SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2025
ORGANIZATION AND MANAGEMENT SERIES NO. 232

# CONFIGURATIONAL PATHS TO SUCCESSFUL DIGITAL TRANSFORMATION

Anna KWIOTKOWSKA

Silesian University of Technology; akwiotkowska@polsl.pl, ORCID: 0000-0001-5204-1259

**Purpose:** Digital transformation has emerged as a strategic priority fostering the advancement of high-quality small and medium-sized enterprises (SMEs). However, existing research provides only limited and fragmented insights into the underlying components that determine digital success within SMEs. The purpose of this study is to identify the key factors shaping the digital transformation process in SMEs and to explore effective paths for their successful digital adaptation.
**Design/methodology/approach**: The study was conducted using the fuzzy-set Qualitative Comparative Analysis (fsQCA) method, which was applied to a sample of 56 small and medium-sized enterprises (SMEs) in order to identify the key configurational paths leading to successful digital transformation.
**Findings:** The findings indicate that the success of digital transformation in SMEs is not driven by a single factor but rather emerges from the adaptive interplay of multiple variables. Five main paths to successful digital transformation in SMEs were identified. A comparative analysis of these paths reveals substitutive effects among certain drivers of digital transformation.
**Originality/value:** This study advances the understanding of the antecedents of digital transformation in SMEs by uncovering the complex causal relationships among influencing factors. At the same time, it provides practical insights and guidance for enterprises pursuing digital transformation initiatives.
**Keywords:** digital transformation, configurations, fuzzy set qualitative comparative analysis, necessary condition analysis, SMEs.
**Category of the paper:** research paper.

## 1. Introduction

The swift progress and broad diffusion of emerging digital technologies, such as cloud computing, big data, and the Internet of Things have reshaped the global competitive environment, stimulated the growth of the digital economy, and propelled industries across the world toward digital transformation. Digital transformation refers to the process through which firms employ digital technologies to reconfigure business models and operational practices,

thereby improving efficiency, generating new revenue opportunities, enhancing customer engagement, and strengthening overall competitiveness (Meier et al., 2025). For SMEs, digital transformation has become a critical requirement for enhancing operational efficiency, reducing costs, and strengthening competitive advantage. At the same time, policy support and evolving market demands are driving these firms toward digitalization, equipping them with tools to better address challenges and adapt to shifting market conditions (Yin, Zhao, 2024). Nevertheless, the digital transformation of SMEs remains marked by gaps and disparities, as well as considerable variation in digital maturity across different industries (Omrani et al., 2022). SMEs face a range of barriers, including limited technological infrastructure, a shortage of specialized digital competencies, difficulties in precisely identifying transformation needs, and the absence of unified standards. These factors often result in fragmented, inconsistent, and disorganized transformation processes. An additional challenge stems from the slow returns of digital initiatives, which cause many SMEs—despite their willingness to embrace change—to delay implementation due to uncertainty and risk aversion. A key obstacle is also the lack of in-depth knowledge about their internal capabilities, which prevents firms from developing digital transformation strategies tailored to their specific characteristics. This study aims to support SMEs in identifying digital transformation pathways suited to their individual conditions, thereby enabling them to achieve intended transformation goals through diverse and customized approaches.

Methodologically, most existing research on the digital transformation of SMEs relies on descriptive qualitative analyses or traditional linear regression and econometric methods to assess how individual factors influence the transformation process. However, such approaches fail to fully capture the complex interdependencies among the multiple determinants shaping digitalization (He et al., 2023; Kwiotkowska, 2024). Digital transformation in SMEs is in fact driven by the interplay of interconnected elements, including technological capabilities, market dynamics, and institutional support. Examining these factors in isolation risks oversimplifying the critical synergies necessary for successful and sustainable transformation. This limitation in the current literature highlights a significant research gap: the need for a comprehensive understanding of how diverse factors interact and reinforce one another in driving digital transformation within the SME sector.

This study seeks to address the following research questions:

RQ1: What are the key technological, organizational, and environmental factors influencing the digital transformation of SMEs?

RQ2: How do these factors interact with one another and, in combination, configurationally shape the digital transformation of SMEs?

RQ3: What pathways lead to successful digital transformation?

This study examines the complex interactions between technological, organizational, and environmental factors to assess their configurative impact on the digital transformation of SMEs. Applying this framework to SME digital transformation, this study aims to demonstrate

how these factors converge to drive or constrain SME digital development. This approach advances this area of research, which remains underexplored in the literature. Unlike traditional research approaches, this paper employs fs/QCA to analyze the digital transformation of SMEs, enabling the exploration of multidimensional factor interactions, the identification of necessary conditions, the tracing of the stepwise nature of transformation, and the clarification of the relationship between resources and market dynamics, as well as the recognition of equivalent transformation pathways. By combining in-depth qualitative insights with rigorous quantitative analysis, fs/QCA provides a powerful lens through which to understand the complexity of digital transformation, advancing both theoretical frameworks and practical implications in the SME context.

It is important to emphasize that, from a configurational perspective, this study examines the complex causal interactions among multiple factors and their influence on the outcomes of digital transformation. This approach provides a more comprehensive understanding of the paths and mechanisms of transformation, offering new theoretical insights to the literature on SME digital transformation. Furthermore, the findings provide both theoretical contributions and practical recommendations for SMEs pursuing digital transformation. From a practical standpoint, SMEs are encouraged to adopt transformation strategies tailored to their specific circumstances and resource constraints, rather than replicating the approaches of larger firms. Such a customized approach enables SMEs to more effectively identify and capitalize on digital opportunities, thereby enhancing their flexibility and adaptive capacity in response to evolving market dynamics (Merin-Rodriganez et al., 2024).

The structure of this paper is as follows: it first outlines the theoretical foundations followed by a detailed description of the data and methodological approach. The subsequent section presents the empirical findings along with their interpretation. The paper concludes with a synthesis of the main contributions, practical implications, and directions for future research.

## 2. Literature review

Digital transformation refers to significant organizational changes driven by the integration of information, computing, communication, and networking technologies, which enhance business processes (Vial, 2019). So far, research in the literature has mainly focused on internal factors, such as: technological capabilities, human resources, and knowledge (Stief et al., 2016), leadership, organizational culture, employee and partner engagement, alignment of business and IT strategies, process standardization, data integration, employee training and skills development, agile change management, and the use of both internal and external knowledge (Cichosz et al., 2020). Studies also emphasize the role of mechanisms of influence, including:

changes in management structures (Steiber et al., 2021), the development and adoption of technologies (Vial, 2019), innovative organizational integration (Hanelt et al., 2021).

It is important to note that SMEs tend to adopt digital transformation more slowly than large enterprises. This often happens because decisions are made reactively, under pressure from emerging technologies in the industry (Rochet, Tirole, 2008). As a result, many SMEs introduce digital transformation mainly to ensure survival and remain competitive. Another relevant factor is the level of regional digital development, which serves as an incentive for organizations to adopt changes. Government policies promoting digital innovation in SMEs play a particularly important role here (Ramdani et al., 2022).

Nevertheless, most existing studies on digital transformation remain descriptive in nature. There is a lack of empirical analyses that examine the specific conditions of digitalization in SMEs. The mechanisms underlying the choice of transformation pathways remain unclear, and understanding the complex cause-and-effect relationships between variables and their configurations is still limited. Therefore, it is essential to investigate the configurations of factors and transformation paths that enable SMEs to achieve successful digital transformation.

This study adopts a theoretical framework based on the idea that the adoption and use of innovative technologies in organizations are influenced by three factors: technology, organization, and environment. Technological factors refer to the characteristics and properties of technologies relevant to the functioning of an enterprise, encompassing both the solutions already implemented and those available on the market but not yet adopted (Baker, 2012). Organizational factors capture the influence of managerial conditions, including firm-specific attributes and resources such as organizational size and structure, business profile, internal communication processes, and the extent of slack resources (Zhu et al., 2006). In turn, environmental factors concern the uncertainty of the external environment, arising from elements such as industry structure, relationships with suppliers, and market scope (Barker et al., 2022).

As digital transformation processes deepen and digital technologies evolve rapidly, the business environment and management information systems become increasingly complex. Within this context, the three key perspective: technological, organizational, and environmental interact in a coordinated manner, shaping firms' innovation capabilities and performance outcomes. Consequently, examining the drivers of digital transformation solely through the lens of a single factor, such as resources or capabilities, risks oversimplification. A more comprehensive understanding requires investigating multi-factor configurations that influence the choice of transformation paths and underlie higher rates of success in digitalization efforts.

The technological perspective encompasses both the technological innovation capability and the quality of digital infrastructure. For SMEs, strengthening innovation capabilities fosters the development of new products and services while simultaneously enhancing operational efficiency. Equally important is the expansion of modern digital infrastructure and the adoption of advanced solutions such as data analytics, cloud computing, the Internet of Things,

and artificial intelligence. These technologies enable firms to acquire external knowledge, reduce information asymmetry between supply and demand, improve internal knowledge flows, and ultimately increase the effectiveness of digital transformation processes (Chang et al., 2019). Conversely, SMEs with outdated digital infrastructures face considerable pressure to modernize in order to meet contemporary business requirements. Such modernization not only enhances operational efficiency but also reinforces competitive positioning. As a result, this pressure serves as a critical driver of digital transformation, allowing SMEs to adapt and grow in an increasingly dynamic market environment.

The organizational perspective encompasses two key elements: digital strategy and risk resilience. Digital strategy is one of the key driving forces behind the transformation and modernization of enterprises. By defining an organization's vision, strategic priorities, and directions for development, it structures and standardizes the process of change (Correani et al., 2020). Formulating a clear concept of digital transformation—based on well-defined objectives and realistic action plans—is a necessary prerequisite for initiating modernization efforts, as it provides the company with a coherent and well-directed development path (Proksch et al., 2021). Risk resilience, defined as the capacity to adapt to uncertainty and external disruptions, has become a key driver of digital transformation. SMEs, often facing unstable environments, need to strengthen this capability to overcome barriers in their digitalization processes. Prior studies show that resilience is positively associated with successful digital transformation (Wang, Chen, 2022), while low resilience hampers broader business change (Chen et al., 2023). Thus, effective risk management is essential for ensuring sustainable digital initiatives.

The environmental perspective comprises government support and market competitiveness. Government support plays a vital role in advancing digital transformation by easing financial constraints, reducing risks, and enhancing firms' confidence in digital initiatives. By providing external intervention and regulatory guidance, public authorities help enterprises accelerate ecosystem development and adopt standardized digital modernization practices (Wang et al., 2019). In the context of advancing digitalization, capital markets increasingly reward industries characterized by a high level of technological sophistication and superior profitability, while rising consumer expectations regarding product and service quality further intensify competitive pressures (Barker et al., 2022). At present, both market standing and competitive strength represent critical determinants of a firm's readiness to pursue innovation and transformation. Enterprises with stronger competitive positions are generally more inclined to leverage digital transformation as a strategic tool to reinforce their advantage in uncertain market environments.

To conclude, a research model has been developed and illustrated in Figure 1.

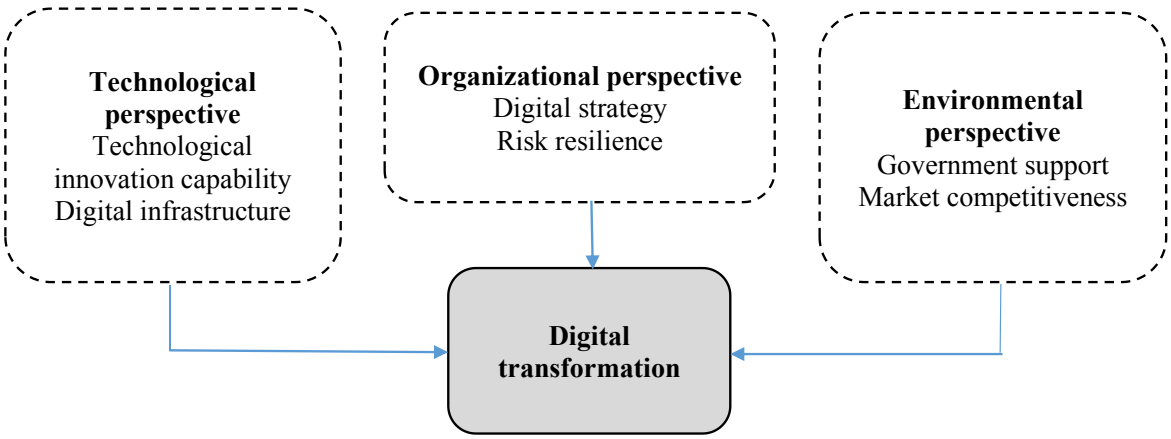


**Figure 1.** Research model.

Source: own study.

The research model presented in Figure 1 integrates the technological, organizational, and environmental dimensions that jointly determine the digital transformation processes of SMEs. It demonstrates that successful digital transformation results not from isolated factors, but from the interdependence and alignment of multiple conditions that together shape firms' ability to adapt, innovate, and compete in a dynamic market environment.

Accordingly, the model serves as a conceptual basis for further empirical investigation into the specific configurations of factors that enable SMEs to achieve effective digital transformation. It provides a structured framework for examining how various internal and external determinants interact to influence strategic decisions, innovation capacity, and performance outcomes. By adopting this multidimensional perspective, the study contributes to a more comprehensive understanding of the mechanisms underlying digital transformation in small and medium-sized enterprises.

## 3. Methods

In this study, a configurational approach was applied to analyze the determinants of successful digital transformation in the SME sector. This perspective is based on three key assumptions. First, digital transformation is the result of complex interactions between three perspective of a company's operations: technological, organizational, and environmental. Accordingly, the study employs the QCA method, which unlike traditional regression models that focus on the influence of individual variables, enables the identification of synergistic effects arising from combinations of multiple factors and reveals the mechanisms leading to effective digital transformation. This approach is particularly well-suited for exploring intricate complex causal relationships (Pappas, Woodside, 2021). Second, it is important to emphasize that the determinants of transformation processes do not function in isolation but are

interconnected in various configurations. The principle of equifinality, which is characteristic of QCA, allows for the examination of multifactorial dependencies and the identification of different pathways leading to the same outcome. Third, due to the partial nature of membership in both the causal and outcome conditions, classifying them in binary categories ("0" and "1") would be insufficient. Therefore, fuzzy-set qualitative comparative analysis (fs/QCA) was used, which makes it possible to study combinations of resources and capabilities in a way that reflects the varying intensity of individual conditions. This approach captures important differences in the strength of factor influence and thereby provides a more precise explanation of the mechanisms leading to successful digital transformation in SMEs. In this study, version 3.0 of fs/QCA for Windows (Ragin, Davey, 2016) was used.

A structured survey questionnaire was developed based on a comprehensive review of prior literature, ensuring high content validity. In the initial stage, the reliability of the instrument was tested on a pilot sample of 39 respondents representing ten SMEs. To explore the three key dimensions of business operations: technological, organizational, and environmental, that are essential to the digital transformation process, data were collected from Polish SMEs currently undergoing digital transformation and possessing relevant experience. The automotive industry was selected for this study due to its pioneering role in adopting innovative digital technologies and its superior technological infrastructure compared to other sectors (Schuh et al., 2017). Data collection was carried out in 2024 and targeted middle and senior-level managers from 56 small and medium-sized enterprises in Poland. A total of 113 completed questionnaires were initially obtained. However, to ensure data quality, incomplete or empty responses were excluded from the final dataset. Consequently, 73 fully completed questionnaires were included in the analysis. The basic characteristics of the research sample are presented in Table 1.

**Table 1.**
*Basic characteristics of the research sample*

| Content | Proportion |
|---|---|
| **The stage of the companies' development** | |
| Start-up period | 9.6 |
| Growth period | 38.4 |
| Maturity period | 49.4 |
| **Scale of enterprises** | |
| Micro companies | 17.3 |
| Small companies | 38.8 |
| Middle companies | 43.9 |
| **Respondent's position in the company** | |
| Manager | 29.3 |
| Senior Manager | 43.7 |
| Executive (CEO, CMO, CFO, CIO) | 27 |
| **Respondent's period of employment in the company** | |
| 5 years | 8.2 |
| 6-10 years | 18.9 |
| 11-15 years | 46.8 |
| More than 15 years | 26.1 |

Source: own study.

The survey questionnaire employed a 7-point Likert scale to measure each item, where 1 indicated complete disagreement and 7 indicated full agreement. To ensure the validity of the study, established and validated measurement scales were applied. Specifically, the scale for assessing digital transformation was adopted from AlNuaimi et al. (2022). Within the technological perspective, technological innovation capability and digital infrastructure were assessed using the scales developed by Liu and Xie (2020) and Nambisan et al. (2017), respectively. Regarding the organizational perspective, resilience to risk was measured with the scale proposed by Nguyen et al. (2023), while digital strategy was evaluated using the instrument of AlNuaimi et al. (2022). Finally, for the environmental perspective, government support was captured through the scale of Wang et al. (2019), whereas market competitiveness was measured following the approach of Nguyen, Pham, et al. (2023).

In order to evaluate the reliability of the measurement instruments, Cronbach's alpha coefficients were calculated. The obtained values were 0.87 for digital transformation, 0.85 for technological innovation capability, 0.83 for digital infrastructure, 0.92 for digital strategy, 0.84 for resilience to risks, 0.89 for government support, and 0.82 for market competitiveness. Since all coefficients exceeded the recommended threshold of 0.70, the scales employed in this study can be considered reliable.

## 4. Results

The first step in the fs/QCA procedure involves calibrating both the outcome variable and the causal conditions to determine their fuzzy set membership scores. In this study, the direct calibration method was employed, and the calibration function in fs/QCA 3.0 software was used to transform the raw data into membership values within the [0,1] interval. For each variable, the mean score was calculated and treated as its final value. Following established calibration standards, the thresholds were set at the 95th percentile for full membership, the 50th percentile for the crossover point, and the 5th percentile for full non-membership. The specific calibration anchors for each variable are reported in Table 2.

A necessity analysis was conducted for the antecedent conditions and their negations across different modes of transformation in order to mitigate the risk of omitting necessary conditions in the parsimonious solution. The results of this analysis, obtained using fsQCA 3.0 software, are presented in Table 3. According to the established criterion that the consistency level of a necessary condition must exceed 0.90, none of the variables examined in this study qualified as a necessary condition for digital transformation.

**Table 2.**
*Calibration anchors of each fuzzy set*

| Sets | | Calibration anchors | | |
|---|---|---|---|---|
| | | **Fully in** | **Crossover** | **Fully out** |
| Digital transformation | | 5.8 | 4.9 | 1.5 |
| Technological | Technological innovation capability | 6 | 4.8 | 1.5 |
| | Digital infrastructure | 6 | 5 | 1.5 |
| Organizational | Resilience to risk | 5.9 | 4.75 | 1.5 |
| | Digital strategy | 5.7 | 4.8 | 1.5 |
| Environmental | Government support | 6 | 4.7 | 1.5 |
| | Market competitiveness | 5.75 | 4.9 | 1.5 |

Source: own study.

**Table 3.**
*Analysis of necessity for digital transformation*

| Conditions | High digital transformation | |
|---|---|---|
| | **consistency** | **coverage** |
| Technological innovation capability | 0.51 | 0.54 |
| ~Technological innovation capability | 0.84 | 0.80 |
| Digital infrastructure | 0.58 | 0.58 |
| ~Digital infrastructure | 0.81 | 0.81 |
| Resilience to risk | 0.57 | 0.56 |
| ~Resilience to risk | 0.79 | 0.82 |
| Digital strategy | 0.51 | 0.56 |
| ~Digital strategy | 0.86 | 0.55 |
| Government support | 0.52 | 0.84 |
| ~Government support | 0.81 | 0.57 |
| Market competitiveness | 0.54 | 0.56 |
| ~Market competitiveness | 0.79 | 0.83 |

Source: own study.

To reduce potential contradictory configurations and possible subset relations, the empirical data in this study were analyzed using fsQCA 3.0, with the PRI threshold set at 0.8 and the minimum frequency of cases set at 1. In the standardized truth table analysis the "present or absent" option was selected to generate the intermediate solution. Following established methodological conventions, antecedent conditions that appeared in both parsimonious and intermediate solutions were classified as core conditions, whereas those that appeared only in intermediate solutions were identified as peripheral conditions. The detailed results of the configurational analysis are presented in Table 4.

**Table 4.**
*Sufficient configurations for digital transformation*

| Solutions | Sets | Raw Coverage | Unique Coverage | Consistency |
|---|---|---|---|---|
| S1a | **Digital infrastructure*Technological innovation capability***Government support***Market Competitiveness** | 0.95 | 0.10 | 0.91 |
| S1b | **Digital infrastructure*** Resilience to risk***Technological innovation capability***Digital strategy***Market Competitiveness** | 0.37 | 0.08 | 0.94 |
| S2a | **Digital infrastructure***Digital strategy***~Government support** | 0.34 | 0.07 | 0.92 |

Cont. table 4.

| | | | | |
|---|---|---|---|---|
| S2b | **Digital infrastructure*~Government support***~Market competitiveness | 0.23 | 0.03 | 0.91 |
| S2c | **Digital infrastructure***Technological innovation capability*~Resilience to risk***~Government support** | 0.31 | 0.05 | 0.91 |
| Overall solution coverage: 0.58 | | | | |
| Overall solution consistency: 0.91 | | | | |
| Note:<br>• * logical AND; ~logical negation.<br>• bold indicates core conditions, while no bold indicates peripheral conditions. | | | | |

Source: own study.

As shown in Table 4, different combinations of antecedent conditions generated five configurations leading to successful digital transformation. Each configuration demonstrated a solution consistency of 0.91, 0.94, 0.92, 0.91 and 0.91, respectively, all exceeding the threshold of 0.90, thereby confirming their sufficiency for achieving a high level of digital transformation in enterprises. Furthermore, these configurations were classified into two distinct configuration paths, differentiated on the basis of core conditions.

In highly competitive market environments, configuration S1a indicates that firms may attain successful digital transformation even in the absence of risk resilience or a formally articulated digital strategy, as long as they exploit the complementary effects of digital infrastructure, technological innovation capability, and governmental support. This path explains 95% of advanced digital transformation cases among the analyzed SMEs, with 10% of cases being uniquely attributable to this configuration.

Configuration S1b suggests that within highly competitive markets, enterprises may still realize successful digital transformation by reinforcing digital infrastructure, enhancing technological innovation capability and market competitiveness, and adopting a comprehensive digital strategy underpinned by risk resilience, regardless of financial support from government sources. This pathway accounts for 37% of successful digital transformation cases among SMEs, with 8% uniquely explained by this configuration.

Configuration S2a highlights that, for companies operating without government support, improving their digital infrastructure and strategic digital planning can collectively enhance digital transformation. This path indicates that companies without explicit government support or policy incentives benefit from adopting a proactive approach, transforming their organizational models, and implementing advanced technologies to strengthen digital capabilities. The configuration's consistency is 0.92, and the coverage is 0.34, indicating that this path accounts for 34% of digital transformation cases among SMEs.

Configuration S2b demonstrates that for enterprises lacking government support but operating in markets with low competitiveness, strengthening digital infrastructure alone can drive successful digital transformation. In this path, digital infrastructure plays a pivotal role, accounting for approximately 23% of successful digital transformation cases among SMEs.

In configuration S2c, enterprises constrained by insufficient risk resilience and the absence of government subsidies can still achieve advanced digital transformation by enhancing digital infrastructure and developing strong technological innovation capabilities. This path accounts for approximately 31% of high-level digital transformation cases among SMEs. The differences between configurations S2a and S2c highlight the substitutability of digital strategy and technological innovation capability as conditional factors. In the case of configuration S2c, enterprises can partially offset the lack of government support by strengthening their technological innovation capability, thereby effectively managing transformation-related uncertainty.

To assess the robustness of the findings, a set-theoretic approach with a high degree of methodological rigor was employed. Robustness was examined by adjusting both the calibration thresholds and the consistency cutoff level. Specifically, the 90th and 10th percentiles of the sample distribution were used as benchmarks for full membership and full non-membership, respectively, while the consistency threshold was modified by ±0.5. The analysis considered potential changes in the number of configurations, their composition, as well as associated consistency and coverage parameters. The results of these robustness checks revealed no significant variations across these dimensions, thereby confirming the stability and reliability of the study's outcomes.

## 5. Discussion and conclusions

In this study, the fs/QCA method was applied to examine the synergistic effects and equifinal paths through which factors from three perspectives: technological, organizational, and environmental jointly enhance digital transformation in SMEs. The entire research process was framed within a holistic configurational perspective. The primary aim of this study is to identify the key determinants shaping the digital transformation of SMEs and to investigate effective paths that facilitate their successful digital adaptation. The main results can be summarized as follows:

First, the success of digital transformation does not stem from the isolated impact of a single factor but rather from the convergence of complex interactions among multiple internal and external determinants. The analysis demonstrates that none of the conditions within the technological, organizational, or environmental dimensions alone constitutes a necessary prerequisite for achieving an advanced level of digital transformation. These findings align with the results of Song, Chen, and Gu (2023), who emphasize that the combined influence of multiple factors significantly outweighs the effect of any single determinant. By examining the sufficiency of different configurations, the study identified five alternative combinations leading to high levels of digital transformation, thereby illustrating the principle of "multiple

paths to the same outcome." Based on core conditions, these configurations can be further classified into two main types: (1) high technological innovation capability coupled with strong digital infrastructure under conditions of intense market competitiveness (configurations S1a and S1b), and (2) robust digital infrastructure compensating for the absence of government support (configurations S2a, S2b and S1c).

Second, the analysis of the five configurations leading to successful digital transformation reveals the presence of substitution effects, whereby certain elements can act as interchangeable drivers of transformation outcomes. For instance, enterprises equipped with advanced digital infrastructure and strong technological innovation capabilities may enhance the level of their digital transformation either by obtaining government subsidies and institutional support or by strengthening risk resilience and formulating an appropriately aligned digital strategy. This finding is consistent with the study of Chen and Tian (2022), who identified a substitutive relationship among the drivers of digital transformation. Furthermore, in contexts where government support is limited, firms can advance digital transformation not only through the development of digital infrastructure but also by pursuing strategic positioning, formulating coherent digital strategies, and reinforcing their technological innovation capabilities.

Third, the identified configurations reveal that digital infrastructure, technological innovation capability, and market competitiveness constitute the primary drivers of digital transformation in SMEs. These factors operate synergistically with other conditions, further underscoring that successful digital transformation is not the outcome of isolated determinants. Moreover, the findings, particularly configurations S2a, S2b, and S2c, indicate that government support does not represent a key condition for advancing digital transformation among SMEs. This conclusion is consistent with the results of Nguyen et al. (2023), who demonstrated that internal technological factors, such as IT infrastructure, together with organizational elements, including specific skills and resources, play a more decisive role in enabling digital transformation than external governmental interventions. While public policy and subsidies may enhance SMEs' confidence in pursuing digitalization, the effective implementation of digital transformation strategies fundamentally depends on the development of digital talent, the strengthening of technological innovation capabilities, and the reinforcement of core market competitiveness.

This study offers several important theoretical contributions to the literature on digital transformation. First, it develops a comprehensive analytical framework that enables the identification of complex causal mechanisms underlying the digitalization of SMEs, thereby enriching the understanding of their developmental trajectories and transformation processes. Second, by applying the fs/QCA method, the research captures the interplay of multiple concurrent conditions, providing a multidimensional perspective on the determinants of digital transformation success. In line with the findings of Jia et al. (2024), the analysis highlights the central role of digital infrastructure as a critical enabler of successful transformation. Moreover, the results emphasize the significance of building strong technological innovation capabilities

and point to market competitiveness as a powerful catalyst that accelerates firms' digital initiatives. Third, the research model further enables the identification of multiple configurations that drive digital transformation success, underscoring that the process is not uniform but can be realized through various distinct paths.

This study also offers practical implications for SME management. Managers should focus on streamlining business processes, setting clear and measurable goals for digital transformation, developing appropriate digital platforms, making data-driven decisions, and ensuring integration within the broader digital ecosystem. The findings indicate that consistent managerial commitment to digital initiatives is essential for successful transformation. It is crucial for managers to prioritize strategies that enable the digitalization of both organizational and operational processes, while also fostering alignment and synergy between digital technologies and core business functions. This integrated approach can significantly enhance overall organizational performance.

Despite providing valuable insights, this study is not without its limitations. The proposed research model incorporated a limited number of variables, which narrows the scope of the analysis. Future studies could expand the model by including a broader range of factors influencing digital transformation, drawing from diverse theoretical frameworks and research perspectives. Additionally, the empirical investigation focused exclusively on a small number of SMEs operating in Poland. Subsequent research could broaden the geographical scope to include firms from other countries, a larger sample size, and a mix of organizational types, including large corporations. Given the dynamic and ongoing nature of digital transformation, it is also important to explore this process as it evolves over time. The application of time-series QCA could offer deeper insights into how different configurations of conditions influence digital transformation in a temporal context. Moreover, future research could investigate the role of governments in enhancing the monitoring and management of environmental impacts, particularly with regard to improving transparency in carbon footprint reporting (Yin, Zhao, 2024).

## References

1. AlNuaimi, B.K., Singh, S.K., Ren, S., Budhwar, P., Vorobyev, D. (2022). Mastering digital transformation: The nexus between leadership, agility, and digital strategy. *Journal of Business Research*, *145*, 636-648.
2. Baker, J. (2012). The technology–organization–environment framework. *Information Systems Theory: Explaining and Predicting Our Digital Society*, *1*, pp. 231-245.
3. Barker, V.L., J. Luger, A. Schmitt, Xin, K.R. (2022). Corporate Decline and Turnarounds in Times of Digitalization. *Long Range Planning*, *57*, 102211.

4. Chang, H.H., Wong, K.H., Chiu, W.S. (2019). The effects of business systems leveraging on supply chain performance: Process innovation and uncertainty as moderators. *Information & Management*, *56(6),* 103140.
5. Chen, H., Tian, Z. (2022). Environmental Uncertainty, Resource Orchestration and Digital Transformation: A Fuzzy-Set QCA Approach. *Journal of Business Research*, *139*, pp. 184-193
6. Chen, L., Wu, P., Dou, Y., Wu, Y. (2023). Investigating Senders' Switching Intention to Smart Lockers: An Extension of Push-Pull Mooring Model. *Journal of Retailing and Consumer Services*, *74*, 103414.
7. Cichosz, M., Wallenburg, C.M., Knemeyer, A.M. (2020). Digital transformation at logistics service providers: Barriers, success factors and leading practices. *International Journal of Logistics Management*, *31(2),* pp. 209-238.
8. Correani, A., De Massis, A., Frattini, F., Petruzzelli, A.M., Natalicchio, A. (2020). Implementing a Digital Strategy: Learning From the Experience of Three Digital Transformation Projects. *California Management Review*, *624*, 37-56.
9. Hanelt, A., Bohnsack, R., Marz, D., Antunes Marante, C. (2021). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. *Journal of Management Studies*, *58(5),* pp. 1159-1197.
10. He, Z., Huang, H., Choi, H., Bilgihan, A. (2023). Building Organizational Resilience With Digital Transformation. *Journal of Service Management*, *341*, pp. 147-171.
11. Jia, J., Xu, Y., Li, W. (2024). A Study on the Strategic Momentum of SMEs' Digital Transformation: Evidence From China. *Technological Forecasting and Social Change*, *200*, 123038.
12. Kwiotkowska, A. (2024). Creating organizational resilience through digital transformation and dynamic capabilities: findings from fs/QCA analysis on the example of Polish CHP plants. *Sustainability*, *16(14),* pp. 1-18.
13. Liu, J., Xie, J. (2020). Environmental Regulation, Technological Innovation, and Export Competitiveness: An Empirical Study Based on China's Manufacturing Industry. *International Journal of Environmental Research and Public Health*, *174*, 1427.
14. Meier, A., Eller, R., Peters, M. (2025). Creating Competitiveness in Incumbent Small- and Medium-Sized Enterprises: A Revised Perspective on Digital Transformation. *Journal of Business Research*, *186*, 115028.
15. Merín-Rodrigáñez, J., Dasí, À., Alegre, J. (2024). Digital Transformation and Firm Performance in Innovative SMEs: The Mediating Role of Business Model Innovation. *Technovation*, *134*, 103027.
16. Nambisan, S., Lyytinen, K., Majchrzak, A., Song, M. (2017). Digital Innovation Management: Reinventing Innovation Management Research in a Digital World. *MIS Quarterly*, *411*, pp. 223-238.

17. Nguyen, D.K., Broekhuizen, T., Dong, J.Q., Verhoef, P.C. (2023). Leveraging Synergy to Drive Digital Transformation: A Systems Theoretic Perspective. *Information & Management*, *607*, 103836.
18. Nguyen, H., Pham, A.V., Pham, M.D.M., Pham, M.H. (2023). Business Resilience: Lessons From Government Responses to the Global COVID-19 Crisis. *International Business Review*, *325*, 102166.
19. Omrani, N., Rejeb, N., Maalaoui, A., Dabic, M., Kraus, S. (2022). Drivers of Digital Transformation in SMEs. *IEEE Transactions on Engineering Management*, pp. 1-14.
20. Pappas, I.O., Woodside, A.G. (2021). Fuzzy-Set Qualitative Comparative Analysis fsQCA: Guidelines for Research Practice in Information Systems and Marketing. *International Journal of Information Management*, *58*, 102310.
21. Proksch, D., Rosin, A.F., Stubner, S., Pinkwart, A. (2021). The Influence of a Digital Strategy on the Digitalization of New Ventures: The Mediating Effect of Digital Capabilities and a Digital Culture. *Journal of Small Business Management*, *6*, pp. 1-29.
22. Ragin, C.C., Davey, S. (2016). *Fuzzy-Set/Qualitative Comparative Analysis*. California: University of California.
23. Ramdani, B., Raja, S., Kayumova, M. (2022). Digital innovation in SMEs: A systematic review, synthesis and research agenda. *Information Technology for Development*, *28(1),* pp. 56-80.
24. Rochet, J.C., Tirole, J. (2008). Tying in two-sided markets and the honor all cards rule. *International Journal of Industrial Organization*, *26(6),* pp. 1333-1347.
25. Schuh, G., Anderl, R., Gausemeier, J., Hompel, M., Wahlster, W. (2017). *Industrie 4.0 maturity index. Managing the digital transformation of companies*. Herbert Utz Verlag, National Academy of Science and Engineering.
26. Song, Q., Chen, X., Gu, H. (2023). How Technological, Organizational, and Environmental Factors Drive Enterprise Digital Innovation: Analysis Based on the Dynamic FsQCA Approach. *Sustainability, 1516,* 12248.
27. Steiber, A., Alänge, S., Ghosh, S., Goncalves, D. (2021). Digital transformation of industrial firms: An innovation diffusion perspective. *European Journal of Innovation Management*, *24(3),* pp. 799-819.
28. Stief, S.E., Eidhoff, A.T., Voeth, M. (2016). Transform to succeed: An empirical analysis of digital transformation in firms. *International Journal of Economics and Management Engineering*, *10(6),* pp. 1833-1842.
29. Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28(2),* pp. 118-144.
30. Wang, D., Chen, S. (2022). Digital Transformation and Enterprise Resilience: Evidence From China. *Sustainability*, *1421*, 14218.

31. Wang, N., Xue, Y., Liang, H., Wang, Z., Ge, S. (2019). The dual roles of the government in cloud computing assimilation: An empirical study in China. *Information Technology & People*, *32(1),* pp. 147-170.
32. Yin, S., Zhao, Y. (2024). An Agent-Based Evolutionary System Model of the Transformation From Building Material Industry BMI to Green Intelligent BMI Under Supply Chain Management. *Humanities and Social Sciences Communications*, *111*, 468.
33. Zhu, K., Kraemer, K.L., Xu, S. (2006). The process of innovation assimilation by firms in different countries: A technology diffusion perspective on e-business. *Management Science, 52(10),* pp. 1557-1576.