

Digital Transformation and Sustainable Business Performance: An Empirical Multidimensional Analysis

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Abstract. The rapid diffusion of digital technologies has fundamentally reshaped how firms operate, compete, and pursue sustainability, yet empirical evidence on how digital transformation translates into sustainable business performance remains fragmented, particularly in volatile and emerging contexts. Existing studies often focus on isolated performance outcomes and provide limited insight into the internal mechanisms and external conditions that shape digital transformation effects. This study examines the relationship between digital transformation and sustainable business performance, emphasizing the mediating role of organizational capabilities and the moderating effect of environmental uncertainty. Using cross-sectional survey data from 400 firms operating in manufacturing, services, and information technology sectors, the study employs Partial Least Squares Structural Equation Modelling to test a moderated mediation framework. The results indicate that digital transformation has a significant positive association with sustainable business performance across economic, social, and environmental dimensions. Organizational capabilities specifically structural flexibility, human resource management, and data management partially mediate this relationship, enabling firms to convert digital adoption into tangible performance outcomes. Moreover, environmental uncertainty positively moderates the relationship, suggesting that firms operating in more volatile environments derive greater benefits from digital transformation. By integrating insights from the Resource-Based View, Dynamic Capabilities Theory, and Stakeholder Theory, this study contributes to the literature by offering a multidimensional and context-sensitive explanation of sustainable business performance in the digital era. The findings provide practical implications for managers and policymakers, highlighting the importance of aligning digital investments with capability development and governance-oriented sustainability strategies.

Keywords: Digital Transformation, Environmental Uncertainty, Organizational Capabilities, Sustainable Business Performance

Introduction

Background and Relevance of Digital Transformation

Digital transformation has emerged as one of the most consequential forces shaping firm behavior and performance in the twenty-first-century economy. Advances in artificial intelligence, big data analytics, cloud computing, blockchain, and related digital technologies have fundamentally altered how firms organize production, coordinate activities, and engage with markets and stakeholders (Schilirò, 2024). Unlike earlier waves of technological adoption that focused primarily on automation or cost reduction Shonubi (2025), digital transformation represents a deeper organizational shift involving the reconfiguration of business processes, decision-making structures, and value creation mechanisms. The strategic relevance of digital transformation is particularly pronounced in emerging and rapidly transforming economies, where firms operate in environments characterized by institutional change, market volatility, and technological disruption. In such contexts, digital technologies are increasingly promoted as tools for productivity enhancement, industrial upgrading, and global value chain integration (Shanti et al., 2023). However, firms in these environments also face significant uncertainty related to competition intensity, regulatory change, and technological turbulence (Gun et al., 2024). As a result, digital transformation is not merely a technological choice but a strategic response to uncertainty and complexity.

From an economic perspective, digital transformation has been linked to improvements in efficiency, innovation, and competitiveness. Digital systems enhance information processing capabilities, reduce coordination costs, and enable firms to respond more quickly to market signals (Sui et al., 2023). At the same time, digital technologies support new

business models, such as platform-based ecosystems and data-driven services, which can fundamentally alter industry dynamics (Gawer, 2021). These developments have elevated digital transformation from an operational initiative to a core determinant of long-term firm viability.

1.1. Sustainable Business Performance as a Multidimensional Concept

While digital transformation has attracted extensive scholarly attention, its performance implications remain contested, in part because of how performance is conceptualized. Traditional economic and management research has largely relied on financial indicators such as profitability, return on assets, and growth to assess firm success (Verhoef et al., 2019). Although these indicators remain important, they are increasingly insufficient in capturing the broader objectives firms are expected to pursue in contemporary economies.

Sustainable business performance reflects a multidimensional perspective that integrates economic, social, and environmental outcomes. Firms are now evaluated not only on their ability to generate financial returns, but also on how they manage environmental resources, engage employees, serve customers responsibly, and maintain transparent and accountable governance practices (Liu et al., 2023). This broader understanding of performance has gained prominence due to rising stakeholder expectations, regulatory pressures, and global sustainability agendas.

Digital transformation is closely intertwined with this expanded notion of performance. Digital technologies can improve sustainability outcomes by optimizing resource use, reducing waste, enhancing transparency, and enabling data-driven monitoring of environmental and social impacts (Hariyani et al., 2025). For example, data analytics can improve energy efficiency, while digital platforms can strengthen supply chain traceability and stakeholder communication. Consequently, the performance effects of digital transformation cannot be fully understood without adopting a multidimensional sustainability-oriented framework.

Despite this recognition, much of the existing empirical literature continues to rely on narrow performance measures (Alojail & Khan, 2023). This creates a disconnect between the conceptual understanding of sustainable business performance and its empirical operationalization, limiting insights into how digital transformation contributes to long-term and socially responsible value creation.

1.2. Research Gap and Problem Statement

Although prior studies provide valuable insights into digital transformation and firm performance, several critical limitations remain. First, existing research often examines the impact of digital transformation on isolated performance outcomes, such as innovation or productivity, rather than on sustainable business performance as an integrated construct. As a result, it remains unclear whether digital transformation supports broader sustainability objectives or primarily enhances short-term efficiency.

Second, many studies implicitly assume that digital technologies generate performance benefits directly. This assumption overlooks the role of organizational capabilities in translating technological investments into tangible outcomes. Digital technologies are widely accessible and can be imitated; therefore, their performance effects are likely to depend on firm-specific capabilities such as structural flexibility, human resource management, and data integration. However, empirical research that explicitly models these capabilities as mediating mechanisms remains limited.

Third, the external environment in which digital transformation occurs has received insufficient attention. Firms operate under varying degrees of environmental uncertainty stemming from market turbulence, competitive pressure, and rapid technological change. Such uncertainty can shape strategic behavior and influence whether digital transformation enhances or constrains performance. Yet, few empirical studies systematically examine environmental uncertainty as a moderating factor in digital transformation–performance relationships.

Finally, much of the existing evidence is drawn from developed economies, where institutional stability and resource availability differ substantially from those in emerging contexts. This limits the generalizability of findings to environments characterized by higher uncertainty and structural change.

Taken together, the central research problem addressed in this study is the lack of an integrated empirical framework that explains how digital transformation influences sustainable business performance through internal organizational capabilities and under conditions of environmental uncertainty, particularly in emerging and volatile economic contexts.

1.3. Objectives and Research Questions

To address this problem, the study pursues a focused set of objectives. The overarching aim is to empirically examine how digital transformation relates to sustainable business performance within a multidimensional framework that accounts for both internal and external contingencies. Specifically, the study seeks to:

1. Examine the association between digital transformation and sustainable business performance across economic, social, and environmental dimensions.
2. Analyze whether organizational capabilities mediate the relationship between digital transformation and

sustainable business performance.

3. Assess whether environmental uncertainty moderates the impact of digital transformation on sustainable business performance.

These objectives give rise to the following research questions:

- How is digital transformation associated with sustainable business performance?
- Do organizational capabilities function as a mechanism through which digital transformation affects sustainable business performance?
- Does environmental uncertainty condition the strength of this relationship?

1.4. Contributions of the Study

This study makes several distinct contributions to the literature. First, it advances research on digital transformation by explicitly linking it to sustainable business performance as a multidimensional construct, thereby moving beyond narrow financial or innovation-focused outcomes.

Second, the study contributes to theory by integrating organizational capabilities as a mediating mechanism within a digital transformation framework. By doing so, it demonstrates that digital technologies create value not in isolation, but through their interaction with firm-specific capabilities.

Third, the study introduces environmental uncertainty as a moderating condition, offering a context-sensitive explanation for variation in digital transformation outcomes across firms. This responds to calls for greater attention to external contingencies in digital transformation research. From a theoretical perspective, the study integrates insights from the Resource-Based

View, Dynamic Capabilities Theory, and Stakeholder Theory into a single empirical model. From a practical perspective, the findings provide guidance for managers and policymakers on how to align digital investments with capability development and sustainability objectives, particularly in uncertain environments.

1.5. Structure of the Paper

The remainder of the paper is organized as follows. Section 2 reviews the relevant literature and develops the theoretical framework and hypotheses. Section 3 presents the conceptual model. Section 4 outlines the research methodology. Section 5 reports the empirical results. Section 6 discusses the findings and their theoretical and practical implications. The final section concludes the paper by summarizing key insights, acknowledging limitations, and suggesting directions for future research.

2. Literature Review and Theoretical Foundation

2.1. Digital Transformation and Firm Outcomes

Digital transformation is widely understood as a strategic process through which firms integrate digital technologies into their operations, structures, and business models to enhance value creation. Unlike earlier waves of information technology adoption, which primarily emphasized automation and efficiency, digital transformation entails a fundamental reconfiguration of organizational processes, decision-making routines, and competitive logic (Piccoli et al., 2024). As such, it has become a central topic in economics, management, and innovation research.

A substantial body of empirical literature reports a positive association between digital transformation and firm outcomes, including productivity, innovation performance, and market competitiveness. Digital technologies improve firms' information-processing capacity, reduce coordination and transaction costs, and enable faster and more accurate responses to market changes (Wang & Shao, 2024). At the strategic level, digital transformation facilitates new forms of value creation, such as data-driven services, platform-based ecosystems, and digitally enabled supply chains.

However, empirical findings are far from uniform. While some studies document strong performance gains, others report weak, delayed, or even insignificant effects. These inconsistencies have given rise to an important theoretical debate. Early technology-deterministic perspectives implicitly assume that the adoption of advanced digital technologies is sufficient to improve performance (Michelson et al., 2023). In contrast, more recent research adopts a contingent view, arguing that the performance effects of digital transformation depend on firm-specific conditions and external environments (Barba-Sánchez et al., 2024). This shift reflects growing recognition that digital technologies are widely accessible and easily imitable, and therefore unlikely to generate sustainable advantages on their own.

This divergence in findings suggests that digital transformation should not be examined as a direct input-output

relationship, but rather as a process whose outcomes depend on internal organizational mechanisms and contextual conditions (Cao et al., 2025). Understanding these mechanisms is essential for explaining why some firms successfully translate digital transformation into superior performance, while others do not.

2.2. Sustainable Business Performance: Economic, Social, and Environmental Dimensions

The concept of business performance has evolved significantly in response to changing economic and societal expectations. Traditional performance assessments focused primarily on financial indicators, reflecting a shareholder-oriented perspective (Nogueira et al., 2025). Although financial performance remains essential, this narrow focus has become increasingly inadequate in contexts where firms are expected to address broader social and environmental responsibilities.

Sustainable business performance reflects a multidimensional approach that integrates economic, social, and environmental outcomes. Economic performance captures firms' ability to generate profits and maintain competitive viability. Social performance refers to outcomes related to employees, customers, and broader societal engagement, such as workforce well-being, customer satisfaction, and ethical conduct (Eelager et al., 2025). Environmental performance concerns firms' ability to manage natural resources responsibly, reduce emissions and waste, and minimize ecological impact. This multidimensional perspective is theoretically grounded in stakeholder theory, which emphasizes that firms create value not only for shareholders but also for a wide range of stakeholders (Mahajan et al., 2023). From this viewpoint, performance is sustainable only if it balances economic objectives with social legitimacy and environmental responsibility.

Digital transformation is closely linked to these dimensions. Digital technologies can enhance economic performance by improving efficiency and supporting innovation. At the same time, they can strengthen social and environmental performance by enabling transparency, traceability, and data-driven monitoring. For example, digital platforms facilitate stakeholder engagement, while analytics support resource optimization and environmental management (Pricopoaia et al., 2025). Consequently, digital transformation has the potential to serve as a catalyst for sustainable business performance rather than merely a tool for short-term efficiency gains.

Despite this potential, much of the empirical literature continues to operationalize performance narrowly. This limit understanding of how digital transformation contributes to sustainability-oriented outcomes and risks underestimating its broader economic and societal implications (Guandalini, 2022). Addressing this limitation requires empirical models that explicitly treat sustainable business performance as a multidimensional construct.

2.3. Organizational Capabilities as a Mediating Mechanism

The Resource-Based View provides a foundational explanation for why digital transformation does not automatically lead to superior performance. According to this perspective, sustainable advantage arises from firm-specific resources and capabilities that are valuable, rare, inimitable, and non-substitutable (Willie, 2024). Digital technologies, by contrast, are increasingly standardized and accessible, suggesting that their value depends on how firms deploy and integrate them.

Organizational capabilities represent the mechanisms through which digital transformation is converted into performance outcomes. These capabilities include structural flexibility, which enables firms to reconfigure processes and decision-making structures; human resource capabilities, which encompass digital skills, learning orientation, and adaptive leadership; and data management capabilities Zhang et al. (2025), which support the collection, integration, and strategic use of digital information.

From a process perspective, these capabilities facilitate learning, coordination, and resource reconfiguration. Digital transformation generates large volumes of data and new technological possibilities, but without appropriate capabilities, firms may struggle to interpret information, align digital initiatives with strategy, or embed technologies into everyday routines (Rizana et al., 2025). Capabilities therefore function as "translation mechanisms" that transform technological potential into realized economic, social, and environmental outcomes.

Empirical research increasingly supports this view, showing that firms with stronger organizational capabilities derive greater benefits from digital transformation. However, many studies stop short of explicitly modelling capabilities as mediators, particularly in relation to sustainable business performance (Chen et al., 2024). As a result, the causal pathways linking digital transformation to multidimensional performance remain underexplored.

2.4. Environmental Uncertainty as a Contextual Moderator

In addition to internal capabilities, the external environment plays a critical role in shaping the outcomes of digital transformation. Environmental uncertainty refers to the degree of unpredictability associated with market demand, competitive behavior, technological change, and regulatory conditions (Chen & Tian, 2021). High levels of uncertainty increase information-processing demands and intensify the need for strategic flexibility.

Contingency-based and dynamic capability perspectives suggest that uncertainty can amplify the value of digital transformation. In volatile environments, digital technologies enable firms to sense changes more rapidly, respond flexibly, and reconfigure resources in real time (Saeedikiya et al., 2024). As a result, digital transformation may yield stronger performance benefits under conditions of high uncertainty than in stable environments, where the need for rapid adaptation is less pronounced.

At the same time, uncertainty can also heighten risks, particularly for firms lacking sufficient capabilities or resources. This dual role underscores the importance of treating environmental uncertainty as a moderating factor rather than assuming a uniform effect (Saiyed et al., 2025). Empirical studies rarely incorporate this perspective explicitly, often treating uncertainty as a background condition or control variable.

This limitation is particularly relevant in emerging and transitional economies, where firms face greater institutional volatility, resource constraints, and technological turbulence (Yan & Ahmad, 2025). In such contexts, environmental uncertainty is not an exception but a defining characteristic, making it essential to examine how it conditions the effects of digital transformation on sustainable business performance.

2.5. Theoretical Perspectives This study integrates three complementary theoretical perspectives to explain the relationship between digital transformation and sustainable business performance.

The Resource-Based View explains why digital transformation alone is insufficient for generating sustainable advantages and highlights the importance of organizational capabilities as mediating mechanisms.

Dynamic Capabilities Theory extends this logic by emphasizing firms' ability to sense opportunities, seize them, and reconfigure resources in response to environmental change. Digital transformation strengthens these processes by enhancing information flows, analytical capacity, and coordination, particularly under conditions of uncertainty.

Stakeholder Theory broadens the performance lens by emphasizing value creation for multiple stakeholder groups. From this perspective, digital transformation supports sustainable business performance by enhancing transparency, accountability, and engagement across economic, social, and environmental dimensions.

Together, these theories provide a coherent and integrated foundation for examining digital transformation as a capability-dependent and context-sensitive process with implications for sustainable performance.

2.6. Research Gap and Hypotheses Development

The literature review reveals a clear and unresolved gap. While prior research has examined digital transformation, organizational capabilities, environmental uncertainty, and firm performance, these elements are rarely integrated into a single empirical framework. In particular, there is limited empirical evidence explaining how digital transformation affects sustainable business performance through organizational capabilities and how this relationship is shaped by environmental uncertainty, especially in emerging and volatile contexts.

To address this gap, the present study proposes an integrated model in which digital transformation influences sustainable business performance both directly and indirectly through organizational capabilities, with environmental uncertainty moderating the strength of this relationship. This framework moves beyond technology-deterministic explanations and offers a more nuanced understanding of digital transformation outcomes. Based on this reasoning, the following hypotheses are proposed:

- H1: Digital transformation is positively associated with sustainable business performance.
- H2: Digital transformation is positively associated with organizational capabilities.
- H3: Organizational capabilities mediate the relationship between digital transformation and sustainable business performance.
- H4: Environmental uncertainty positively moderates the relationship between digital transformation and sustainable business performance, such that the relationship is stronger under higher levels of uncertainty.

These hypotheses form the basis for the conceptual framework and empirical analysis presented in the subsequent sections.

Conceptual Framework and Hypotheses

2.7. Conceptual Model Description

This study develops and tests a moderated mediation model to explain how digital transformation influences

sustainable business performance through internal organizational mechanisms and under varying external conditions. The conceptual framework integrates insights from the Resource-Based View, Dynamic Capabilities Theory, and Stakeholder Theory to provide a comprehensive explanation of digital transformation outcomes.

In the proposed model, digital transformation (DT) represents the extent to which firms strategically adopt and integrate digital technologies into their core operations, structures, and decision-making processes. Digital transformation captures what firms do in terms of technology adoption and strategic digitalization. In contrast, organizational capabilities (OC) represent how firms are able to use these technologies effectively. Organizational capabilities are conceptualized as firm-specific routines, skills, and competencies such as structural flexibility, human resource management capability, and data management capability that enable firms to deploy digital technologies productively. This distinction addresses potential construct overlap by clearly separating digital inputs from capability-based enablers.

Sustainable business performance (SBP) is conceptualized as a higher-order, multidimensional construct comprising economic, social, and environmental performance. Economic performance reflects financial viability and competitiveness; social performance captures outcomes related to employees, customers, and stakeholder relationships; and environmental performance reflects resource efficiency and ecological responsibility. Modeling SBP as a higher-order construct allows the study to capture the integrated nature of sustainability-oriented outcomes while maintaining analytical parsimony.

Environmental uncertainty (EU) represents the external context in which firms operate, characterized by market turbulence, competitive intensity, and technological change. Environmental uncertainty is modeled as a moderating variable that conditions the strength of the relationship between digital transformation and sustainable business performance. The framework proposes that digital transformation affects sustainable business performance both directly and indirectly through organizational capabilities. At the same time, environmental uncertainty moderates the direct relationship between digital transformation and sustainable business performance, resulting in a moderated mediation structure. This model moves beyond technology-deterministic explanations by explicitly incorporating both internal capability development and external environmental conditions.

2.8. Hypotheses Development

2.8.1. Digital Transformation and Sustainable Business Performance

Digital transformation enhances firms' ability to collect, process, and utilize information, leading to improvements in efficiency, innovation, and coordination. From an economic perspective, digital technologies reduce transaction costs and support data-driven decision-making, thereby strengthening financial performance. From a stakeholder perspective, digital transformation enhances transparency, accountability, and responsiveness, contributing to improved social and environmental outcomes.

Importantly, digital transformation can influence sustainable business performance through mechanisms that are not fully captured by organizational capabilities alone. For example, digital technologies can generate signaling effects that enhance stakeholder trust, improve governance transparency, and strengthen legitimacy, even before deep capability reconfiguration occurs. Additionally, digital platforms and information systems can standardize reporting and compliance processes, directly supporting sustainability outcomes.

Accordingly, even after accounting for organizational capabilities, a residual direct relationship between digital transformation and sustainable business performance is theoretically expected.

H1: Digital transformation is positively associated with sustainable business performance.

2.8.2. Digital Transformation and Organizational Capabilities

From the Resource-Based View, digital technologies do not constitute strategic resources in isolation, as they are widely accessible and easily imitated. Their value depends on how firms integrate them into organizational routines and structures. Digital transformation acts as a catalyst for capability development by forcing firms to redesign processes, invest in skills, and establish data governance systems.

Dynamic Capabilities Theory further suggests that digital transformation strengthens firms' ability to sense opportunities, seize them, and reconfigure resources. Through learning-by-doing, experimentation, and cross-functional integration, digital transformation enhances structural flexibility, human capital development, and data utilization practices. Firms that engage more deeply in digital transformation are therefore expected to exhibit stronger organizational capabilities.

H2: Digital transformation is positively associated with organizational capabilities.

2.8.3. Organizational Capabilities as a Mediating Mechanism

Organizational capabilities constitute the primary mechanism through which digital transformation is translated into sustainable business performance. Structural flexibility enables firms to adapt workflows and decision-making structures in response to technological and market changes. Human resource management capability ensures that employees possess the skills and motivation required to exploit digital tools. Data management capability allows firms to convert digital information into actionable insights that support strategic and sustainability-oriented decisions.

Through these mechanisms, organizational capabilities facilitate learning, coordination, and resource reconfiguration. Digital transformation generates technological potential, but without adequate capabilities, firms may experience underutilization or misalignment of digital investments. Capabilities therefore function as process-level conduits that transform digital inputs into realized economic, social, and environmental outcomes.

This logic suggests that organizational capabilities partially mediate the relationship between digital transformation and sustainable business performance, while allowing for a residual direct effect.

H3: Organizational capabilities mediate the relationship between digital transformation and sustainable business performance.

2.8.4. Environmental Uncertainty as a Moderating Factor

Environmental uncertainty shapes the strategic value of digital transformation by influencing information-processing demands and the need for flexibility. In highly uncertain environments, firms face rapid changes in customer preferences, technological standards, and competitive behavior. Under such conditions, digital technologies provide tools for real-time monitoring, rapid response, and adaptive decision-making, thereby amplifying their performance benefits.

However, uncertainty may also increase risks and implementation challenges, particularly for firms lacking adequate capabilities. This creates a potential tension: uncertainty can either enhance or diminish the returns to digital transformation. Drawing on Dynamic Capabilities

Theory, this study argues that when firms possess sufficient organizational capabilities, uncertainty increases the marginal value of digital transformation by activating sensing, seizing, and reconfiguring processes.

Accordingly, the positive effects of digital transformation on sustainable business performance are expected to be stronger under higher levels of environmental uncertainty.

H4: Environmental uncertainty positively moderates the relationship between digital transformation and sustainable business performance, such that the relationship is stronger when environmental uncertainty is high.

2.9. Conceptual Framework Illustration

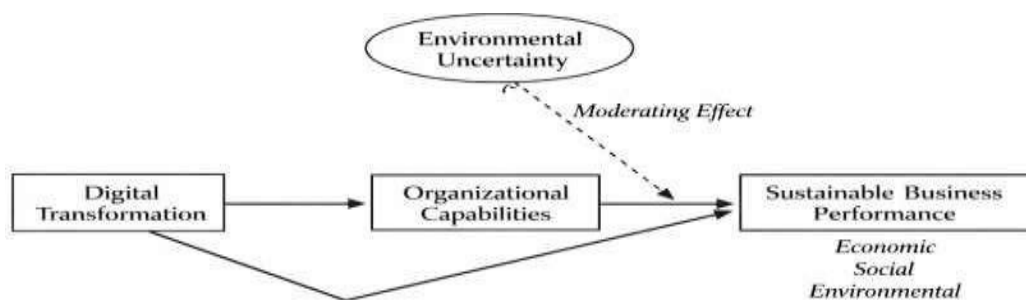


Figure 1. Conceptual Framework of the Study

Figure 1 presents the conceptual framework of the study. Digital transformation is modeled as having (i) a direct effect on sustainable business performance and (ii) an indirect effect through organizational capabilities. Organizational capabilities serve as a mediating mechanism linking digital transformation to sustainable business performance. Environmental uncertainty moderates the direct relationship between digital transformation and sustainable business performance. Sustainable business performance is specified as a higher-order construct comprising economic, social, and environmental dimensions.

Methodology

2.10. Research Design

This study employs a quantitative, cross-sectional research design to examine the relationships among digital transformation, organizational capabilities, environmental uncertainty, and sustainable business performance. The quantitative approach is appropriate given the study's objective of testing theoretically derived relationships among multiple latent constructs using firm-level data. A cross-sectional survey design allows for the systematic collection of comparable data across firms operating in different sectors and under varying environmental conditions.

The study is explanatory in nature and focuses on identifying associational relationships rather than establishing causality. This distinction is explicitly maintained throughout the analysis and interpretation of results. Given the presence of multiple constructs, mediating and moderating relationships, and a multidimensional dependent variable, Partial Least Squares Structural Equation Modeling (PLS-SEM) is selected as the primary analytical technique. PLS-SEM is particularly suitable for theory-driven models that emphasize prediction, accommodate complex model structures, and are robust to violations of normality assumptions commonly associated with survey data.

2.11. Population and Sampling

2.11.1. Population and Emerging Economy Context

The target population comprises firms operating in emerging economy contexts, where digital transformation is unfolding alongside rapid economic development, institutional transition, and heightened environmental uncertainty. Firms in these contexts often face volatile market conditions, technological turbulence, and resource constraints, making them a relevant setting for examining the contingent effects of digital transformation on sustainable business performance.

2.12. Industry Sectors and Firm Size

To enhance external validity and capture variation in digital transformation practices, the study includes firms from three major sectors: manufacturing, services, and information technology. Manufacturing firms are characterized by process-intensive operations and increasing adoption of automation and digital production systems. Service firms rely heavily on customer interaction and digital platforms, while information technology firms represent digitally intensive organizations with advanced technological capabilities.

Both small and medium-sized enterprises (SMEs) and large firms are included in the sample. Firm size is classified based on the number of employees using commonly accepted thresholds. Including firms of different sizes allows the analysis to account for structural differences in resources, flexibility, and digital adoption capacity.

2.12.1. Sampling Method, Inclusion Criteria, and Sample Size A stratified sampling strategy was employed to ensure balanced representation across sectors and firm sizes. Questionnaires were distributed to middle- and senior-level managers who were directly responsible for digital strategy, information systems, operations, or organizational development. These inclusion criteria ensured that respondents possessed sufficient knowledge of their firm's digital transformation initiatives and performance outcomes. Firms without any form of digital technology adoption and respondents without managerial decision-making responsibilities were excluded from the study.

Data collection was conducted over a defined survey period, during which 500 questionnaires were distributed. A total of 400 valid responses were received, resulting in an effective response rate of 80 percent. The final sample size exceeds recommended minimum thresholds for PLS-SEM analysis and provides adequate statistical power for testing mediation and moderation effects within a complex model.

2.13. Data Collection and Instrument Development

Primary data were collected using a structured questionnaire developed on the basis of validated measurement scales from prior empirical research. The questionnaire was designed to capture firm-level perceptions of digital transformation, organizational capabilities, environmental uncertainty, and sustainable business performance (Krisnayanto et al., 2024). All measurement items were assessed using a five-point Likert scale, ranging from 1 ("strongly disagree") to 5 ("strongly agree").

To ensure content validity and clarity, the initial questionnaire draft was reviewed by academic experts specializing in digital transformation and management research. A pilot test was subsequently conducted with a small group of managers to evaluate item wording, clarity, and relevance (Verma et al., 2018). Feedback from the pilot test was used to refine the questionnaire before large-scale administration.

Several procedural remedies were implemented to reduce common method bias. Participation was voluntary, responses were anonymous, and respondents were assured that the data would be used exclusively for academic purposes (Yao & Xu, 2021). No identifying firm-level information was collected, and items were carefully worded to

minimize social desirability bias.

2.14. Variables and Measurement

Technology-Driven Transformation (TDT) is the independent variable and reflects the extent to which firms strategically adopt and integrate digital technologies into core business processes and decision-making systems. Measurement items capture the scope of digital technology adoption, the degree of functional integration, and the strategic importance of digitalization within the firm.

Organizational Capabilities (OC) function as the mediating variable and are conceptualized as firm-specific competencies that enable the effective utilization of digital technologies. OC is operationalized through three dimensions: structural flexibility, human resource management capability, and data management capability. These dimensions capture the firm's ability to reconfigure processes, develop employee skills, and manage digital information.

Environmental Uncertainty (EU) serves as the moderating variable and reflects perceived unpredictability in the external environment. Measurement items assess market turbulence, competitive intensity, and technological change. Higher values indicate greater perceived uncertainty.

Sustainable Business Performance (SBP) is the dependent variable and is modeled as a multidimensional higher-order construct encompassing economic, social, and environmental performance. Economic performance includes indicators such as efficiency and competitiveness; social performance captures employee engagement and customer satisfaction; and environmental performance reflects resource efficiency and waste reduction. Modeling SBP as a higher-order construct allows for an integrated assessment of sustainability-oriented outcomes.

To account for alternative explanations, control variables including firm size, firm age, and industry sector were incorporated into the model.

2.15. Data Analysis Technique (PLS-SEM)

Data analysis was conducted using SmartPLS software, following a two-stage PLS-SEM procedure. First, the measurement model was evaluated to assess reliability and validity. Internal consistency reliability was examined using Cronbach's alpha and composite reliability. Convergent validity was assessed through average variance extracted (AVE), while discriminant validity was evaluated using the Fornell-Larcker criterion and the heterotrait-monotrait (HTMT) ratio. Variance inflation factor (VIF) values were calculated to assess multicollinearity.

Second, the structural model was evaluated by examining path coefficients, their statistical significance obtained through bootstrapping, coefficients of determination (R^2), predictive relevance (Q^2), and effect sizes (f^2). Mediation was assessed by testing indirect effects through organizational capabilities, while moderation was examined using interaction terms between digital transformation and environmental uncertainty. The moderated mediation structure was evaluated by jointly considering indirect and interaction effects.

Throughout the analysis, results are interpreted as associational relationships, consistent with the cross-sectional design, and causal language is deliberately avoided. Ethical Considerations and Bias Control

Ethical standards were rigorously observed throughout the research process. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection. Respondents were informed of the study's purpose, assured of confidentiality, and granted the right to withdraw at any time without consequence.

All data were anonymized and stored securely. No sensitive or identifiable information was collected. Potential sources of bias were addressed through careful questionnaire design, pilot testing, and procedural remedies such as anonymity and neutral item wording. Methodological limitations associated with cross-sectional data and self-reported measures are explicitly acknowledged and discussed in the concluding section of the paper.

3. Results

This section reports the empirical findings of the study. In accordance with best practices, the presentation of results is strictly separated from interpretation, which is reserved for the Discussion section. Results are presented in five subsections: sample characteristics, descriptive statistics and correlations, measurement model assessment, structural model and hypothesis testing, and a summary of results.

3.1. Sample Characteristics

Table 1 presents the descriptive characteristics of the sampled firms by industry sector and firm size. The final sample consists of 400 firms operating in manufacturing, services, and information technology sectors within an emerging economy context.

Table 1. Sample Characteristics of Respondent Firms (N = 400)

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Industry Sector	Firm Size	Frequency	Percentage (%)
Manufacturing	Large	80	20.0
Manufacturing	Medium	120	30.0
Manufacturing	Small	60	15.0
Services	Large	40	10.0
Services	Medium	80	20.0
Services	Small	20	5.0
Information Technology	Large	30	7.5
Information Technology	Medium	40	10.0

Information Technology	Small	10	2.5
Total	–	400	100.0

Notes: Firm size classification is based on the number of employees (Small < 50; Medium = 50–249; Large ≥ 250).

Manufacturing firms constitute the largest share of the sample (65 percent), followed by service firms (35 percent) and information technology firms (20 percent). Medium-sized enterprises are the most represented category, accounting for 60 percent of the total sample.

3.2. Descriptive Statistics and Correlations

Descriptive statistics for the main study variables are reported in Table 2. Mean values, standard deviations, and observed ranges are provided to describe the distribution of the constructs.

Table 2. Descriptive Statistics of Study Variables (N = 400)

Variable	Mean	Standard Deviation	Minimum	Maximum
Technology-Driven Transformation (TDT)	3.78	0.65	2.10	4.95
Organizational Capabilities (OC)	3.45	0.72	1.80	4.85
Environmental Uncertainty (EU)	3.20	0.81	1.50	4.95
Sustainable Business Performance (SBP)	3.68	0.77	2.00	4.90

Notes: All variables were measured on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree).

The mean values indicate moderate to relatively high levels of digital transformation and sustainable business performance across the sample, with environmental uncertainty showing the greatest variability. Table 3 presents Pearson correlation coefficients among the study variables.

Table 3. Pearson Correlation Matrix

SBP	0.56***	0.58***	0.32**	1.00
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Notes: *** $p < 0.001$; ** $p < 0.01$.

All correlations are positive and statistically significant. The magnitude of correlations does not indicate multicollinearity concerns, which are further examined in the measurement model assessment.

Variables	TDT	OC	EU	SBP
TDT	1.00			
OC	0.62***	1.00		
EU	0.35**	0.38***	1.00	

3.3. Measurement Model Assessment

The measurement model was evaluated for reliability, convergent validity, and discriminant validity prior to testing the structural model. Table 4 summarizes the results.

Table 4. Measurement Model Assessment

Construct	Cronbach's α	Composite Reliability (CR)	AVE	VIF Range	HTMT
TDT	0.89	0.92	0.67	1.22–2.45	0.71
OC	0.88	0.91	0.64	1.10–2.30	0.69
EU	0.83	0.89	0.61	1.15–2.15	0.66
SBP	0.91	0.93	0.70	1.30–2.55	0.73

Notes: Cronbach's $\alpha \geq 0.70$; CR ≥ 0.70 ; AVE ≥ 0.50 ; HTMT < 0.85 .

All constructs meet recommended thresholds for internal consistency reliability and convergent validity. Discriminant validity is supported as HTMT values are below the conservative threshold. VIF values indicate no multicollinearity concerns.

3.4. Structural Model and Hypothesis Testing

The structural model was evaluated to test the hypothesized relationships among constructs. Table 5 reports standardized path coefficients, t-values, p-values, coefficients of determination (R^2), predictive relevance (Q^2), and effect sizes (f^2).

Table 5. Structural Model Results and Hypothesis Testing

Hypothesis	Path	β	t-value	p-value	R^2	Q^2	f^2	Result
H1	TDT \rightarrow SBP	0.42	7.85	<0.001	0.49	0.33	0.18	Supported
H2	TDT \rightarrow OC	0.55	9.42	<0.001	0.37	0.25	0.24	Supported
H3	OC \rightarrow SBP	0.37	6.11	<0.001	–	–	0.16	Supported
H4	EU \times TDT \rightarrow SBP	0.14	2.89	<0.01	–	–	0.07	Supported

Notes: Bootstrapping with 5,000 resamples; β = standardized coefficient. The model explains 49 percent of the variance in sustainable business performance and 37 percent of the variance in organizational capabilities, indicating substantial explanatory power. All hypothesized paths are statistically significant.

The mediating role of organizational capabilities was assessed through the indirect effect of TDT on SBP via OC ($\beta = 0.20$, $p < 0.001$), indicating partial mediation. The interaction term between digital transformation and environmental uncertainty is statistically significant, supporting the moderating hypothesis.

The results provide empirical support for all proposed hypotheses. Digital transformation is positively associated with

sustainable business performance and organizational capabilities. Organizational capabilities partially mediate the relationship between digital transformation and sustainable business performance. Environmental uncertainty significantly moderates the relationship between digital transformation and sustainable business performance. Overall, the findings demonstrate that the proposed moderated mediation model is empirically supported and that the relationships specified in the conceptual framework are statistically significant.

4.

Discussion

The purpose of this section is to interpret the empirical findings in light of the research objectives, situate them within the existing literature, and articulate their theoretical, practical, and policy relevance (Dahal et al., 2024). Unlike the Results section, this discussion focuses on meaning, explanation, and implications rather than statistical reporting.

4.1. Interpretation of Main Findings

The primary objective of this study was to examine how technology-driven transformation influences sustainable business performance, with particular attention to the mediating role of organizational capabilities and the moderating role of environmental uncertainty. The findings indicate that digital transformation is positively associated with sustainable business performance across economic, social, and environmental dimensions (Wang & Zhang, 2024). This suggests that digital transformation functions not merely as a technological upgrade but as a strategic mechanism that supports sustainability-oriented outcomes.

The results further show that organizational capabilities partially mediate the relationship between digital transformation and sustainable business performance. This indicates that while digital transformation can generate direct benefits, a substantial portion of its impact operates through firm-specific capabilities such as structural flexibility, human resource management, and data management (Ilham et al., 2026). These capabilities enable firms to convert digital investments into operational improvements, innovation, and stakeholder value creation.

In addition, environmental uncertainty positively moderates the relationship between digital transformation and sustainable business performance. This finding suggests that the benefits of digital transformation are amplified in volatile environments, where firms face rapid market changes, competitive pressure, and technological turbulence (Zhan & Li, 2024). Under such conditions, digital technologies appear to enhance firms' adaptive capacity and responsiveness, strengthening their sustainability outcomes.

Taken together, the findings support the proposed moderated mediation framework and demonstrate that digital transformation outcomes are contingent on both internal organizational readiness and external environmental conditions (Wang & Zhang, 2025).

4.2. Comparison with Previous Studies

The positive association between digital transformation and firm performance is consistent with prior research that emphasizes efficiency gains, innovation, and competitiveness resulting from digital adoption (Zhou et al., 2025). However, this study extends existing evidence by demonstrating that these benefits also apply to sustainable business performance, rather than being limited to purely financial outcomes.

Previous studies have often focused on narrow performance indicators or single dimensions such as productivity or innovation. In contrast, the present findings align with more recent research that calls for a multidimensional understanding of performance, incorporating social and environmental considerations alongside economic outcomes (Iranmanesh et al., 2020). The results therefore reinforce arguments that digital transformation plays a broader role in enabling sustainability-oriented strategies.

The mediating role of organizational capabilities is consistent with studies grounded in capability-based perspectives, which argue that technology alone does not create value unless supported by appropriate organizational structures and skills. While earlier research has acknowledged the importance of capabilities, empirical evidence explicitly modeling mediation effects remains limited (Konopik et al., 2021). This study contributes by empirically demonstrating that capabilities serve as a key transmission mechanism between digital transformation and sustainable outcomes.

The moderating effect of environmental uncertainty aligns with contingency-based research suggesting that uncertain environments increase the value of flexibility, information processing, and rapid adaptation. However, some prior studies have reported mixed or even negative effects of uncertainty, particularly in highly regulated or resource-constrained settings (Lutfi, 2020). The present findings suggest that when firms possess sufficient organizational capabilities, uncertainty can act as a catalyst rather than a constraint, enhancing the strategic value of digital transformation.

4.3. Theoretical Implications

This study makes several contributions to theory by integrating insights from the Resource- Based View, Dynamic Capabilities Theory, and Stakeholder Theory within a single empirical framework.

From a Resource-Based View perspective, the findings confirm that digital technologies are not inherently strategic resources. Instead, their value depends on complementary organizational capabilities that are firm-specific and difficult to imitate. By empirically demonstrating the mediating role of organizational capabilities, the study strengthens the argument that sustainable competitive advantage arises from the interaction between technology and internal resources.

From a Dynamic Capabilities perspective, the positive moderation effect of environmental uncertainty highlights the importance of sensing, seizing, and reconfiguring capabilities in volatile environments. Digital transformation enhances firms' ability to respond to change, particularly when uncertainty is high. This supports the view that dynamic capabilities are most valuable under conditions of rapid environmental change and that digital technologies serve as enablers of these capabilities.

From a Stakeholder Theory perspective, the multidimensional operationalization of sustainable business performance demonstrates that digital transformation contributes not only to economic outcomes but also to social and environmental value creation. Enhanced transparency, accountability, and data-driven governance enabled by digital technologies strengthen stakeholder relationships and organizational legitimacy. This finding reinforces the relevance of stakeholder- oriented performance frameworks in the digital economy.

By integrating these perspectives, the study advances a more holistic theoretical understanding of digital transformation as a capability-dependent and context-sensitive process with sustainability implications.

4.4. Practical and Policy Implications

The findings offer several implications for managers, policymakers, and practitioners. For business managers, the results underscore that digital transformation should not be approached as a purely technological initiative. Investments in digital technologies must be accompanied by investments in organizational capabilities, including employee skills development, flexible organizational structures, and robust data management systems. Firms that neglect these complementary capabilities risk underutilizing digital technologies and failing to achieve sustainability benefits.

For managers operating in uncertain and volatile environments, the results suggest that environmental turbulence should not be viewed solely as a threat. When supported by appropriate capabilities, uncertainty can amplify the benefits of digital transformation by encouraging experimentation, rapid learning, and adaptive responses.

For policymakers, the findings highlight the importance of creating enabling environments for digital transformation in emerging economies. Policy initiatives should go beyond infrastructure development and include support for capability building, such as digital skills training, innovation support programs, and data governance frameworks. Encouraging responsible digital adoption aligned with sustainability objectives can enhance national competitiveness and inclusive growth.

For industry practitioners, the results emphasize the value of adopting multidimensional performance metrics that capture economic, social, and environmental outcomes. Such metrics can guide strategic decision-making and improve alignment with sustainability goals and stakeholder expectations.

4.5. Originality and Contribution

This study makes several original contributions. First, it integrates mediation and moderation into a single empirical framework, offering a more nuanced explanation of digital transformation outcomes than prior studies that examined these mechanisms in isolation. Second, it explicitly links digital transformation to sustainable business performance, extending the scope of digital transformation research beyond efficiency and profitability. Third, it provides empirical evidence from an emerging economy context, addressing a gap in a literature dominated by studies from developed economies.

4.6. Limitations and Boundaries of Generalization

Despite its contributions, the study has limitations. The cross-sectional design limits the ability to draw causal inferences or capture dynamic changes over time. The reliance on self-reported survey data may introduce perceptual bias, although procedural remedies were applied to mitigate this risk. In addition, the sample is limited to three industry sectors, which may constrain generalizability to other sectors or institutional contexts.

Accordingly, the findings should be interpreted within the scope of emerging economy firms operating under conditions of environmental uncertainty. Generalization beyond this context should be undertaken with caution.

4.7. Future Research Directions

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Future research could address these limitations by adopting longitudinal designs to examine how digital transformation and organizational capabilities evolve over time. Mixed-method approaches combining quantitative analysis with qualitative case studies could provide deeper insight into the mechanisms underlying capability development. Further studies could also explore additional contextual moderators, such as regulatory quality or cultural factors, and examine governance-related challenges such as data ethics, privacy, and digital inequality.

Conclusion

This study set out to examine how technology-driven transformation influences sustainable business performance, with particular attention to the mediating role of organizational capabilities and the moderating role of environmental uncertainty in an emerging economy context. Drawing on survey data from firms across manufacturing, services, and information technology sectors, the empirical analysis demonstrates that technology-driven transformation is positively associated with sustainable business performance across economic, social, and environmental dimensions. The findings further show that organizational capabilities specifically structural flexibility, human resource management capability, and data management capability partially mediate this relationship. This indicates that digital transformation generates stronger and more consistent sustainability outcomes when firms possess the internal capabilities required to effectively deploy and integrate digital technologies. In addition, environmental uncertainty was found to positively moderate the relationship between digital transformation and sustainable business performance, suggesting that the benefits of digital transformation are amplified under conditions of market and technological volatility.

Overall, the results confirm that digital transformation is not a standalone driver of sustainable performance. Instead, its effectiveness depends on both internal organizational readiness and the external environment in which firms operate.

This study makes several important contributions to the literature. First, it advances understanding of digital transformation by explicitly linking it to sustainable business performance, rather than limiting performance assessment to financial or operational outcomes. By adopting a multidimensional performance perspective, the study responds to growing calls for sustainability-oriented evaluation of firm success.

Second, the study contributes theoretically by integrating insights from the Resource-Based View, Dynamic Capabilities Theory, and Stakeholder Theory within a single moderated mediation framework. This integrated approach provides a more comprehensive explanation of how and under what conditions digital transformation affects firm outcomes.

Third, the study contributes empirically by providing evidence from an emerging economy context, where environmental uncertainty and institutional change are salient. This addresses a notable gap in the literature, which has been dominated by studies conducted in developed economies.

Despite its contributions, this study has several limitations that should be acknowledged. First, the cross-sectional research design limits the ability to capture dynamic changes over time and precludes strong causal inference. Second, the study relies on self-reported survey data, which may be subject to perceptual bias, despite the procedural steps taken to mitigate such concerns. Third, the sample is limited to three industry sectors, which may constrain the generalizability of the findings to other sectors or institutional settings.

Accordingly, the conclusions of this study should be interpreted within the boundaries of firms operating in emerging economies under conditions of environmental uncertainty.

Future research could build on this study in several ways. Longitudinal designs would allow researchers to examine how digital transformation and organizational capabilities evolve over time and how their effects on sustainable performance unfold dynamically. Mixed-method approaches combining survey data with qualitative case studies could provide deeper insight into the processes through which capabilities are developed and deployed.

In addition, future studies could explore other contextual moderators, such as regulatory quality or cultural factors, and extend the framework to additional sectors or geographic regions. Research focusing on governance challenges associated with digital transformation, including data ethics and digital inclusion, would further enrich understanding of sustainability in the digital economy.

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- Conceptualization: All authors
- Methodology: All authors

- Data Analysis: All authors
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