

Identifying Key issues in Digital Transformation of SMEs: A Study of Data from 2017-2022 in the European Union*

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Abstract

The growing pace of digital transformation is reshaping business structures across the European Union. While large enterprises have embraced mainly digital technologies, small and medium-sized enterprises (SMEs) remain unevenly integrated into the digital economy. This paper investigates the extent and nature of digital transformation among SMEs in the EU between 2017 and 2022. The study is motivated by the observed gap in the literature, where quantitative analyses often focus on large firms, overlooking the micro-level dynamics of SME digitalization. Using an indicator-based approach grounded in Eurostat and DESI data, the research evaluates key metrics of digital adoption, including internet access, e-commerce activity, and the use of advanced technologies such as cloud computing and artificial intelligence. The methodology combines descriptive and comparative analysis to identify trends and disparities in digital maturity across EU member states. The findings reveal that although SMEs have made incremental progress in digital transformation, significant structural barriers persist, particularly related to financing, skills, and access to ICT infrastructure. The results underline the need for targeted policy interventions to enhance SMEs' participation in the digital economy and to promote inclusive technological growth within the EU.

Keywords: Digitalization; SMEs; European Union; Technological Innovation Policy, Indicator-based Analysis

Introduction

The process of digital transformation is characterized by structural changes in business operations that extend beyond purely technological adjustments, encompassing modifications in business models as well as broader social shifts. The issue of digital transformation in enterprises holds particular importance in the context of economic development, as forecasts for 2020–2030 indicate that global investment in direct digital transformation will amount to approximately USD 7.4 trillion, with annual growth reaching around 17% (Siarkiewicz, 2020). Within this framework, a significant share of the potential and opportunities associated with digital transformation is attributed to small and medium sized enterprises (SMEs), which are regarded as one of the key pillars of the European Union's contemporary economy. SMEs are particularly adept at identifying niche markets, adapting rapidly to change, and seizing opportunities at an early stage.

This study aims to examine whether and in what ways digital transformation has occurred among SMEs in the European Union between 2017 and 2022, and to identify the key features of this transformation. The research employs both qualitative and quantitative approaches. The qualitative dimension is based on a critical review of the relevant literature and a genetic explanation method, which involves tracing the evolution of processes and phenomena over time. The quantitative dimension includes indicator-based analysis and evaluation of digitalization measures applied to the SMEs under study.

In this context, the following research problem has been formulated in the form of a guiding question:

RP: What constitutes, and how is digital transformation expressed among SMEs in the European Union?

To answer this research question, the authors first conducted a synthetic review of the literature on digital transformation and subsequently analyzed empirical data for small and medium-sized enterprises in the European Union, focusing on their digital transformation during the period 2017–2022. The motivation behind this study lies in the growing recognition that SMEs, as the backbone of the EU economy, face increasing challenges in aligning with the pace of digital transformation observed among larger enterprises. Despite their central role in employment and innovation, empirical evidence on the digital readiness of SMEs across EU member states remains fragmented and limited, warranting further investigation.

Digital Transformation of Enterprises – Theoretical Perspective

Digitalization refers to the widespread adoption and integration of digital technologies, as well as the extensive implementation of electronic infrastructure into socio-economic life. This phenomenon has been shaping societies since the 1990s, when the widespread adoption of the Internet and personal computers led to a significant shift in sales to digital platforms. Digitalization is a multidimensional process leading to the convergence of the physical and virtual worlds, becoming the primary driver of innovation and economic change (Łobejko, 2018). Today, the process is advancing rapidly and has become an inseparable element of the modern economy, where so-called Industry 4.0 is “gradually being replaced” by Industry 5.0, signaling a new stage of progress.

According to A. Toffler, such “progress” requires a complete restructuring of society, due to the profound impact of computers and the Internet on communication, the economy, education, labor, culture, and social organization as a whole. He predicted that digitalization would have far-reaching consequences, altering the way people live, work, communicate, and organize their societies. Under the concept of “future shock,” Toffler understood the disorientation resulting from profound changes occurring over a short period of time (Toffler, 1999). In a similar vein, D. Tapscott highlighted that, within the framework of the “Net Generation” concept, digital change particularly affects the younger generation, which is the first to grow up entirely in the digital era. The 'Net Generation' refers to those born after 1980 who have grown up with the internet and digital technologies, shaping their worldview and expectations. He also emphasized the importance of digital transformation within organizations. Enterprises must therefore adapt to new technologies and evolve customer expectations in order to remain competitive, which inevitably involves digital transformation (Tapscott, 2008).

The term *transformation* derives from Latin and means conversion or metamorphosis. While *change* can refer to any modification of a given element, *transformation* denotes a deliberate process aimed at creating a new and lasting state of the environment, ideally one that is desirable (Lipiński, 2017). In the sciences, transformation is understood as a discursive and constructive paradigm, a recognized way of perceiving reality within a discipline, comprising the concepts and theories that form their foundation, particularly as explained in the context of modernization theory in the social sciences (Maciejewski, 2010).

M. Kaufman identified the fundamental elements that constitute a coherent paradigm for defining the essence of transformation (Kaufman, 1988), which are illustrated in Figure 1.

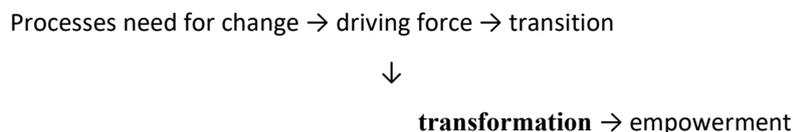


Fig. 1. The essence of transformation in the context of change

Source: Siuta-Tokarska, Żmija, Kruk, Krzemiński, Thier (2025).

Explanation: The driving force behind the implementation of change may lie in the evolution of knowledge and science, as well as in institutions of authority and their bureaucratic structures, which have the capacity to accelerate or hinder transformation processes.

As P. Kawalec rightly notes, digital transformation is not just a trend, but a comprehensive and fundamental reconfiguration of enterprise operations. It entails reshaping the way digital technologies are employed to create new business models that enhance value creation and increase efficiency. The urgency of this transformation is underscored by the numerous emerging technology trends that serve as its drivers, including social media, mobility, the Internet of Things (IoT), cybersecurity, big data and analytics, cloud computing, robotic process automation (RPA), artificial intelligence and machine learning, and blockchain, among others (Tang, 2021).

During digital transformation, enterprises may grow in four main ways (Kowalczyk, 2017): 1) Process optimization, 2) Expanding market outlets, 3) Creation of innovative products, 4) More efficient use of human capital. Digital transformation should therefore be recognized as one of the most crucial contemporary trends in reshaping enterprises. It extends significantly beyond technological aspects, driving changes of both business and social character (Reis, 2018).

From a social perspective, the goals of digital transformation may include (Ebert & Duarte, 2018):

- fostering a more innovative and collaborative culture in industry and society, reforming the education system to provide new skills and a future orientation, enabling individuals to thrive in digital work and society,
- creating and maintaining digital communication infrastructures and ensuring their governance, accessibility, quality, and affordability,
- strengthening digital data services, protection, transparency, autonomy, and trust, improving accessibility and quality of digital services offered to the population. From an economic perspective, these goals include (Ebert & Duarte, 2018):
- implementing new and innovative business models,
- increasing income generation, productivity, and value creation in the economy, improving regulatory frameworks and technical standards.

As Parviainen et al. emphasize, digital transformation entails a comprehensive reconfiguration of the enterprise, rendering it a strategic process in the context of organizational functioning and development (Parviainen et al., 2017). Ultimately, it should enable firms to achieve a competitive advantage (Sebastian et al., 2020). Considering both the drivers and the outcomes of digital transformation, a conceptual model can be proposed that centers on three key elements: technologies, management, and people. This model is presented in Figure 2.

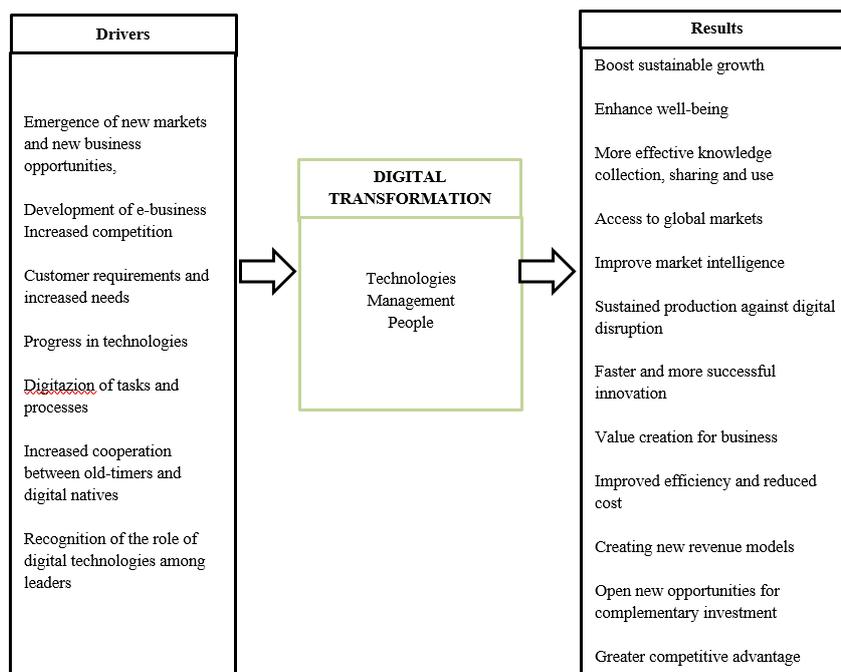


Fig. 2. Conceptual model of digital transformation

Source: Verina & Titko, (2019).

Methodological Assumptions

For empirical research, specific methodological assumptions were adopted, which constitute the foundation of the study's methodological framework. These include:

- 1) Identification of the research gap
- 2) Formulation of the research problem
- 3) Definition of the subject, object, spatial, and temporal scope of the research
- 4) Determination of research objectives and hypotheses
- 5) Selection of appropriate research methods enabling the achievement of objectives, verification of hypotheses, resolution of the research problem, and filling of the identified research gap.

A preliminary review of the literature revealed a research gap, characterized by the lack of comprehensive theoretical, cognitive, and empirical studies on the digital transformation of SMEs in the European Union between 2017 and 2022. This gap is particularly evident in the absence of studies that employ both qualitative and quantitative methods, including comparative analyses between SMEs and large-sized enterprises (LSEs).

Taking this gap into account, the research problem was formulated in the form of the following guiding question: *What constitutes, and in what ways, is the digital transformation of SMEs in the European Union expressed?*

The **research subject scope** encompasses the analysis and evaluation of the digital transformation of enterprises within the SME sector, excluding microenterprises. The **object scope** includes small and medium-sized enterprises, which, according to the official definition applied in the European Union, are characterized as follows:

- small enterprise: an entity that, in at least one of the last two financial years, simultaneously met the following conditions: a) employed fewer than 50 workers on average annually¹, and b) achieved annual net turnover from sales of goods, products, and services, including financial operations, not exceeding EUR 10 million, or total assets in the balance sheet prepared at the end of one of those years not exceeding EUR 10 million, and which is not a microenterprise².
- medium enterprise: An entity that, in at least one of the last two financial years, simultaneously met the following conditions: a) employed fewer than 250 workers on average annually, and b) achieved an annual net turnover from sales of goods, products, and services, including financial operations, not exceeding EUR 50 million, or total assets in the balance sheet prepared at the end of one of those years not exceeding EUR 43 million, which is not a microenterprise or a small enterprise.

The **spatial scope** of the research covers the European Union, considered as a socio economic and political union of 27 member states: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Greece, Spain, the Netherlands, Ireland, Lithuania, Latvia, Luxembourg, Malta, Germany, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden, Hungary, and Italy, with a total area of 4.233 million km². The **temporal scope** covers the years 2017–2022. The **main research objective (MO)** was defined as examining whether, and in what ways, the digital transformation of SMEs in the European Union took place in the period 2017–2022.

Within this framework, the following **specific objectives (SOs)** were established:

SO1: To review, systematize, and specify the fundamental concepts related to the digital transformation of enterprises.

SO2: To explain the essence of the process of digital transformation of enterprises in the context of change,

¹ The average annual employment is calculated in full-time equivalents, with precision and clarity, by excluding employees on maternity leave, leave under the conditions of maternity leave, paternity leave, parental leave, caregiver's leave, childcare leave, and those employed for vocational training.

² A microenterprise is an enterprise that, in at least one of the last two financial years, simultaneously met the following conditions: a) employed fewer than 10 workers on average annually, and b) achieved an annual net turnover from the sale of goods, products, and services and from financial operations not exceeding the equivalent of EUR 2 million, or the total assets of its balance sheet prepared at the end of one of those years did not exceed the equivalent of EUR 2 million, thereby emphasizing the importance of these financial thresholds.

together with a graphical presentation of the interdependencies among its components.

SO3: To analyze and evaluate the digital transformation of SMEs in the European Union during 2017–2022.

On this basis, the following research hypotheses were formulated:

H1: Among SMEs in the European Union between 2017 and 2022, positive changes in digital transformation are observed, expressed in the improvement of most baseline indicators used to evaluate this process.

H2: SMEs in the European Union between 2017 and 2022 were characterized by a relatively small share of entities with high and medium levels of digitalization.

H3: SMEs in the European Union between 2017 and 2022 achieved, in most cases, worse results regarding the popularity of individual e-commerce technologies and solutions compared to LSEs.

The research design employs a combination of qualitative and quantitative methods. The qualitative approach is based on a critical literature review and genetic explanation, i.e., identifying the changes to which a process or phenomenon is subject over time, within a framework for examining the characteristics of the research object. The quantitative approach involves indicator-based analysis and evaluation of digitalization measures applied to the enterprises under study. The indicators selected for analysis include: 1) Enterprises whose employees have access to the Internet (% of enterprises), 2) Employees with Internet access for business purposes (% of enterprises), 3) Enterprises using DSL or other fixed broadband connections (% of enterprises), 4) Enterprises providing more than 20% of their employees with portable devices supporting Internet connection via mobile networks, for business purposes (% of enterprises), 5) Employees provided with portable devices supporting Internet connection via mobile networks for business purposes (% of enterprises), 6) Enterprises using any social media (% of enterprises), 7) Enterprises using two or more social media (% of enterprises), 8) E-commerce sales (% of enterprises), 9) Total turnover from e-commerce sales (% of turnover).

The main limitation of the research is the exclusion of microenterprises, which are formally part of the SME sector, due to the lack of publicly available empirical data for this category. As a result, the study was restricted exclusively to small and medium-sized enterprises. The applied indicator-based analysis draws on Eurostat's Digital Economy and Society Index (DESI) and related sub-indicators describing digital infrastructure, ICT use, e-commerce, and digital skills among SMEs. This approach enables a comparative assessment of digital maturity levels across EU member states and facilitates the identification of progress patterns in SME digitalization between 2017–2022. The analysis included only those indicators that are crucial for understanding digital transformation and for which data were available for all associated countries, allowing for the calculation of an average value for the European Union. Therefore, only the most common measures were considered—those that best capture the essence of digital transformation and for which data were consistently available across all years of the analyzed period.

A particular research limitation was the selection of the study period itself, which was intentionally designed to cover a comprehensive six-year period. This period included three years preceding the COVID-19 pandemic (2017–2019) and three years during the pandemic (2020–2022), allowing for a thorough understanding of the economic conditions affecting the operations of small and medium-sized enterprises.

Empirical Analysis of Digital Transformation of SMEs in the European Union

Small and medium-sized enterprises (SMEs) are widely recognized as the driving force behind the European Union's economy, given their significant role in the development of both national economies and the EU as a whole. This importance is reflected in their share of the total number of enterprises, their contribution to employment in the business sector, and their role in generating GDP, including the added value they bring to the economy. SMEs also play a crucial role in enabling economies to adapt to socio-economic changes. For this reason, their number and potential are often regarded as indicators of economic development. However, as indicated earlier, SMEs are not a homogeneous group, even though certain qualitative features clearly distinguish them from large-scale enterprises. According to the European Commission (2022), these characteristics include:

- operating in geographic or product niches with limited diversification, restricted access to resources such as finance, expertise, skills, and human capital,
- ownership and management concentrated on the same individual, making them dependent on the values and convictions of the owner-manager,
- Limited influence in the broader business environment (e.g., through lobbying activities) and supply chains.

As emphasized by B. Piasecki, the role of SMEs in the economy arises from functions such as (Ekonomika i zarządzanie, 1999; Lachiewicz & Matejun, 2012): a) fostering entrepreneurial attitudes and opportunities for self-employment, absorbing labor surpluses (thus reducing unemployment), b) offering opportunities for success and upward social mobility, c) stimulating activity within local and regional communities, d) facilitating the creation of horizontal and vertical cooperative and integrative networks, unleashing initiative, creativity, and flexibility while also—crucially in the context of sustainable economic development—fostering responsibility.

In the literature, the following additional qualitative characteristics of SMEs are highlighted (Siuta-Tokarska, Gołąb-Kobylińska, Krzemiński, 2025):

- simplified and often loosely formalized organizational structures, frequently with a single decision-making center,
- the role of the owner as both entrepreneur and manager, with their personality often dominating decision-making,
- reliance primarily on equity financing rather than external loans or credits, legal independence, expressed through autonomy and self-reliance,
- flexibility in operations, allowing for rapid responses to changes in demand and consumer behavior,
- relatively small market share, often with a local market focus,
- limited resources for market research, innovation, or R&D activities, specific systems of employee recruitment and motivation, often based on recommendations and family ties,
- difficulties in achieving economies of scale,
- firm reliance on personal networks with contractors, along with organizational “porosity,” resulting from close contacts with a narrow circle of suppliers and customers, which reduces anonymity and fosters beneficial cooperative relationships.

This qualitative profile of SMEs enables the identification and systematization of their defining characteristics, while also highlighting their distinctiveness from large enterprises. Importantly, SMEs possess considerable potential to engage in digitalization processes actively, enabling them to achieve better results and progress to new stages of development.

SMEs are indeed preparing for the digital age and can maintain solid market positions by occupying niche markets (Stich et al., 2020). However, research shows that only a small proportion of SMEs are characterized by high or very high levels of digital intensity (Brodny & Tutak, 2022). In 2021, the Digital Intensity Index of SMEs in the EU revealed that 45.2% of enterprises had very low digital intensity, while only 2.8% were categorized as very high (with 33.9% low and 18.2% high) (Siuta-Tokarska et al., 2025).

Positive developments can nonetheless be observed in specific digitalization indicators for SMEs in the EU between 2017 and 2022:

- 1) Enterprises whose employees have Internet access: increased from 97% in 2017 to 98.9% in 2022 (+1.9 p.p.),
- 2) Employees with Internet access for business purposes: increased from 47.4% in 2017 to 57.4% in 2022 (+10 p.p.),
- 3) Enterprises using DSL or other fixed broadband connections: rose from 92.3% in 2017 to 94% in 2022 (+1.6 p.p.),
- 4) Enterprises providing more than 20% of employees with portable devices supporting Internet connections via mobile networks for business purposes: increased from 33.8% in 2018³ to 48.2% in 2022 (+14.4 p.p.),
- 5) Employees provided with portable devices supporting Internet connections via mobile networks for business purposes: increased from 23.2% in 2018⁴ to 33.7% in 2022 (+10.5 p.p.),
- 6) Enterprises using any social media: increased from 44.5% in 2017 to 58% in 2021 (+13.5 p.p.),
- 7) Enterprises using two or more social media platforms: increased from 17.5% in 2017 to 28.4% in 2021 (+10.9 p.p.),
- 8) E-commerce sales: increased from 19.4% in 2017 to 22.2% in 2022 (+2.8 p.p.), 9) Total turnover from e-commerce sales: increased from 8.3% in 2017 to 8.7% in 2021 (+0.4 p.p.).

Although SMEs demonstrated upward trends in most individual digitalization measures from 2017 to 2022, a comparative perspective reveals a more problematic picture relative to large enterprises. Table 1 presents data on the adoption of specific e-commerce technologies and solutions by SMEs and LSEs.

³ Data for 2017 – not available.

⁴ Data for 2017 – not available.

Table 1. Popularity of individual e-commerce technologies and solutions in SMEs and LSEs in the EU-27, 2017–2022 (% of enterprises)

Technology	SMEs	LSE
CRM ⁵	32.9–33.9	61.7–65.2
ERP System ⁶	34.8–42.0	80.1–81.2
IoT ⁷	28.1	48.4
AI ⁸	7.0	28.4
Cloud Computing ⁹	23.1–40.1	53.1–71.6
Big Data ¹⁰	13.6	34.3
3D Printing ¹¹	3.6–4.9	13.6–17.5
Robotics ¹²	5.7–6.2	24.8–25.8

Source: own elaboration based on Siuta-Tokarska et al. (2025).

The data confirm that large enterprises adopt e-commerce technologies and solutions— such as CRM, ERP systems, IoT, AI, cloud computing, big data, 3D printing, and robotics—at significantly higher rates than SMEs. In most cases, the share of LSEs using these solutions was at least double that of SMEs, while in the case of AI, 3D printing, and robotics, the difference was as fourfold.

These findings confirm the ongoing digital transformation process among SMEs in the European Union. Nevertheless, the key challenge remains the overall level of transformation, which is still very low for the vast majority of SMEs. When compared to large enterprises, the discrepancies reach at least a twofold difference in most indicators, and in some cases as high as fourfold.

Summary

Small and medium-sized enterprises (SMEs) constitute a crucial pillar of economic development in the European Union. The context of their digital transformation demonstrates that they are on the right path towards modernization. However, the level they have achieved thus far remains significantly lower than that of large enterprises. Moreover, in qualitative terms, there is a clear predominance of SMEs characterized by a low level of digital intensity. This finding is significant, as digital technologies and tools that drive digital transformation can act as catalysts for innovation within SMEs. For example (Siuta-Tokarska et al., 2025):

- CRM supports the building of long-term relationships with customers, ERP enhances

⁵ CRM – Customer Relationship Management: A business strategy and information system that collects, manages, and analyzes all customer-related information in one place.

⁶ ERP Enterprise Resource Planning System: Software that integrates and automates a company’s key business processes within a single system, using a shared database.

⁷ IoT- Internet of Things: A network of physical devices, machines, tools, and other objects equipped with sensors and software that enable them to collect, process, and exchange data via the Internet.

⁸ AI – Artificial Intelligence: A field of computer science focused on creating systems capable of performing tasks that normally require human intelligence. Core features include machine learning, deep learning, natural language processing, pattern recognition, and autonomous decision-making.

⁹ Cloud Computing – The delivery and use of computing resources (e.g., servers, storage, databases, or software) via the Internet, replacing the need for local ownership and management of these resources.

¹⁰ Big Data - Diverse, high-volume, and fast-flowing datasets whose size and complexity exceed the capabilities of traditional data processing systems, requiring advanced tools and techniques for efficient management and analysis.

¹¹ 3D Printing (Additive Manufacturing): A process of creating physical three-dimensional objects from a digital model by layering and bonding materials sequentially.

¹² Robotics - The design, construction, programming, and application of robots to perform tasks autonomously or with minimal human intervention.

customer satisfaction, thereby fostering loyalty,

- AI improves business management, operational efficiency, and automates routine tasks, allowing employees to focus on higher-value activities.
- Cloud computing enables remote work and universal file access, while simplifying accounting and providing deeper insights into financial performance.
- Big Data analytics enhances operational efficiency, drives growth and competitiveness, optimizes resource management, streamline procurement, forecast demand, supports pricing strategies, and refines product offerings.
- Robotics increases the efficiency and scalability of inventory management and order processing, improving accuracy, reducing labor costs, and boosting overall operational performance.

The analysis of data on the digital transformation of SMEs in the EU between 2017 and 2022 confirmed the existence of positive trends in this process. Nevertheless, substantial barriers and challenges remain, particularly concerning the generally low level of technological adoption among SMEs. The smaller the enterprise, the greater the difficulty in leveraging advanced digital tools.

The research confirmed the hypotheses formulated in the study:

- **H1:** SMEs in the EU between 2017 and 2022 experienced positive changes in their digital transformation, expressed in improvements across most baseline evaluation indicators.
- **H2:** SMEs in the EU during the same period were characterized by a relatively small share of entities with medium or high levels of digitalization.
- **H3:** SMEs in the EU between 2017 and 2022 achieved, in most cases, weaker results regarding the popularity of individual e-commerce technologies and solutions compared with large-sized enterprises (LSEs).

Consequently, the research has helped fill the identified research gap, resolve the stated research problem, and achieve the study's objectives. Importantly, it has generated added value by clarifying the essence of digital transformation and its key determinants among SMEs in the European Union from 2017 to 2022. The findings further reveal the necessity of conducting more detailed analyses of internal and external factors, particularly structural ones—that influence both the dynamics and the quality of digital transformation processes. This highlights a promising direction for future research on the digital transformation of SMEs in the European Union.

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