factors in digital transformation, with the relationship to 'dynamic digital capabilities' also being examined in light of the evolving digital environment (Kim & Ahn, 2024).

For digital transformation to be successful and yield desired management results, it is crucial for organizational members to recognize the need for technological adoption and work changes, and to actively utilize digital technology in their roles. However, systematic research on the relationship between these perceptions and attitudes—specifically the acceptance of technology by organizational members—and a company's digital capabilities, digital transformation, and business performance is limited.

This study highlights the increasing importance and interest in digital transformation across organizations,

driven by rapid changes in digital technologies and growing market uncertainty. Understanding the relationships and roles among various variables that directly and indirectly influence digital transformation is crucial. Many studies have introduced the positive impact of digital transformation on firm performance, yet research on organizational capabilities and attitudes as prerequisites or situational variables for successful digital transformation remains limited. Therefore, this study aims to systematically analyze how dynamic digital capabilities and employees' digital acceptance within an organization impact firm performance through the process of digital transformation. Specifically, it seeks to examine the causal relationships between dynamic digital capabilities, level of digital transformation, digital technology acceptance, and firm performance. Furthermore, it empirically analyzes how dynamic digital capabilities mediate the path to firm performance through digital transformation and the role of employees' technological acceptance in this process. The findings of this research are expected to provide insights useful for understanding the role of dynamic digital capabilities and technological acceptance in successfully driving and enhancing the outcomes of digital transformation initiatives.

2. Research Background

2.1. Digital Transformation

Digital transformation generally refers to the innovation of a company's traditional operating methods and services by introducing and integrating advanced digital technologies such as artificial intelligence (AI), big data, and the Internet of Things (IoT) (Kraus et al., 2021). Before the advent of digital transformation, digital technology was employed under the concepts of automation and informatization. However, digital transformation emphasizes fundamental changes in existing organizations or businesses through the use of advanced and converged technologies, aiming for a more systematic framework for managing change. This distinction sets digital transformation apart from mere automation and informatization (Kim & Ahn, 2024).

Research topics on digital transformation can generally be categorized into two main areas: 'the latest digital technology' and 'business changes utilizing digital technology' (Kim & Ahn, 2024).

First, research focusing on 'the latest digital technology' examines the development process of digital technology within organizations, the characteristics of digital technology, and the level and effect of technology adoption. For example, Li (2018) and Cichosz et al. (2020) studied the convergence process of cutting-edge technologies that

integrate various recent digital systems. Kim (2019) explored the implementation of systems that combine the physical and virtual worlds through the use of AI and IoT technologies, along with accumulated data. Ghobakhloo (2020) analyzed changes in digital technology during the process of product, organizational structure, and process innovation.

In studies on 'business changes utilizing digital technology,' Hess et al. (2016) investigated the impact of digital technology on business strategy and organizational changes. Bharadwaj et al. (2013) argued that digital technology fundamentally transforms the interrelationships among business strategy, business processes, company capabilities, products and services, and expanded business networks. Peter and Kraft (2020) systematically analyzed the mechanisms that enhance a company's work processes through digital technology.

Digital transformation is recognized both theoretically and practically as a significant factor influencing financial and non-financial firm performance (Karimi & Walter, 2015; Kim & Ahn, 2024; McLaughlin, 2017). Factors influencing digital transformation include digital leadership (Kim & Ahn, 2024), dynamic capabilities (Jaisy & Hamidah, 2023), and dynamic digital capabilities (Kim & Ahn, 2024).

2.2. Dynamic Digital Capabilities

In traditional resource-based theory, the ability of a company to create value by combining tangible and intangible resources is referred to as capability or competence. Among the capabilities a company possesses, core competence is known to be the source of competitive advantage, differentiating it from competitors and serving as the foundation of business success (Prahalad & Hamel, 1990). Furthermore, Teece (2018), based on the logic of creating a driving force for innovation through creative destruction, defined dynamic capabilities as the abilities of companies to sense new environments, seize business opportunities, and reorganize business practices to transform the resources they possess.

As information technology has advanced and its utilization within organizational settings has increased, research into digital capabilities, particularly IT field capabilities, has become more active. Audrina et al. (2024) conducted a comprehensive analysis of existing research on digital capabilities, categorizing eight areas including technology use, cybersecurity, content management, communication and collaboration, critical inquiry, responsibility, well-being, and identity and development, into digital capabilities required in the business field. Recently, companies have recognized the rapidly changing business environment and the advancements in convergent information technology. They have identified the

appropriate information technology needed for their organizations and are systematically introducing it, focusing on agility and flexibility to innovate business processes. Interest and research on capabilities and procedures are ongoing. For example, Kim and Ahn (2024) established the concept of 'dynamic digital capabilities' as a dynamic capability in the digital environment and analyzed its relationship with other variables. They divided dynamic digital capabilities into three areas: digital sensing, digital seizing, and digital transforming, systematized measurement items, and demonstrated that these items are important elements for improving the level of digital transformation.

In the business domain, just as dynamic capabilities have various impacts on organizational structure, business processes, organizational culture, and managerial performance, analyzing the diverse impacts of dynamic digital capabilities on organizations, business processes, and managerial performance is also considered to be a meaningful area of research.

2.3. Digital Acceptance

The intention to accept technology refers to the willingness of organizational members to use tools, technologies, and systems to achieve a specific purpose. It directly influences consumer behavior and is a crucial factor for predicting future actions (Fishbein & Ajzen, 1980). Research on this topic can be broadly divided into individual-level and organizational-level acceptance intentions.

A representative technology acceptance model at the individual level is Davis's (1989) Technology Acceptance Model (TAM). TAM identifies the perceived usefulness and ease of use of an information system as factors influencing the intention to use the system. To address the limitations of existing technology acceptance models, Venkatesh et al. (2003) developed the Unified Theory of Acceptance and Use of Technology (UTAUT). This model suggests that performance expectancy, effort expectancy, social influence, and facilitating conditions are factors that influence the intention to use technology. In both TAM and UTAUT, intention to use is measured by terms such as 'intent to use', 'expect to use', and 'plan to use' the information system.

At the organizational level, technology acceptance models include the DOI and TOE models. The Diffusion of Innovation (DOI) framework, developed by Rogers (1983), explains technology acceptance by suggesting that factors such as relative advantage, compatibility, and complexity influence an organization's acceptance of technological innovation. However, DOI has been criticized for focusing solely on technical factors. Consequently, the Technology, Organization, and Environment (TOE) framework emerged.

The TOE framework presents factors influencing the adoption and implementation of technological innovation in an organization as ‘technology characteristics’, ‘organizational characteristics’, and ‘environmental characteristics’ (Li et al., 2022; Ziba & Kang, 2020). According to the TOE, technical characteristics include technological readiness, security, IT knowledge, and compatibility with other technologies. Organizational characteristics encompass the organization's size, resources, leadership, processes, budget, and human resources. Environmental characteristics include the industry and market structure to which the company belongs, competitors, government regulations, and support.

Intention to accept technology is specified as ‘intention to use’, ‘necessity’, ‘service help’, and ‘utilize for work’. The validity and effectiveness of the TOE model have been verified through various empirical studies (Chen et al., 2018; Kim et al., 2021; Kumar et al., 2022; Mohtaramzadeh et al., 2018).

As a study on the concept and role of technology acceptance in digital transformation, Kim and Ahn (2024) conducted an empirical study on the moderating effect of digital technology acceptance in the relationship between dynamic digital capabilities and digital transformation. They applied the concept of digital technology acceptance in the digital environment as the intention to accept technology, dividing it into organizational members' perception of benefits from digital technology and their intention to utilize the technology as sub-elements.

Other related studies include research on the relationship between the intention to utilize big data and digital capabilities (Kim & You, 2020), a study on dynamic capabilities and technology orientation (Zhang et al., 2021), and numerous studies that have found favorable attitudes towards technology acceptance play a positive role in business performance (Park & Choi, 2021; Zhong & Moon, 2023).

2.4. Firm Performance

Firm performance is gauged by the added value created relative to objectives, and the productivity realized from resource investment, stemming from specific activities aimed at achieving the company's strategic goals (Kim & Ahn, 2024; Lee & Seo, 2023; Poister, 2003). It encompasses various dimensions, such as productivity, profitability, goal attainment, and the internal and external capabilities of the company (Choi, 2022; Kaplan & Norton, 1996; Park & Lee, 2022).

Traditionally, firm performance has been assessed based on financial outcomes. However, with increasing complexity in the internal and external environments and the emergence of diverse stakeholders, it has become apparent

that relying solely on financial metrics presents limitations in fully capturing a company's performance.

Consequently, financial performance, which is inherently result-oriented and short-term, is deemed insufficient for a comprehensive evaluation of a company's capabilities or growth potential. It is now recognized as more prudent to employ a variety of indicators in a balanced and integrated approach (Bong & Ahn, 2018; Kaplan & Norton, 1996; Kim & Ahn, 2017).

In this study, we categorize firm performance into financial and non-financial dimensions. For financial performance, we intend to utilize metrics such as sales, operating profit margin, market share, and return on investment. For non-financial performance, we aim to measure the satisfaction of organizational members, acquisition of new customers, product quality, and work process efficiency, thereby providing a more holistic view of firm performance.

3. Research Design

3.1. Research Model

The primary aim of this study is to explore the interrelationships among dynamic digital capabilities, digital transformation, technology acceptance, and firm performance. Building on prior research, this work specifically seeks to empirically examine the mediating roles of digital transformation and technology acceptance in enhancing firm performance.

We have delineated dynamic digital capabilities into three distinct sub-factors: digital sensing capability, digital seizing capability, and digital transforming capability. Similarly, digital transformation is broken down into three levels: strategic, business model (BM), and operational. Additionally, the organization's acceptance of digital technology is characterized by its perception of benefits and its intention to utilize these technologies. Firm performance is categorized into two types: financial performance and non-financial performance.

The research model, illustrating these relationships, is depicted in <Figure 1>.

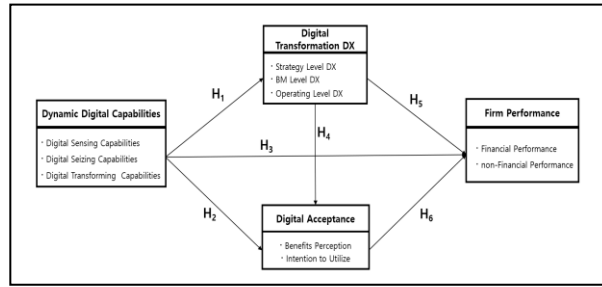


Figure 1: Research model

3.2. Hypothesis

3.2.1. Relationship between dynamic digital capabilities and digital transformation

Dynamic digital capabilities, as defined within the digital environment, encompass the abilities and skills of organizational members to sense the digital landscape, seize opportunities with digital technologies, and instigate organizational or procedural changes utilizing these technologies (Kim & Ahn, 2024; Kraus et al., 2021; Noh, 2020).

Research utilizing dynamic digital capabilities as the independent variable, with digital transformation level as the dependent variable, has been conducted by Lee and Baek (2023), Lee and Seo (2023), and Kim and Ahn (2024). These studies collectively indicate that dynamic digital capabilities exert a positive influence on the level of digital transformation. Furthermore, Kim et al. (2023) discovered that the level of digital transformation mediates the impact of dynamic digital capabilities on financial performance.

Based on the synthesis of these findings, the following hypothesis is proposed to investigate further the impact of dynamic digital capabilities on digital transformation:

H1: Dynamic digital capabilities exert a positive influence on digital transformation.

3.2.2. Relationship between dynamic digital capabilities and digital technology acceptance

Digital technology acceptance is conceptualized as the perception of the benefits and the intention to utilize digital technologies among organizational members (Kim & Ahn, 2024). As an organization's proficiency in leveraging technology to sense, seize, and transform innovations increases, it is anticipated that the attitudes and perceptions of its members toward digital technology will evolve (Kim & Kang, 2024; Park & Choi, 2018).

Research by Han and Yang (2018) has shown that dynamic digital capabilities significantly influence the intention of small and medium-sized enterprises to utilize big data. Similarly, Kim and You (2020) have observed that a firm's dynamic digital capabilities positively affect their

intention to adopt smart factory technologies. Furthermore, studies by Kim and Choi (2019) reveal that dynamic digital capabilities enhance the perception and intention toward adopting personal information risk prevention technologies (Arifin, 2017; Arifin & Frmanzah, 2015; Shen et al., 2021).

Building on these findings, the following hypothesis is proposed to explore the impact of dynamic digital capabilities on digital technology acceptance

H2: Dynamic digital capabilities have a positive influence on the acceptance of digital technology.

3.2.3. Relationship between dynamic digital capabilities and firm performance

Traditional capabilities theory posits that the capabilities of organizational members are crucial for firm performance, as evidenced by various studies (Bae & Park, 2017; Chae & Kim, 2019; Kim & Lee, 2014; Kim & Shin, 2014). In today's rapidly evolving business environment, research indicates that dynamic capabilities more effectively explain business performance than traditional capabilities (Kim & Yi, 2018; Oh & Yi, 2021; Zhang et al., 2021).

Among domestic studies on the relationship between dynamic capabilities and business performance, Yang and Jung (2022) observed that dynamic capabilities positively affect both innovation and financial performance. Afonso Ricardo et al. (2018) demonstrated that dynamic capabilities, particularly those spurred by the 4th Industrial Revolution, significantly influence both financial and non-financial performance. Similarly, Lee and Ji (2018) found that the dynamic capabilities of small and medium-sized enterprises substantially impact firm performance. Furthermore, Kim and Ahn (2024) identified dynamic digital capabilities as dynamic capabilities within the digital environment and showed that these capabilities positively impact digital transformation and, consequently, enhance firm performance.

Drawing on these studies, the following hypothesis is proposed to examine the relationship between dynamic digital capabilities and firm performance:

H3: Dynamic digital capabilities have a positive influence on firm performance.

3.2.4. Relationship between digital transformation and acceptance of digital technology

In traditional technology acceptance theory, it is posited that the intention of organizational members to use information technology is influenced by its perceived usefulness, ease of use, and performance expectations (Jeong, 2016; Park & Kim, 2013; Zhou et al., 2023). Additionally, a digital technology acceptance model from an organizational perspective suggests that acceptance is

shaped by various factors including technological characteristics, organizational leadership, organizational processes, and environmental conditions (Kim et al., 2021; Lee & Chang, 2018).

The relationship between digital transformation and the acceptance of digital technology suggests that if digital transformation is perceived to enhance organizational effectiveness, simplify tasks, and improve organizational culture or processes, then the acceptance of technology by organizational members is likely to increase.

Empirical evidence supports this relationship: Kim (2020) found that digital transformation in manufacturing significantly impacts technology acceptance; Kim et al. (2020) showed that digital transformation heavily influences the intention toward digital transformation; Seo (2024) confirmed that digital transformation positively affects the acceptance of unmanned service technologies; and Song and Chang (2023) observed that digital transformation significantly affects the resistance to technology acceptance (Chathura et al., 2023; Chen, 2022; Diego et al., 2022).

Building on these findings, the following hypothesis is proposed to explore the influence of digital transformation on technology acceptance:

H4: Digital transformation positively influences acceptance of digital technology.

3.2.5. Relationship between digital transformation and firm performance

Digital transformation, an advanced iteration of 'organizational informatization,' is a strategic management innovation that enhances internal efficiency and performance by integrating digital technology into organizational work processes and services. This transformation aims to bolster an organization's competitiveness and performance, with its causal relationships increasingly validated in both practical and academic realms.

Recent research highlights that digital transformation significantly boosts the management performance of commercial entities (Jung & Whang, 2024; Kim & Ahn, 2024; McLaughlin, 2017). Moreover, its application extends beyond profit-oriented firms, encompassing non-profit organizations and public institutions, with notable implementations in social enterprises (Lee & Seo, 2023) and government bodies (Choi, 2022).

Furthermore, studies underscore that management performance enhancements attributable to digital transformation are not confined to financial gains. They also catalyze innovation, organizational growth (Tumbas et al., 2015), and enhanced competitiveness (Neumeier et al., 2017).

Building on this foundation, the following hypothesis is

proposed to explore the relationship between digital transformation and firm performance:

H5: Digital transformation exerts a positive influence on firm performance.

3.2.6. Relationship between digital technology acceptance and firm performance

Digital technology acceptance encompasses organizational members' perceptions of the benefits, attitudes towards the technology—whether positive or negative—and their intention to use the technology. It is posited that the greater the acceptance of technology among organizational members, the more extensive and effective the utilization of digital technology, which in turn enhances management performance (Kim & Ahn, 2024).

Research on the connection between digital technology acceptance and firm performance has yielded significant findings. Park and Choi (2021) showed that acceptance of digital innovations notably boosts performance, while Lee et al. (2013) found that a positive attitude towards technology adoption directly influences performance enhancements.

Further, numerous studies suggest that acceptance of digital technology serves as a mediating factor in the relationship between various variables and management performance. For instance, Kim and You (2020) observed that a company's dynamic capabilities significantly impact management performance via the acceptance of smart factories. Similarly, Zhang et al. (2021) confirmed that dynamic capabilities substantially enhance management performance through the intention to embrace technology orientation (Anjum, 2018; Carolin et al., 2012).

Based on the evidence and theoretical underpinnings from these studies, this research proposes the following hypothesis regarding the influence of digital technology acceptance on firm performance:

H6: Digital technology acceptance positively influences firm performance.

3.3. Data Collection

For this study, we targeted 7,707 small and medium-sized enterprises participating in mini-clusters within industrial parks nationwide. From October to December 2023, we distributed surveys via email and collected 258 valid responses (response rate: 3.34%) for data analysis. Additionally, the survey design introduced the survey's objectives, applications, and methodology. The survey content was structured into four areas: dynamic digital capabilities, digital transformation, digital technology acceptance, and firm performance, with respective items

developed accordingly.

3.4. Scale of Variable

Digital Transformation is delineated into three levels based on extensive literature: strategic-level transformation, Business Model (BM)--level transformation, and operational-level transformation. This classification draws upon the foundational work of Hess et al. (2016), Bharadwaj et al. (2013), Peter and Kraft (2020), and Kim and Ahn (2024).

Dynamic Digital Capabilities are categorized into three distinct functions: digital sensing, digital seizing, and digital transforming. These categories are framed within Teece's model of dynamic capabilities, which includes sensing, seizing, and transforming. Detailed measurement items were influenced by research from Alessandro et al. (2021), Dahmani (2024), and Kim and Ahn (2024).

Firm Performance is assessed through two dimensions: financial performance and non-financial performance. The framework for this assessment is supported by the studies of Aaker (1989), Bong and Ahn (2018), Choi (2022), Kaplan and Norton (1996), Kim and Ahn (2017), Kim et al. (2023), and Lee and Seo (2023).

Acceptance of Digital Technology encompasses organizational members' recognition of the benefits of digital technology, their attitude toward its adoption, and their intention to actively utilize it. This variable is split into two sub-factors: the perception of benefits and the intention to utilize. The perception of benefits includes parameters such as usefulness and ease of use from the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT), along with convenience and suitability from the Diffusion of Innovations (DOI) and Technology-Organization-Environment (TOE) frameworks. Intention to utilize encompasses necessity, interest, and planned extent of use, drawing from seminal works by Rogers (1983), Davis (1989), Tronatzky et al. (1990), and Venkatesh et al. (2003).

Detailed descriptions of each variable and measurement item are presented in Table 1, with responses recorded on a 5-point Likert scale.

Table 1: Scale of variable

Variable		Source
Digital Transformation (DX)	Strategy Level DX	Our company utilizes digital technology for market environment analysis.
		Our company utilizes digital technology when developing product strategies
		Our company utilizes abundant data, information, and knowledge in our BS
		Our company utilizes information technology for performance monitoring
		Our company is aligning its IT strategy with BS
	BM Level DX	Our company utilizes digital technology to deliver new value to our customers.
		Our company utilizes digital technology to establish and manage partnerships.
		Our company utilizes digital technology for CS and relationship management.
		Our company utilizes digital technology to enhance organizational structure
		Our company utilizes digital technology for revenue enhancement
		Bharadwaj(2013) Hess et al.(2016) Kim & Ahn (2024) Peter & Kraft (2020)

Dynamic Digital Capabilities	Operating Level DX	Our company utilizes digital technology in the process of technology development.	Alessandro et al.(2021) Dahmani(2024) Kim & Ahn (2024) Teece et al. (2018)
		Our company utilizes digital technology for product performance	
		Our company utilizes digital technology in marketing and sales activities	
		Our company utilizes digital technology in production planning	
		Our company utilizes digital technology in management tasks	
	Digital Sensing	Our company possesses the knowledge & skills to observe industry trends	
		Our company possesses the knowledge & skills to identify target markets	
		Our company possesses knowledge & skills to find information	
		Our company is willing to participate in knowledge exchange activities	
		Our company is willing to reference industry-leading digital new BP	
	Digital Seizing	Our company can invest in digital technology for our customers	
		Our company is willing to adopt industry BP utilizing digital technology	
		Our company is willing to address the shortcomings in our digital technology	
		Our company can transform operational methods digitally	
		Our company can develop new business models using new digital technology	
Digital Transforming	Our company is committed to implementing new management methods		
	Our company is committed to improving the application of digital technology		
	Our company can implement marketing strategies using new digital technology		
	Our company can apply new or substantially digitized methods		
	Our company is willing to apply newly acquired digital knowledge or know-how		
Firm Performance	Financial Performance	Our company has experienced an increase in revenue (vs past 3 years)	Aaker (1989) Bong & Ahn (2018) Choi (2022) Kaplan & Norton (1996) Kim & Ahn (2017) Kim et al. (2023) Lee (2023)
		Our company has seen an increase in operating profit margin (vs past 3 years)	
		Our company has experienced an increase in market share (vs past 3 years)	
	non-Financial Performance	Our company has seen an increase in return on investment (vs past 3 years)	
		Our company's employee satisfaction is continuously improving	
		Our company's product and service quality is continuously improving	
Digital Acceptance	Benefits Perception	Employees believe that digital technology will enhance performance	Davis (1989) Rogers (1983) Tronatzky et al. (1990) Venkatesh et al. (2003)
		Employees believe that digital technology will make overall tasks easier to perform	
		Employees believe that digital technology will be beneficial to the company's environment and organizational culture	
		Employees believe that our company is suitable for the overall adoption of digital technology	
	Intention to Utilize	employees believe that utilizing digital technology is necessary in our company	
		Employees show a high level of interest in utilizing digital technology	
		Employees are willing to use newly established digital technologies	
		Employees are making various efforts to enhance the utilization of digital technology	

4. Research Methods

4.1. Analysis Method

In this study, small and medium-sized enterprises (SMEs) engaged in mini-cluster projects within industrial complexes nationwide were selected for data collection. Respondents completed questionnaires on a company-wide basis, resulting in 258 valid responses for statistical analysis. The data were analyzed using a structural equation model constructed with AMOS software. This approach facilitated a detailed examination of the relationships among the studied variables.

4.2. Demographic Character Analysis

The companies participating in the survey are spread across 13 locations nationwide, effectively representing Korea's mini-cluster companies. In terms of workforce size and revenue, the majority are small and medium-sized businesses, with 34.1% having fewer than 10 employees and 27.9% reporting annual sales between 5 to 30 billion won. The manufacturing sector dominates the sample, comprising 78.3% or 202 companies. Additionally, males make up 87.5% of the respondent pool, totaling 226 companies. Notably, 238 respondents, accounting for 92% of the total, hold pivotal roles such as CEO or CIO, directly involved in or knowledgeable about their company's digital transformation efforts. Detailed demographic characteristics of the respondents are presented in Table 2 below.

Table 2: Demographic characteristics of responding companies

Classification	Detailed Items	Frequency	(%)	
Employees	Less than 10	88	34.1	
	Less than 50, but 10 or more	77	29.8	
	Less than 100, but 50 or more	39	15.1	
	Less than 300, but 100 or more	26	10.1	
	300 or more	28	10.9	
	Subtotal	258	100.0	
Business Type	manufacturing business	202	78.3	
	IT & communication	12	4.7	
	service industry	16	6.2	
	others	28	10.9	
Subtotal	258	100.0		
Business Experience	Less than 3 years	-	-	
	Less than 5 years, but 3 years or more	27	10.5	
	Less than 10 years, but 5 years or more	80	31.0	
	Less than 20 years, but 10 years or more	48	18.6	
	Over 20 years	103	39.9	
	Subtotal	258	100.0	
Respondents	position	CEO	78	30.0
		CIO/IT Director	160	62.0
		others	20	8.0
		Subtotal	258	100.0
		sex	man	226
	woman		32	12.5
	Subtotal		258	100.0
	age	30 years of age or younger	-	-
		30 to 40 years of age	17	6.5
		40 to 50 years of age	106	41.0
		over 50 years of age	135	52.5
		Subtotal	258	100.0

4.3. Validity and Reliability Analysis

To ensure the validity of each factor in the survey, confirmatory factor analysis (CFA) was conducted, incorporating secondary latent variables as per the classification system utilized in prior research. The results indicated that all standardized loading values exceeded .693 and all p-values were below .01, affirming robust factor validity. Additionally, the Composite Reliability (CR) for each construct was above 0.8, and the Average Variance Extracted (AVE) surpassed .5, confirming satisfactory convergent validity. In terms of reliability, all Cronbach's alpha values were greater than .7, demonstrating high internal consistency across the measurements.

Table 3: Convergent Validity & Reliability

factor	Items	s.l	s.e	t-value	P-value	CR	AVE	Cronbach's α		
Dynamic Digital Capabilities	SEN	SEN1	.857	-	-	-	.861	.625	.899	
		SEN2	.829	.054	16.659	***				
		SEN3	.826	.055	16.565	***				
		SEN4	.720	.057	13.397	***				
		SEN5	.776	.059	14.977	***				
	SEI	SIZ1	.837	-	-	-	.812	.662	.898	
		SIZ2	.833	.058	16.479	***				
		SIZ3	.845	.060	16.852	***				
		SIZ4	.811	.059	15.790	***				
		SIZ5	.837	.058	16.599	***				
	TRA	TRN1	.836	-	-	-	.845	.639	.921	
		TRN2	.862	.061	17.462	***				
		TRN3	.814	.067	15.916	***				
		TRN4	.877	.059	17.996	***				
		TRN5	.819	.059	16.096	***				
Digital Transformation DX	BS	BS1	.787	-	-	-	.832	.583	.900	
		BS2	.881	.068	16.003	***				
		BS3	.838	.073	14.969	***				
		BS4	.808	.077	14.286	***				
		BS5	.743	.075	12.838	***				
	BM	BM1	.805	-	-	-	.868	.570	.921	
		BM2	.761	.064	13.425	***				
		BM3	.754	.069	13.256	***				
		BM4	.752	.068	13.220	***				
		BM5	.777	.068	13.789	***				
BO	BO1	.797	-	-	-	.832	.622	.895		
	BO2	.830	.066	15.052	***					
	BO3	.842	.066	15.355	***					
	BO4	.812	.073	14.628	***					
	BO5	.851	.074	15.577	***					
Digital Acceptance	BP	BP1	.807	-	-	-	.836	.532	.779	
		BP2	.782	.073	13.520	***				
		BP3	.793	.073	13.754	***				
		BP4	.816	.076	14.239	***				
	IU	IU1	.849	-	-	-	.875	.587	.847	
		IU2	.750	.061	13.843	***				
		IU3	.831	.060	16.125	***				
		IU4	.838	.059	16.342	***				
	Firm	FP	FP1	.698	-	-	-	.912	.527	.779

Performance		FP2	.740	.094	10.661	***	.885	.560	.733
		FP3	.693	.091	10.047	***			
		FP4	.705	.108	10.211	***			
	NFP	NFP1	.717	-	-	-			
		NFP2	.749	.092	11.172	***			
		NFP3	.773	.087	11.496	***			
		NFP4	.753	.100	11.224	***			

Chi-square = 1818.46 (DF=973, p=.000), $\chi^2/DF=1.869$, GFI=.766, CFI=.911, RMSEA=.058, RMR=.044
 (1) Secondary factor standard loading. *** Significant at p<0.01 level

4.4. Correlation and Discriminant Validity Analysis

The relationships between variables were assessed through correlation analysis. As presented in Table 4, the highest correlation coefficient was between the strategic level and the operational level at .759, while the lowest was between financial performance and the perception of technology benefits at .509. All correlation coefficients were significant, with a p-value of less than .05. Additionally, the square root values of the Average Variance Extracted (AVE) ranged from .726 to .813, all exceeding the coefficients of determination (R^2) among other construct variables, thereby confirming discriminant validity.

Table 4: Correlation and root square of AVE

	SEN	SEI	TRA	BS	BM	BO	BP	IU	FP	NFP
SEN	.790									
SEI	.734	.813								
TRA	.734	.733	.799							
BS	.701	.736	.761	.763						
BM	.754	.746	.750	.749	.755					
BO	.684	.728	.756	.759	.752	.789				
BP	.579	.701	.690	.615	.658	.640	.729			
IU	.651	.703	.680	.621	.668	.636	.693	.766		
FP	.646	.571	.606	.619	.697	.662	.509	.532	.748	
NFP	.623	.589	.609	.630	.662	.662	.540	.570	.716	.726

** : p < .01, Correlation significant (two-tailed)
 The diagonal value is the square root of the AVE

BS: Strategy Level
 BM: BM Level
 BO: Operating Level
 SEN: Digital Sensing
 SEI : Digital Seizing
 TRA: Digital Transforming
 FP: Financial Performance
 NFP: non-Financial Performance
 BP: Benefits Perception
 IU: Intention to utilize

4.5. Hypothesis Verification Result

To test the hypothesis, a structural equation model was developed and implemented. Hypothesis testing was conducted through path analysis using secondary latent variables, as well as primary latent variables, to examine causal relationships for each sub-factor. The results of the path analysis model were $\chi^2=1782.05$, $df=954$, $\chi^2/df=1.868$, GFI=.769, CFI=.913, RMSEA=.058, RMR=.048, indicating a high degree of model fit.

Table 5: Path Model Analysis

path	path coefficient	t-value	p-value	Accepted or not	R ²
H1: DDC → DX	.928	11.289	***	Accepted	.861
H2: DDC → DA	.650	3.974	***	Accepted	.672
H3: DDC → FP	-.272	-1.541	.123	not	.699
H4: DX → DA	.181	1.174	.240	not	.672
H5: DX → FP	.923	5.112	***	Accepted	.699
H6: DA → FP	.199	2.134	.033**	Accepted	.699

Chi-square = 1782.05 (DF=954, p=.000), $\chi^2/DF=1.868$, GFI=.769, CFI=.913, RMSEA=.058, RMR=.048

*** Significant at the p<0.01 level, ** Significant at the 0.01<p<0.05 level

DDC: Dynamic Digital Capabilities DX: Digital Transformation DX
 DA: Digital Acceptance FP: Firm Performance

The path model analysis results indicate that Hypothesis 1, the relationship between dynamic digital capabilities and digital transformation level, Hypothesis 2, the relationship between dynamic digital capabilities and digital technology acceptance, Hypothesis 5, the relationship between digital transformation level and firm performance, and Hypothesis 6, the relationship between technology acceptance and firm performance, were all accepted at the p < .05 level of statistical significance.

Meanwhile, Hypothesis 3, the relationship between dynamic digital capabilities and firm performance, and Hypothesis 4, the relationship between the level of digital transformation and digital technology acceptance, were not accepted under the condition of statistical significance.

As a result of the hypothesis testing, it was found that dynamic digital capabilities do not have a direct effect on firm performance but rather influence firm performance through digital transformation or acceptance of digital technology. Organization members' acceptance of technology is not directly influenced by digital transformation but instead depends on competency factors such as dynamic digital capabilities.

Figure 2 shows the standardized regression coefficients and explanatory power(R^2) values between variables.

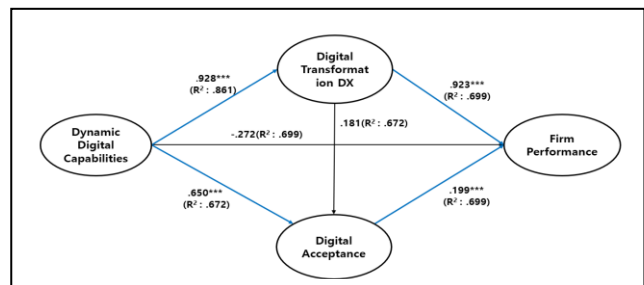


Figure 2: Path model among variables

5. Discussion

This study aimed to analyze the interrelationships between dynamic digital capabilities, digital transformation levels, technology acceptance, and firm performance. Specifically, it focused on empirically identifying the mediating effects of digital transformation and technology acceptance in the relationship between dynamic digital capabilities and firm performance.

The results indicated that dynamic digital capabilities enhance firm performance through digital transformation and technology acceptance. However, the mediating effect of technology acceptance in the relationship between digital transformation and firm performance was not confirmed. This implies that for firms aiming for sustained growth in a digital environment, strategies that integrate digital transformation or technology acceptance are necessary rather than relying solely on dynamic digital capabilities.

Additionally, it was found that technology acceptance within an organization is more influenced by other factors, such as organizational capabilities, than by the implementation of visible information technology like digital transformation. This suggests the need for more diverse and in-depth analyses of the relationship between the organization's technology acceptance and other variables.

Furthermore, causal path analysis was conducted to examine the relationships between primary latent variables. The detailed results are presented in Table 6.

Table 6: Path Model Analysis (causal relationship)

Hypothesis	Causal relationship		Estimate	p
H1: DDC → DX	SEN	→ BS	.246	***
	SEN	→ BM	.508	***
	SEN	→ BO	.165	***
	SEIZ	→ BS	.175	***
	SEIZ	→ BM	.144	***
	SEIZ	→ BO	.267	***
	TRAN	→ BS	.346	***
	TRAN	→ BM	.121	***
	TRAN	→ BO	.294	***
H2: DDC → DA	TRAN	→ BP	.172	***
	SEIZ	→ BP	.164	***
	SEN	→ BP	-.062	.306
	TRAN	→ IU	.131	.007
	SEIZ	→ IU	.254	***
	SEN	→ IU	.158	.014
	SEN	→ FP	.122	.012

H3: DDC → FP	SEN	→	NFP	.110	.050
	SEIZ	→	FP	-.040	.251
	SEIZ	→	NFP	-.011	.797
	TRAN	→	FP	.019	.617
	TRAN	→	NFP	-.033	.443
H4: DX → DA	BS	→	BP	.015	.820
	BS	→	IU	.089	.203
	BM	→	BP	.193	.021
	BM	→	IU	.016	.858
	BO	→	BP	.101	.106
H5: DX → FP	BO	→	IU	.054	.414
	BS	→	MFP	.100	.103
	BS	→	FP	.053	.313
	BM	→	FP	.252	***
	BM	→	NFP	.148	.057
	BO	→	FP	.193	***
H6: DA → FP	BO	→	NFP	.193	***
	BP	→	FP	.017	.734
	BP	→	NFP	.103	.073
	IU	→	FP	.018	.690
	IU	→	NFP	.132	.015

In the relationship between dynamic digital capabilities and digital transformation (H1), all primary latent variables exhibited a strong causal relationship. This indicates that digital sensing, seizing, and transforming capabilities play a crucial role in digital transformation across business strategy, business model, and operational levels. Similarly, significant causal relationships were observed between dynamic digital capabilities and technology acceptance (H2), and between digital transformation and firm performance (H5).

In the relationship between dynamic digital capabilities and firm performance (H3), the secondary latent variable, dynamic digital capabilities, showed low significance. However, among the primary latent variables, sensing capabilities significantly impacted financial performance ($p = .012$) and non-financial performance ($p = .050$). This suggests that the ability to analyze trends in new technologies and select beneficial technologies is a key factor directly influencing firm performance, beyond just through digital transformation or technology acceptance.

Furthermore, in the relationship between digital transformation and technology acceptance (H4), there was no significant relationship between the two variables overall, suggesting that technology acceptance may serve a different role, such as a preceding or moderating factor, rather than as

a resultant variable of digital transformation. Among the primary latent variables, business model conversion (BM) significantly influenced the perception of technology benefits, indicating the need for more in-depth future research on the relationships between these variables.

Lastly, in the relationship between technology acceptance and firm performance (H6), all primary latent variables significantly influenced non-financial performance more than financial performance, to utilize showing a stronger correlation with firm performance than benefits perception. This implies that the perception of technology benefits leads to firm performance when actualized through utilization, and that the perception and intention to utilize technology acceptance has a larger impact on non-financial performance. Additional factors may also significantly affect financial performance.

This study is an exploratory and experimental investigation into areas such as dynamic digital capabilities, digital transformation, and technology acceptance. It is concluded that the findings regarding the relationships among these variables require further refinement and detailed exploration in future research.

6. Conclusions

With the onset of the 4th Industrial Revolution driven by advanced and converged information and communication technologies, business environment uncertainty is increasing due to intensified global competition and changing consumer needs. Companies are responding by enhancing competitiveness and management performance through various leadership approaches, developing dynamic digital capabilities, and embracing digital transformation.

This study analyzed each relationship including the impact of dynamic digital capabilities on digital transformation levels, digital technology acceptance, and firm performance, as well as the impact of digital transformation levels and digital technology acceptance on firm performance. The results showed significant effects of dynamic digital capabilities on the relationships with digital transformation levels, digital technology acceptance, and firm performance. However, no significant effects were found in the relationships between dynamic digital capabilities and firm performance, as well as between digital transformation levels and digital technology acceptance.

The study suggests that for organizations to achieve firm performance through digital transformation, enhancing dynamic digital capabilities is crucial, along with improving the perceptions or attitudes of organizational members towards information technology. To enhance dynamic digital capabilities, it seems crucial to establish the organization's digital strategy and vision, sense the latest

trends in digital technology, seize business opportunities, and build capabilities to transform the technological infrastructure that the company possesses. Efforts should be made across the organization to ensure these initiatives can be effectively implemented. Additionally, to improve employees' perceptions and attitudes toward IT acceptance, it is necessary to communicate the necessity and value of IT technologies and systems. This involves educating and training through various methods on how IT technologies can contribute to improving firm performance and demonstrating to employees how IT technologies can be effectively utilized. It also requires actively sharing and promoting successful use cases of IT technology.

Despite these insights, the study has several limitations:

First, the variables of dynamic digital capabilities, digital transformation, and firm performance may change over time and differ depending on measurement methods. The self-reporting method used in this study may introduce common method bias, necessitating more objective indicators. Digital competence index, transformation maturity index, time series data could be the solution.

Second, this study does not reflect the characteristics of individual companies because it has conducted variable-based research on dynamic digital capabilities, digital transformation, and technology acceptance. In the future, dividing companies into various categories and comparing and analyzing them could yield useful insights, such as benchmarking opportunities.

In addition to the above-mentioned research, it is considered beneficial to conduct studies on successful cases of digital transformation, the maturity of digital transformation by industry, exploration of various variables related to digital transformation, causal relationships among the components of each variable, and their relationships with organizational innovativeness, environmental dynamics, and other diverse variables. This theoretical and practical foundation is expected to help drive successful corporate digitalization and achieve management goals.

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