



Open Innovation at the Digital Frontier: Unraveling the Paradoxes and Roadmaps for SMEs' Successful Digital Transformation

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Abstract

Purpose: The purpose of this paper is to fill a gap in the literature regarding the open innovation management approaches that SMEs can use to access digital technologies and incorporate them into their organizational processes. The research question is: What organizational and process-level managerial actions do SMEs take to successfully access and implement digital technologies within their organizational processes?

Methodology: Using Guertler et al.'s (2020) Action Innovation Management Research (AIM-R) framework, this study examines the digital transformation experiences of 10 European SMEs to gain insights into the managerial actions that foster successful digital transformation.

Findings: The findings of the paper reveal two major contributions. First, a digital transformation roadmap for SMEs is proposed, with a focus on accessing external resources and reconfiguring internal ones to ease their digital transformation journey. Second, three distinct paradoxes that influence the digital transformation process in SMEs are highlighted, providing useful insights into the challenges and tensions SMEs face during this journey.

Originality: This paper provides a unique perspective on the digital transformation of SMEs by examining the managerial actions required for successful technology adoption and revealing the paradoxes that may emerge during this transformative process. The findings form the basis for future research, deepening our understanding of digital transformation in SMEs and providing actionable advice to managers and practitioners navigating this journey.

1 Introduction

Digital transformation (DT) – an overarching concept encapsulating the integration of digital technologies into all aspects of an organization – has fundamentally altered the dynamics of innovation management and entrepreneurship (Nambisan, 2017; Crupi et al., 2022). As firms strive to adapt to the rapidly evolving digital landscape, DT has emerged as a critical priority for organizations of all sizes and across various industries (Nambisan et al., 2019). The adoption of digital technologies not only streamlines operations and enhances efficiency but also fosters innovation, facilitates data-driven decision-making, and engenders new business models, paving the way for sustained competitive advantage in the digital era (Appio et al., 2021). The implications of DT are manifold, encompassing competitive strategy, culture, and structure, as well as business processes and customer interactions (Frank et al., 2019). Consequently, DT warrants a holistic understanding

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3 of the various factors that contribute to its successful implementation, including change management,
4 workforce upskilling, and the development of an agile mindset (Wu et al., 2021). In the face of
5 accelerated digitalization and increasing market pressures, organizations must navigate the
6 complexities of DT to unlock new growth opportunities and maintain their relevance in an ever-
7 changing landscape (Troise et al., 2022). By fostering a robust digital ecosystem and embracing a
8 culture of adaptability, businesses can capitalize on the transformative potential of digital
9 technologies, thereby positioning themselves for success in the digital age.

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11 In confronting DT, SMEs face both opportunities and challenges. On the one side, the impact of
12 digital technology adoption on SMEs is substantial, as it offers such firms the opportunity to access
13 and incorporate advanced technologies into their existing processes. In turn, digital evolution may
14 considerably benefit SMEs by paving the way for innovative digital products and services, expanding
15 client bases, and enhancing overall performance (Khin & Ho, 2019). However, on the other side,
16 SMEs often encounter challenges when implementing a combination of digital technologies,
17 primarily due to their constrained financial, material, and human resources in comparison to larger
18 enterprises (Horvath & Szabo, 2019; Masood & Sonntag, 2020; Nguyen et al., 2015). Thus, SMEs
19 struggle to harness digital technologies for competitive advantage due to multiple factors, such as the
20 need for a skilled workforce, stakeholder recognition of digital technology value, and managerial
21 readiness to implement innovations (Proksch et al., 2021). Additionally, the misalignment of digital
22 capabilities and tools with the broader DT vision for SMEs can impede the realization of the full
23 potential of digital technologies (Nguyen et al., 2015; Ko et al., 2022).

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25 The susceptibility of SMEs to external (economic and non-economic) disruptions highlights the
26 crucial role of digital transformation in bolstering competitiveness and adaptability (Guo et al., 2020).
27 Nonetheless, achieving resilience and anti-fragility, particularly by tapping into external resources,
28 remains a challenge for numerous SMEs when facing unstable environments (Corvello et al., 2022).
29 In this study, we argue that, to fully exploit the potential of DT by overcoming the internal limits that
30 prevent its full implementation, SMEs should embrace an Open Innovation (OI) approach. Although
31 existing literature has attempted to link OI with digital technologies (e. g., Dabic et al., 2023; Costa
32 et al., 2023; We et al., 2022), a discernible gap remains regarding the managerial solutions that SMEs
33 can employ to access digital technologies and integrate them into their organizational processes from
34 an OI perspective. This gap becomes increasingly significant as the pervasive nature of digital
35 technologies continues to shape companies' innovation processes (Agostini et al., 2017).

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37 Against this background, it is essential to provide scholars and practitioners with guidance on how
38 SMEs could access and integrate digital technologies, by creating a roadmap for innovation
39 management from an open perspective. To address this gap, this paper builds upon research in
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3 resource-based view (RBV) and OI, with the objective of addressing the following research question:
4 What organizational and process-level managerial actions should SMEs take to successfully access
5 and implement digital technologies within their organizational processes?
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8 By investigating the research question, this paper aims to offer valuable insights to the existing
9 literature and practical guidance for SMEs pursuing DT. To accomplish this, the paper utilizes the
10 Action Innovation Management Research (AIM-R) framework, as proposed by Guertler et al. (2020),
11 to examine DT experiences of 10 European SMEs.
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14 The paper's findings present two primary contributions to both academia and practice.
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16 The first contribution involves identifying a *digital transformation roadmap* for SMEs, which assists
17 firms in their DT journey by primarily focusing on accessing external resources (as devised by the
18 OI paradigm) and reconfiguring internal ones. This roadmap provides a structured approach for SMEs
19 to navigate the complexities of DT, ultimately enhancing their competitiveness and agility in the
20 digital landscape. The second contribution relates to the recognition of three distinct paradoxes that
21 influence the DT process in SMEs. These paradoxes underscore the challenges and tensions that
22 SMEs encounter during their DT journey, offering valuable insights for researchers and practitioners
23 alike. The examination of these paradoxes paves the way for further research, enriching the
24 conversation around this vital aspect of DT in SMEs.
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27 The remainder of the paper is structured as follows: in Section 2, the theoretical framework is
28 presented, including discussions on the rising importance of digital transformation (2.1), digital
29 transformation and SMEs (2.2), and digital transformation and open innovation (2.3). Section 3
30 outlines the methodology employed in this study. In Section 4, the digital transformation roadmap is
31 described, detailing its various phases: the scanning phase (4.1), the testing phase (4.2), the adoption
32 phase (4.3), the integration and alignment phase (4.4), and the permanent transformation phase (4.5).
33 Finally, Section 5 presents the discussion and conclusion, highlighting the three identified paradoxes.
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45 **2 Theoretical framework**

46 According to prior literature (e. g., Lombardi et al., 2019; Lu, 2017), DT is an iterative process that
47 involves both incremental and disruptive changes to automate business processes and make logistical
48 and administrative tasks more efficient. These changes enable companies to increase their
49 competitiveness in the market. However, despite its technological focus, implementing DT requires
50 the ability to adapt business models to new technologies and lead technological innovations in a
51 socio-technical environment, as pointed out by several researchers (Frank et al., 2019; Muller et al.,
52 2018; Lu, 2017). Innovation management scholars have also explored how DT can help maintain a
53 company's competitive edge by promoting the creation of more customer-centric products and
54 services (Martínez-Caro et al., 2020), enhancing the organization's collaborative networks (Han and
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3 Trimi, 2022), and minimizing costs while optimizing time and resource utilization (Paolucci et al.,
4 2021; Zangiacomini et al., 2020). These benefits are achievable through the implementation of various
5 digital technologies, including the industrial Internet of Things, horizontal and vertical system
6 integration, big data and analytics, autonomous robots, machine learning, and artificial intelligence.
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8 Some of these technologies facilitate the gathering of more dependable and diverse data in the
9 external and internal environment, while others promote more efficient and swift integration,
10 processing, and utilization of information (Tao et al., 2018). The amalgamation of these technologies
11 establishes the critical infrastructure for digital transformation and serves as an essential resource for
12 building the organization's information-processing capability, alongside other complementary human
13 and organizational resources (Kim et al., 2012; Tippins & Sohi, 2003).

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21 In the case of SMEs, while digital technologies stand as transformative agents with the potential to
22 redefine the operational and strategic facets of SMEs, they also present challenges, particularly in
23 terms of resource constraints. Specifically, SMEs often struggle with financial and human resource
24 limitations when attempting to integrate these advanced technologies (Costa et al., 2023). Yet, amidst
25 these challenges, the adoption of an OI approach may represent a valuable strategy for SMEs. This
26 strategy, we argue, can act as a lifeline for SMEs, enabling them to navigate the barriers inherent in
27 technology adoption. Through the lens of OI, SMEs can not only swiftly access the latest technologies
28 but also unlock new market opportunities. The subsequent paragraphs endeavor to lay the foundation
29 for a strategic roadmap through which SMEs can navigate these intertwined subjects, establishing a
30 core strategy for the adoption of digital technologies.

31 32 33 34 35 36 37 38 *2.1 Digital Transformation and SMEs*

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40 The impact of digital technology infrastructure is primarily associated with its role in enhancing a
41 firm's capacity to access and integrate digital technologies into existing processes. The need for a
42 coordinated implementation of various digital technologies can especially hinder the DT of SMEs
43 (Horvath and Szabo, 2019; Masood and Sonntag, 2020). Indeed, identifying the optimal combination
44 of digital technologies in SMEs can be challenging due to their limited financial, material, and human
45 resources compared to larger enterprises (Nguyen et al., 2015).

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50 Digital evolution has a significant impact on the operations of SMEs. The implementation of digital
51 technologies enables the development of innovative digital products and services, expands customer
52 bases, and enhances SMEs' performance (Khin and Ho, 2019). Rapid communication networks allow
53 SMEs and entrepreneurs to collaborate with suppliers and customers, access real-time data, and adapt
54 to the ever-changing market landscape and supply chains (Skare et al., 2023). Moreover, digital
55 innovations transform SMEs' business models by creating alternative distribution channels and
56 methods for generating and delivering value to customers (Matarazzo et al., 2021). In sum, digital
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3 evolution considerably strengthens the competitiveness of SMEs. By adopting digital technologies,
4 SMEs can enhance their competitive advantage through innovation in value creation, value
5 proposition, value delivery, and value capture (Teoh et al., 2022).
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8 However, several barriers prevent SMEs from fully leveraging digital technologies for a competitive
9 edge. Adopting digital technologies as a key factor in competitiveness requires a skilled workforce,
10 stakeholders who recognize the value of digital technology, and managers willing to implement such
11 innovations (Proksch et al., 2021). Additionally, if the alignment of digital capabilities and tools with
12 the broader digital transformation vision for SMEs remains unclear, the true potential of these
13 technologies for competitiveness is not fully realized (Nguyen et al., 2015; Ko et al., 2022).
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16 External funding is crucial for SMEs' growth and operations. A company's financial capacity reflects
17 favorable development conditions (Bouwman et al., 2019). This financial capacity drives business
18 model innovation, enhances firms' operations, and ultimately improves financial performance (Arner
19 et al., 2020). The ability to invest in a company is vital, and total assets serve as the company's
20 fundamental security (Shi, 2021). Digital financial solutions enhance SMEs' market position through
21 servitization (Chen S, 2021). Digital transformation accelerates supply chain financing, improving
22 SMEs' position and access to financial resources (Chen L, 2021).
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25 DT significantly affects input costs for SMEs (Costa et al., 2023). SMEs undergoing digital
26 transformation tend to be less concerned about managing expenses. By utilizing advanced
27 technologies to create and offer innovative products and services, digital transformation improves
28 small businesses' output while reducing input costs. DT affects both product and process innovation,
29 resulting in increased productivity and decreased production costs for companies (Skare et al., 2023).
30 In fact, through DT, SMEs can explore new ideas, exploit existing knowledge, and adopt technologies
31 from external sources, enabling them to cut costs and remain competitive in an increasingly
32 globalized economy (Albats et al., 2020).
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35 Regulatory requirements may hinder SMEs' growth. However, electronic invoicing helps SMEs
36 comply with tax regulations and reduce administrative burdens. Thus, digital technologies
37 significantly change the traditional regulatory challenges faced by SMEs. Solutions such as digital
38 platforms, cloud computing, one-stop government shops, and corresponding infrastructure help ease
39 administrative burdens through services like e-invoicing, e-signatures, e-taxes, and open government
40 data (OECD Publishing, 2021). This digital government framework allows SMEs to quickly adapt to
41 regulatory changes, enabling managers and owners to concentrate more on business operations and
42 informed decision-making rather than constant administrative tasks (Agostino et al., 2021; Baheer et
43 al., 2020).
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3 Finally, it is worth considering that, compared to larger corporations, SMEs are more vulnerable to
4 external economic and non-economic disruptions. Under disruptive conditions, firms need resilience
5 and anti-fragility to withstand and prosper in unstable environments. While resilience refers to the
6 ability to absorb shocks and recover despite temporary changes, anti-fragility denotes a system's
7 capacity to absorb and bounce back from shocks (Corvello et al., 2022). Both features are relevant
8 for SMEs facing DT. As a result, digitally transformed SMEs are more likely to implement short- and
9 long-term crisis management strategies and achieve better performance outcomes. Furthermore,
10 enhanced competitiveness enables SMEs to adapt and increase flexibility in response to external
11 disruptions (Guo et al., 2020).
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19 *2.2 Digital Transformation and Open Innovation*

20 In the context of SMEs, DT encompasses the digitalization of the entire organization and its business
21 processes, as well as an innovative cultural approach that supports radical changes in the company's
22 organizational structure as it evolves towards a digital configuration (Lu, 2017). Kane et al. (2019)
23 proposed a four-stage evolutionary path for implementing DT in organizations, which includes
24 exploring DT, developing digital initiatives, achieving digital maturity, and ultimately becoming a
25 fully digital organization.
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31 To successfully implement DT, essential factors such as engaging a larger community of
32 stakeholders, adopting an industry-based perspective, cooperating with multipliers and
33 intermediaries, focusing on specific business segments and scenarios, and identifying pilot projects
34 to demonstrate the benefits of DT implementation must be considered (Crupi et al., 2020).
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38 All these factors recall the need to adopt an open innovation approach. Open innovation is currently
39 recognized as "a decentralized innovation method that relies on deliberately managing knowledge
40 transfer across organizational borders, utilizing monetary and non-monetary mechanisms in
41 accordance with the organization's business model" (Chesbrough and Bogers, 2014; p. 12). The
42 literature on open innovation has expanded, with notable contributions addressing various topics,
43 including the impact of open innovation on business performance, the relationship between open
44 innovation strategies and appropriability, the methods for obtaining and transferring technological
45 knowledge, and firms' capacity for absorptive and desorptive capacities.
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51 Concerning the role that OI may play to help SMEs overcome resource constraints to promote their
52 DT processes, some studies have examined open innovation strategies during the transition from non-
53 digital to digital technology, the role of absorptive capacity in incorporating complex IT innovations,
54 the significance of idea markets, the role of Digital Innovation Hubs in connecting diverse knowledge
55 sources, and the managerial actions at the organizational and process level to integrate digital
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3 technologies into open innovation processes (Christensen et al., 2005; Roberts et al., 2012;
4 Natalicchio et al., 2014; Crupi et al., 2020; Urbinati et al., 2020).

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6 However, despite the practical implications and some efforts to link OI with digital technology
7 concepts, the literature reveals a gap in the innovation management approaches SMEs might use to
8 access digital technologies and integrate them into their organizational processes from an open
9 perspective. This gap becomes more critical as the increasing ubiquity of digital technologies impacts
10 companies' innovation processes (Agostini et al., 2017). Providing guidance to managers and
11 practitioners in accessing and integrating digital technologies requires a roadmap for innovation
12 management from an open viewpoint.
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16 Figure 1 illustrates the benefits and barriers faced by SMEs when implementing digital technologies,
17 as highlighted in the preceding theoretical background. Additionally, the figure demonstrates how OI
18 can assist SMEs in overcoming these challenges.
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24 --- Figure 1 ---
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26 **3 Methodology**

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28 Generally speaking, action research aims to connect academia and practice. As stated by Hult and
29 Lennung (1980), action research is an applied practice-oriented research method in cooperation with
30 experts, which concurrently focuses on practical problem-solving and increasing scientific
31 knowledge. In this perspective, the involved practitioners are considered as research partners – and
32 not as distant subjects – by increasing the validity of action research (Eikeland, 2006). Previous
33 literature demonstrated the use of action research in different domains such as organizational studies
34 (e.g., Evered and Roger, 2022), education (e.g., Hauber-Özer and Mertler, 2020), design of
35 information systems (e.g., Gregor and Hevner, 2013), and innovation management (e.g., Guertler et
36 al., 2020). Concerning the latter, in response to the extremely complex nature of the socio-technical
37 systems in which innovations occur, Guertler et al. (2020) suggest a proper methodology for an
38 interventionist ethnographic approach to innovation management research called Action Innovation
39 Management Research (AIM-R) framework able to “combines a high level of researcher involvement
40 and engagement in the innovation process with high levels of methodological rigor and relevance”
41 (Ritala et al., 2020, p. 303).
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52 Since the Action Innovation Management Research's main scope is to try out a theory with
53 practitioners in real situations and gain feedback from this experience (Ollila and Yström, 2020), the
54 SME sample was created by starting through the research's team network. In order to conduct an
55 accurate analysis, the willingness of practitioners to actively participate in research, by providing
56 deeper information and experience, is an important factor in the selection of case studies. Then,
57 starting from an initial set of 57 SMEs, 33 of which responded with interest to our request to
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participate in the study. Through the desk approach, we selected the most suitable of these for the research, relying on two sampling criteria: i) clear evidence that the SME is involved in digital transformation strategies and ii) a heterogeneity of different industries, to take into consideration possible evolutionary patterns due to context-specific variables (e.g. Urbinati et al., 2019). The final sample contains 10 SMEs (see Table 1).

The AIM-R framework was developed through the following steps (Figure 2):

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Step 1 – analysis and framing: During this step, we defined the specific goal of the study, framed the action research methodology, and identified key partners. Specifically, we based the project definition on a literature review of DT and SMEs. We then conducted an exploratory interview with a manager involved in DT strategies for SMEs, resulting in the definition of the problem of framing a digital transformation roadmap for SMEs, which became the problem addressed by the present study. Regarding the key partners identified to conduct the study, we identified a convenience sample consisting of ten firms with diverse backgrounds, industrial sectors, and locations. To varying degrees, these firms are all involved in projects with the authors, which allowed us access to information and previous experiences. In selecting the sample firms, we created a heterogeneous sample of partners to capture information from the various stages of the digital transformation process, as identified in the literature.

Step 2 – project planning: After reviewing the literature, we engaged the project stakeholders. We drafted a semi-structured interview protocol to explore the constraints that affect SMEs in implementing DT strategies and the solutions adopted. Specifically, in its flexibility, the interview outline was organized into two main macro-areas: 1) the theme of DT in its broadest sense, with the aim of exploring the opportunities and challenges to be faced by SMEs; 2) the resources needed by SMEs in implementing the DT and the role played by open innovation to overcome the constraints. In sum, we conducted 19 interviews with the ten firms previously identified. These SMEs act as consultants, intermediaries, and facilitators, collaborating with other SMEs to boost their DT processes and implement open innovation strategies to successfully access external resources. During the interviews with managers, we acknowledged the main barriers faced by SMEs in accessing or adopting digital technologies and explored the most common strategies adopted to overcome these barriers. Interviews were conducted using an iterative approach across multiple phases. In each phase, we analyzed the information obtained, sought confirmation, or requested clarifications. Interview durations ranged from 40 minutes to approximately two hours. These interviews were conducted online from March to December 2021. Table 1 includes all the information regarding the ten firms

involved in the study and the personnel interviewed. The outcome of this step includes a series of phases for SMEs to define their *DT* strategies.

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Step 3 – executing: During this step, we drew the definitive version of the SMEs' digital transformation roadmap. Crucial in this step was the mixed composition of the authors' team, which consisted of four innovation management scholars and one practitioner with decades of work experience in consultancy and managing DT processes for several MNEs leaders in the IT sector. The development of this stage was characterized by an iterative approach during which the authors' team discussed the previous evidence and combined it with their different backgrounds. Scholars on the team integrated the evidence with previous literature in innovation management, while the practitioner combined the findings with previous experience and best practices used in daily DT processes. This iterative process, also characterized by continuous intra-project pivoting, produced the digital transformation roadmap as an outcome.

Step 4 – reflecting and learning: In this step, we analyzed all the project findings, including the interviews, the roadmap, and the individual experiences of the researchers and the practitioner, to derive implications for scholars and managers. The outcomes of this step are a systematic analysis and discussion of research findings, including academic and practical contributions.

4 Findings: characterizing the digital transformation roadmap

The primary outcome of this research is a process-driven roadmap for DT in SMEs, as illustrated in Figure 3. This depiction offers a dynamic, process-centered approach to DT, outlining the crucial implementation stages required for a successful digitally-enabled organizational change strategy. Although the process perspective shares several touchpoints with the component perspective, the dynamic and activity-focused representation of DT provides a coherent analytical framework, particularly vital for the practical implementation of a DT strategy.

Indeed, a DT effort depends on individuals' readiness, willingness, and openness to change, as well as the commitment of top management (Verhoef et al., 2021; Correani et al., 2020; Zaoui and Souissi, 2020; Gurbaxani and Dunkle, 2019; Matt et al., 2015). The corresponding extensive and large-scale organizational revitalization initiative should be based on a structured pathway for organizations to follow. Figure 3 presents the SMEs' Digital Transformation Roadmap, which includes the five steps discussed in detail below.

--- Figure 3 ---

4.1 The scanning phase

The first step in developing a digital transformation strategy is to continuously scan the surrounding environment. This activity can be carried out at every level of the company, as good ideas can come

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3 from anyone and, importantly, from every direction. In fact, considering that digital technologies are
4 inherently pervasive and multidimensional by nature, external environment scanning should be
5 conducted with a broad horizon, not solely focusing on one's own industry or the relevant technology
6 market. In this regard, some effort should be devoted to systematic scouting of new digital business
7 models with potential mid- and long-term impact on the SME's own industry value chain. Industry-
8 related and non-related digital use cases should be mapped, assessed, and prioritized based on their
9 business relevance for the organization.

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11 Observing academic research in various fields and paying attention to strategies and solutions of other
12 non-directly competing companies can provide managers with valuable insights into potential
13 solutions that can be integrated into their own organizations.

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15 For this reason, managers at all levels are required to continually engage in cross-boundary activities,
16 to immerse themselves in the surrounding environment in search of rewarding experiences, and to
17 remain attentive to what happens around them, detecting changes. Participating in shared experiences
18 – such as digital innovation incubators and accelerators or open innovation consortia – is fundamental
19 in this regard (Crupi et al. 2020). From this perspective, it is crucial for the company to demonstrate
20 its ability to access and be part of those digital innovation ecosystems within which the proper
21 resources for open innovation can be found and identified. This external dimension should be
22 combined with the company's internal dimension and needs. Managers are not only required to
23 discover the right digital solutions but also to understand their potential for their own business and
24 the impact that may result (Wu et al., 2022). Magnitude and speed of potential digital impact on the
25 organization's value chain must be thoroughly assessed in order to gain a clear view on the impact of
26 DT dynamics on the organization.

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28 In this stage a pivotal role is played by leadership commitment. Even before initiating the actual
29 adoption of digital technologies, it is the dedication and vision of leaders that set the foundational
30 tone. This proactive leadership engagement underscores to the entire organization the strategic
31 importance and priority of the digital journey, fostering a conducive environment for transformation
32 (Weber et al., 2022). While the focus may shift to continuous evolution in later stages, it's this initial
33 momentum, driven by the leadership, that truly activates and charts the course for the DT process.
34 Hence, from the outset, the role of leadership is indispensable in guiding and ensuring the successful
35 execution of DT strategies.

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37 As evidenced, no SME can rely solely on its own capabilities to acquire all the necessary resources
38 for implementing DT strategies. To this regard, connection with customers, suppliers, retailers,
39 dealers, wholesalers, licensees, and partners is also crucial to gather data across the value chain for
40 joint development of digital innovation.

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3 Working within an open innovation framework and mindset is crucial for identifying external assets
4 that complement internal ones. However, in order to make this framework effective, an open-
5 innovation ecosystem strategy should be defined and aligned with business priorities, along with
6 systematic collaboration with startups hubs and/or corporate venture capital programs from large
7 enterprises.
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11 Digital transformation encompasses not only intellectual but also economic aspects. In this
12 multifaceted process, the identification and procurement of valuable digital assets, as well as their
13 integration with other resources like capital, personnel, IT systems, tools and equipment, are essential
14 for driving a successful strategy. Indeed, it's worth noting that the ability to scan the external
15 environment is closely linked with the importance of managers understanding the costs and benefits
16 of digital technologies before choosing which ones to adopt. Explicitly addressing this consideration
17 is invaluable, particularly for managers of SMEs with limited digital proficiency and commitment to
18 digital technologies.
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21 An example can be found in the experience of Firm M, which recognized a rising trend in clients'
22 needs related to the increasing complexity of the external environment. The firm's management
23 acknowledged the importance of providing companies and professionals with a digital tool to be used
24 as a virtual marketplace for sharing (selling and buying) resources, inventions, and competencies.
25 Having recognized the significance of offering an instrument to overcome the noise created by
26 traditional social networks and to navigate the VUCA (Volatility, Uncertainty, Complexity, and
27 Ambiguity) environment, the firm released an open innovation platform. Even the creation of the
28 platform was implemented through open innovation. This approach allowed the firm to expedite the
29 time to market by reducing the platform development time, lowering costs, and improving market fit
30 by collaborating with target users and key stakeholders to shorten the prototyping phase and expand
31 functionalities.
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44 *4.2 The testing phase*

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46 The Testing Phase is a crucial stage that focuses on validating the effectiveness and feasibility of an
47 identified digital solution. For instance, enhancing existing business models by meshing digital and
48 physical channels – e.g., through click-and-collect services – might require several testing rounds
49 before the new service is ready for market launch.
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52 Thus, the testing phase entails an iterative process in which a lean startup or agile model is adopted,
53 allowing the initial idea to be broken down into smaller blocks for field testing with the opportunity
54 to pivot until the desired outcome is achieved. This will ultimately lead to faster identification (as
55 time is a crucial factor) of the best solution to scale.
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3 This phase is initiated after the identification of a problem that requires a digital intervention to
4 enhance business operations, customer experience, products and/or services or overall efficiency. The
5 Testing Phase involves conducting a small-scale pilot test by implementing the digital solution on a
6 specific part of the problem, following a proof of concept (PoC) approach. A key aspect of this phase
7 is embracing a trial-and-error perspective, which encourages learning from both successes and
8 failures. The key aspects of this phase are, firstly, the *problem segmentation* according to which the
9 problem is broken down into smaller, manageable components. This enables a focused approach and
10 allows for accurate evaluation of the digital solution's impact on the specific aspect of the problem
11 at issue. The second key aspect is the *solution design*, where the digital solution is designed or selected
12 based on thorough research and a clear understanding of the problem. This aspect involves exploring
13 various technologies, tools, and platforms that can address the identified problem and align with the
14 organization's objectives and resources. The third key aspect concerns the *proof-of-concept*
15 *development*. In this stage, a PoC is developed to demonstrate the feasibility and effectiveness of the
16 digital solution in addressing the problem. A functional prototype or a minimum viable product (MVP)
17 that can be tested and assessed is often created at this stage.

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19 After that, the implementation of the phase should encompass the *pilot testing* to apply the PoC in a
20 controlled environment, embracing a trial-and-error perspective. This stage helps gather valuable
21 insights, identify potential issues, and evaluate the overall performance of the digital solution.
22 Experimentation should be encouraged and failures should be permitted at this stage, as they provide
23 essential learning opportunities for refining the solution. It is crucial to involve key stakeholders and
24 end-users during the testing process to gather feedback and ensure the solution meets their needs and
25 expectations. An important part of the stage development is linked to data analysis and evaluation
26 activity the measure the results of the pilot test. Key performance indicators (KPIs) are established,
27 so that the solution's performance and results can be compared against them. This data-driven
28 approach provides quantitative evidence about the effectiveness of the solution and helps guide
29 further improvements. Finally, based on the insights and feedback gathered during the pilot test, the
30 digital solution may undergo modifications and refinements to enhance its performance, usability,
31 and compatibility with the organization's systems and processes. Accordingly, the digital solution is
32 scaled and integrated into the organization's broader operations. This stage entails developing a
33 detailed implementation plan that includes necessary resources, training, and support structures to
34 ensure a smooth transition.

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36 Firm G, for example, guided a partner in addressing a Customer Care issue in which the company
37 was experiencing significant delays in handling customer requests resulting in a sharp decline of
38 customer satisfaction levels. After identifying the overarching problem, Firm G directed the
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3 company's team to segment the issue by focusing solely on customers' comments regarding a specific
4 product. Having evaluated all possible solutions, Firm G devised a technical solution based on an AI-
5 powered chatbot that would guide customers through problem resolution and automate
6 troubleshooting of most common queries. The AI chatbot was designed to learn from customer
7 interactions, continuously improving its ability to assist users effectively. The company then
8 developed a PoC for the AI chatbot, creating a functional prototype to test its feasibility and
9 effectiveness in addressing customers' concerns. Drawing on insights and feedbacks gathered during
10 the pilot test, Firm G assisted the company in refining the AI chatbot to improve its performance,
11 usability, and compatibility with their systems and processes. Following successful modifications,
12 the company planned to gradually scale up the AI solution and integrate it into their broader customer
13 care operations. The case of Firm G makes a good example of a trial-and-error approach. It started
14 by prototyping automation options with a small set of processes (customer care operations) and
15 technologies, before embarking on company-wide automation.

25 26 *4.3 The adoption phase*

27 Adoption represents a more mature stage in which the company and its managers are required to
28 internally implement the digital technologies identified and tested in previous stages to initiate a DT
29 process. This operation is inherently complex and is based on a scale-up strategy during which the
30 validated solution is integrated into the entire process after carefully evaluating its technological and
31 financial impacts. As with any innovative experience, the adoption phase relies on certain premises.
32 One of these premises is that the identified technology aligns with the business needs of the company.
33 Given this assumption, which is corroborated by the testing phase, the firm's managers are tasked
34 with planning the technology adoption.

35 To achieve this result, the objective of the transformation must be identified, and an appropriate
36 assessment of resources must be conducted. Once the necessary resources are identified, it is
37 important to determine whether these resources are sufficient or if it is necessary to tap into new
38 resources and/or align internal ones. During this phase, it is crucial to rely on a solid partner to ensure
39 a successful process of technology adoption and resources alignment. This partner is usually
40 represented by a technology provider or an intermediary that delivers not only the technology but
41 also intervenes in terms of training and guidance during the adoption process. The latter represents a
42 key building block stage during which both managers and employees start familiarizing themselves
43 with the technology and the new processes activated by the innovative solution. The process of
44 adopting a new technology, as further explained in the next phase, has an impact not only at the
45 strategic level but also at the organizational level. Thus, the initial engagement of managers and
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3 employees involved during the adoption phase has particular relevance for creating a common sense
4 of technology acceptance.
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6 It is worth mentioning that from a financial perspective, SMEs might struggle to dedicate the
7 necessary resources to properly navigate this phase. Therefore, it is crucial for top management to
8 find the right sources of funding in the public and private landscape, allowing for sustainable access
9 to the required capital. However, it should be considered that the adoption phase is inherently
10 iterative, and thus involves the creation of specific projects or intermediate implementation stages
11 that enable the company to concurrently adapt its strategy. Despite relying on external resources, it
12 must be acknowledged that DT activities, by their nature, involve high levels of risk and uncertainty,
13 so resources will always be scarce or only partially adequate as the strategy evolves.
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15 Against this background, the experience of Firm F offers insightful highlights on how to collaborate
16 with an SME to implement an internal DT process to support smart operations in terms of
17 manufacturing capacity. Specifically, the manufacturing firm – having recognized the rapid evolution
18 experienced by the global value chain and the rising need for customization and flexibility among
19 buyers – collaborated with Firm F to develop a digital tool for optimizing and controlling the
20 production process remotely. Throughout the entire technology acquisition process, Firm F closely
21 collaborated with the client to analyze the operations, benchmark the identified needs against the
22 technical solutions available on the market, define the adoption roadmap, and guide the entire process.
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24 *4.4 The Integration and Alignment phase*

25 Once the optimal solution has been identified, it is necessary to proceed to the integration into the
26 firm's business model and the subsequent alignment with the new opportunities generated. As
27 demonstrated in the previous phase, the adoption of a new solution is not only a matter of strategy, it
28 also involves the firm's operational structure. Thus, the implementation of this phase encompasses
29 both internal and external factors. First and foremost, it is crucial, for firms, to reiterate the crucial
30 importance of leadership and commitment of top management, which should be constantly involved
31 and aligned on the path forward and committed to its implementation. Indeed, since this adaption
32 process requires structural changes, centralizing the responsibilities related to DT may offer a suitable
33 control and governance mechanism. Centralization can encourage vertical information exchange,
34 bypass lengthy negotiations, and streamline overall coordination (Firk et al., 2021). To this end, a
35 series of alignment mechanisms between the DT strategy and the firm's overall business strategy
36 must be activated.
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38 Analyzing the components that make up the entire stage, it becomes apparent that the first step
39 (integration) requires a structural intervention in operations that necessitates the identification of
40 appropriate resources and a suitable strategy for employing them without affecting the company's
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regular operations. To accomplish this, it is necessary to have a clear focus on the objectives to be achieved, the activities to be performed and related timelines, and the division of roles and responsibilities. Segment management, in this case as well, allows for constant monitoring of the strategy's impact on the company's functioning and enables progressive adaptation and adjustment of the entire structure. Once the integration of technologies has been initiated and completed, the next step is to align the new functions and capabilities with the existing business model. Business model innovation is, indeed, functional for the company as it allows it to create, distribute, and capture value following the adopted transformation strategy. Indeed, it is not enough for the company to innovate the way it creates value; this innovation must reach its customers to meet their needs, fulfill their desires, or solve their problems.

Firm C's experience in IT consulting services demonstrates a profound comprehension of the importance of collaboration when incorporating new technology and knowledge into existing processes. For instance, when integrating AI into production processes, Firm C guided its partner in establishing an internal IT department equipped with the required skilled resources, offering training and technical solutions. Having a dedicated department enables the firm to capitalize on all opportunities presented by AI for operations and strategies. Firm C's advisory role assisted the partner in defining KPIs, developing the infrastructure, and upskilling human resources to effectively integrate AI.

4.5 *The Permanent Transformation phase*

The alignment of the operations and the business model does not exhaust the DT strategy; rather, we could say that it is perhaps the point at which a permanent transformation begins. The process described up to this point clearly involves companies that must adapt to new technologies. However, we have seen that these technologies are constantly evolving, and their areas of application are exponentially multiplying with the increase of applications and experiences. This implies that once a company has accomplished a process of DT, it must activate mechanisms for a continuous evolution to create a permanent phase of DT. To achieve this goal, it may seem trivial to say but the first step is to create an agile organizational culture that is constantly focused on digital evolution. The processes described previously – engagement of leadership, resources alignment, participation in shared experiences of open innovation, and continuous scanning of the surrounding environment – must become endemic to the firm's actions. The elements of this new phase can undoubtedly be found in the following equation:

Innovation focused on needs + resources + dynamic environment + openness = permanent DT.

Indeed, an innovative drive that is continually attentive to the needs of customers and the firm itself will activate those permanent mechanisms of scanning the external environment and collaborating

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3 with external partners that allow the company to be always up-to-date on digital developments. The
4 consequent attention to internal resources, on the other hand, provides the basis for constant attention
5 to innovative forms of financing and, as far as human resources are concerned, ensures they are
6 always adequately skilled and updated. This will contribute to creating a constantly evolving
7 environment in which ideas flourish and innovations take root.
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11 A stimulating environment in which leadership behaviors favor digital adoption, team empowerment
12 and risk-taking, and encourages personnel at all levels to bring new ideas to the firm to constantly
13 fuel its evolution.
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17 Lastly, openness to the external environment as a current practice and the knowledge sharing will
18 increasingly drive open innovation and the search for partners with whom to activate collaboration
19 strategies aimed at generating shared value. A company that consistently facilitates internal changes
20 and contributes to the value proposition within the ecosystem in which it operates has a greater chance
21 of continuously evolving, keeping pace with the times, and even anticipating the future.
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26 **5 Discussion and conclusion**

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28 Our analysis highlights that the implementation of a DT strategy in SMEs involves the adoption of
29 managerial action not only at strategic but also at organizational level to overcome their liabilities by
30 recurring to open innovation. At organizational level, the adoption of digital technologies pushes
31 SMEs to reorganize their leadership, reskill the internal resources, formalize procedures and budget
32 for digital investments, and develop validated practices to promote innovation development and
33 adoption through external collaborations (Nadkarni and Prügl, 2021; Urbinati et al., 2020). However,
34 navigating the DT and collaborating with external partners at the same time is challenging for SMEs'
35 managers also because they must navigate a complex environment governed by paradoxes (McGahan
36 et al., 2021). These paradoxes entail changes at the organizational level. We highlight these paradoxes
37 in the following discussion.
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45 *5.1 The humans' key role*

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47 The first paradox relates to skills. In a world that pushes digital capabilities to unprecedented levels,
48 individuals with their abilities and uniqueness play a crucial role (Eller et al., 2020). In fact, we have
49 observed that individuals, with their approach and attitude, govern transformation processes. Within
50 this vein, leaders and managers are crucial, as they play a fundamental role for at least two main
51 reasons. The first relates to commitment. Digital transformation cannot exist without a genuine
52 engagement from top management (Wrede et al., 2020). Their commitment starts from the early stage
53 of the process with the identification of technologies to implement by means of scanning the external
54 environment. Furthermore, they must guide and govern the process of technology absorption within
55 the firm's processes by managing the relative strategic and organizational implications. The second
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3 aspect is linked to their ability to interpret the new role that digital leaders are called upon to
4 undertake. The digital manager is, in fact, a multipotential manager who exhibits cross-sectoral
5 characteristics and is capable of approaching change with a comprehensive strategic vision (Singh
6 and Hess, 2017). We are no longer dealing with experts in a single discipline, but rather with
7 individuals skilled in broadening their range of cross-cutting knowledge while clearly understanding
8 their gaps, and simultaneously possessing the ability to surround themselves with human resources
9 equipped with complementary skills and ultimately capable of filling those gaps. It is precisely on
10 the skills of individuals that the other aspect of the first paradox manifests itself. Not only is leadership
11 crucial in transformation processes, but so are all the members of the firm (Cetindamar, et al., 2021).
12 They are entrusted with the important role of aligning and updating their skills based on what is
13 necessary in order to effectively deal with digital innovations. Indeed, while new technologies will
14 replace much of manual labor, they will also require the introduction of new roles suitable for
15 managing them (Weber et al., 2022). Although it is hard to predict exactly which type of management
16 skill set will be the most suited to thrive in the digital era, a general principle is clear: flexibility and
17 adaptability will be very much in demand. The human-machine integration thus represents a new
18 opportunity for employment and professional growth for those individuals able to seize its potential.
19 Over the next decade, although it is very unlikely that technologies such as AI will replace managers,
20 it is very likely that managers who are able to use AI will replace those who don't (Brynjolfsson and
21 MacAfee, 2017). To this regard still a lot remains to explore on the aspects of leadership and the
22 future of work answering questions such as: What skills should the leaders of tomorrow possess?
23 What are the characteristics of digital workers? How should companies enhance and cultivate these
24 abilities? How is the concept of work changing, and how is the world of professions evolving? What
25 are the future models for the integration between humans and machines?

26 5.2 *Resources scarcity vs abundancy*

27 The second paradox pertains to resources. SMEs suffer dramatically from a lack of resources for
28 implementing DT strategies, while the external environment is abundant with the necessary resources.
29 This triggers centrifugal mechanisms that push firms to open up externally, creating open and
30 systemic collaborations (Jugend et al. 2020). When discussing resources, as we have seen, we must
31 consider them in their entirety, that is, material resources – understood as financial means – and
32 immaterial resources – understood as human resources, skills, and know-how. Let us begin with the
33 examination of the latter. Digital transformation requires SMEs to primarily invest and reinforce skills
34 (Troise et al., 2022). The role of management and employees is to scan the external environment and
35 the market for technologies to identify the best solutions to integrate into the firm to increase its
36 competitive advantage. Know-how related to digital technologies is often complex and constantly

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3 evolving, and therefore the best solution for firms is to identify the leaders (or owners) of the
4 technologies and interact with them for the acquisition or use of these technologies, rather than
5 developing such know-how internally (which would expose firms to substantial investments and
6 uncertain results).
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10 Once the best technology has been identified and acquired, it is necessary to proceed with aligning
11 the technologies with the business model and the internal organization. This operation will allow the
12 firm to optimize internal processes and, at the same time, necessitate an appropriate strategy to
13 effectively communicate the new value generated externally. In turn, technologies have to be aligned
14 with the firm's internal skills, which must be appropriately redefined based on new needs (Kraus et
15 al., 2022). Thus, in addition to hiring new competencies from outside ("buy" strategies), firms have
16 also to pursue a strategy of up-skilling and re-skilling internal competencies ("build" strategies). In
17 this regard, the relationships that companies are able to establish with universities and research
18 centers may prove to be a win-win strategy for both parties (Greco et al., 2021), as these institutions
19 contribute to maintain a vigilant focus on new training needs and adapting their educational offerings
20 and teaching methods accordingly. On one hand, firms have access to sources of knowledge for
21 updating their skills; on the other hand, universities have the opportunity to understand the real market
22 needs and adjust their offerings accordingly.
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32 As for material resources, we have observed that to govern DT processes, SMEs need initial
33 investments for the purchase or development of technologies, machinery, and the adaptation of
34 internal operations (Marozzo et al., 2023). These resources can be obtained externally in various
35 ways. One of the most common methods employed by small businesses is collaborating with large
36 industrial, commercial, and financial partners to obtain the resources they need in terms of orders,
37 access to facilities, or equity participation, allowing them to increase their capacity to invest in
38 infrastructure and machinery. The second strategy is to utilize digital finance tools such as Initial
39 Coin Offers to access widespread sources of capital. Lastly, firms can also rely on innovation policies'
40 funds issued at all institutional levels.
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48 Innovation policies deserve some ad-hoc reflection. Innovation incentives play a crucial role in the
49 development of innovation and, over the years, have demonstrated their undeniable utility (Mina et
50 al., 2021). However, they often require too great an effort for firms, especially smaller ones (micro),
51 in terms of initial investment for drafting funding proposals or due to barriers related to excessively
52 high technology readiness levels. To overcome those two aspects, SMEs can collaborate with partners
53 such as digital innovation hubs, accelerators, and incubators that offer the opportunity to join already
54 established partnerships for requesting funds in larger projects (Crupi et al., 2020). On the other hand,
55 if the technological readiness level is too low, they can leverage these partnerships or create new ones
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3 with universities and research centers to access policies aimed at incentivizing the development of
4 more nascent technologies for which a significant portion of basic research is still required.
5 Conversely, national and regional policies also play a crucial role (perhaps even more significant for
6 certain aspects), as they represent the first potential means of access to substantial funds for firms.
7 However, these policies are often limited in number or provide inadequate funds compared to the real
8 needs of the entrepreneurial needs. They also impose rigid spending constraints which restrict their
9 effectiveness, ultimately favoring only those companies that already have the necessary liquidity to
10 anticipate investments or address a series of collateral investments required for the development of
11 digital transformation strategies.

12 The analysis of the second paradox thus opens the opportunity to develop further investigations on
13 two main streams. The first is related to the importance for SMEs of having free financial capital to
14 be invested within the company to enhance its capabilities, thereby putting companies in a position
15 to implement a genuine DT strategy. The second aspect is the importance for the company of opening
16 up externally with a focus on OI to draw upon the resources it needs in a collaborative, ecosystem-
17 oriented approach.

18 *5.3 Power to the Smallest*

19 The third paradox pertains to size. New digital technologies are redefining the boundaries of
20 entrepreneurial action (Crupi et al., 2022). Through the implementation of digital technologies, SMEs
21 can both reach the global market and comply with adequate technological standards that allow them
22 to enter global value chains, thereby prompting them to broaden their horizons despite their limited
23 size. Moreover, such technologies enable access to human resources and expertise potentially
24 scattered worldwide. New forms of hybrid work, in fact, allow firms to access a much wider talent
25 pool without the need for them to be physically on the workplace. Consider the potential that
26 technologies such as online freelancing platforms, matchmaking platforms or talent marketplaces
27 offer in acquiring specific, highly specialized expertise from around the world to govern only part of
28 the transformation process while optimizing resources and processes. This paradigm shift calls into
29 question the very concept of the market (in terms of consumers, labor, or technologies) and the
30 relative capacity of firms to access it based on their size.

31 However, the observation of the experiences we have conducted in this study leads us to the definition
32 of the paradox. Despite the increasingly global dimension in which technologies push companies, the
33 local context still exerts a significant influence on SMEs, particularly concerning the initial stages of
34 transformation. What we have noticed is that the evolution of the concept of ecosystem, when related
35 to SMEs, tends to refocus on the notion of territory. SMEs tend to scan their surroundings for new
36 technological solutions to adopt, starting from the territory in which they operate and the partners

they typically collaborate with. The main actors driving DT from this perspective are those most active in the local area. Digital innovation hubs, for example, play a fundamental role in mapping the needs of the territory and seeking potential digital solutions within broader networks to offer affiliated companies. Universities generate a continuous push towards digital innovation by creating a scientific base that requires industrial partnerships for testing and application. Small digital-born consulting firms aim to nurture a technology-driven ecosystem and take charge of guiding incumbents through their transformation processes. These are just a few examples that we have observed and demonstrate the importance of stable local relationships in open innovation, which have an exponential multiplier function in ecosystem creation (Remneland Wikhamn and Styhre, 2023). An ecosystem that evolves and adapts in its composition and definition, based on open innovation capable of self-sustenance, and driven by SMEs in a bottom-up approach.

This observation represents a novelty in the landscape of ecosystem literature, as the classic definition of the ecosystem usually involves a top-down approach in which a focal company drives the creation of relationship networks based on a single value proposition attributable to its interests or the implementation of its technology (Marozzo et al., 2023). In this perspective, the narrative described in the present study is reversed, and SMEs – subject to the centrifugal force that leads them to seek resources externally – create complex networks of relationships with other partners to cover the various needs dictated by the strategies of transformation implemented concurrently. In turn, by employing a word-of-mouth strategy, companies involved in such relationships tend to suggest other partners with whom they have collaborated for the resolution of specific problems. This continuous brokerage activity creates a virtuous cycle that fuels the bottom-up OI ecosystem in which the value proposition is represented by the success of SMEs' DT strategies. Examining in detail the mechanisms underlying the creation and management of these ecosystems, measuring their impact, and understanding their internal dynamics and power relations is perhaps one of the most crucial aspects that research will need to focus on in the future to provide answers and suitable models for supporting SMEs during their transformation phases.

Figure 4 shows the framework derived from the discussion of our results, pinpointing the core challenges associated with each paradox. Within this framework, we emphasize how OI, by fostering interactions with the external environment, can facilitate SMEs in seamlessly adopting digital technologies and unlocking new opportunities in terms of access to the market.

--- Figure 4 ---

6 Conclusions and future research

The outcomes of this study open the door to future research. Our analysis has emphasized the importance of managerial actions at both strategic and organizational levels in implementing DT

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3 strategies for SMEs. However, simultaneously navigating DT and collaborating with external
4 partners remains a challenge for SME managers due to the complex environment characterized by
5 paradoxes.
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8 Concerning the first paradox (skills), while digital capabilities are pushed to unprecedented levels,
9 individuals' abilities to cope with change play a crucial role in governing transformation processes,
10 particularly in a context where i) predictability and stability can no longer be taken for granted; ii)
11 the skills' obsolescence rate is dramatically accelerating; iii) work increasingly consists of complex
12 arrangements of interrelated tasks and new digital tools, requiring new ways of working. Leaders and
13 managers are essential in this context, not only to drive the transformation efforts, but also to turn the
14 traditional hierarchical organization structure of SMEs into a more agile one by means of investing
15 in continuous upskilling initiatives, pioneering new ways of working and introducing a culture that
16 fosters innovation. . More research is needed to understand the aspects of leadership and the future
17 of work, such as the necessary skills for future leaders, the characteristics of digital workers, and how
18 SMEs can enhance, cultivate, refresh and keep these abilities constantly up to date. As for the second
19 paradox (resources), SMEs must overcome several barriers to digitally transform their business. Since
20 some of the most common roadblocks include lack of funding and lack of expertise, the end result is
21 that SMEs often lack the resources needed for implementing DT strategies, while the external
22 environment is abundant with the necessary resources. This creates a push for SMEs to adopt open
23 and systemic collaborations. Future research can explore the importance and value of establishing an
24 ecosystem-oriented approach to enable SMEs to gain access to free financial capital and to a broader
25 talent pool . Finally, concerning the third paradox (size), new digital technologies redefine the
26 boundaries of entrepreneurial action, allowing SMEs to access global markets, value chains, and
27 human resources. However, the local context still exerts a significant influence on SMEs in the initial
28 stages of transformation. Future research can examine the mechanisms underlying the creation and
29 management of ecosystems or collaboration networks that support SMEs during their transformation
30 phases and measure their impact.
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48 The findings of this study carry significant implications for policymakers aiming to foster an
49 environment conducive to the digital transformation of SMEs. First and foremost, while free financial
50 capital is undeniably crucial for SMEs, a broader systemic approach is needed. Policies that
51 strengthen fiscal regulations can provide SMEs with greater financial security and incentives to
52 undertake transformative initiatives. Furthermore, enhancing laws related to intellectual property
53 protection can bolster innovation, as SMEs would be assured that their digital innovations are
54 safeguarded. Risk control mechanisms should be established and refined to give SMEs' managers the
55 confidence to navigate complex digital landscapes without undue exposure to financial or operational
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3 hazards. Additionally, considering the importance of collaborations and ecosystems in the dDT
4 process, fostering policies that facilitate open and systemic collaborations can pave the way for
5 resource-constrained SMEs to access necessary tools and knowledge. In essence, a multi-faceted
6 policy approach, addressing financial, legal, and collaborative aspects, can greatly enhance the
7 external environment and drive the digital transformation of SMEs more effectively.
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Figures



Figure 1 Main SMEs' benefits and barriers in digital technologies implementation identified by the literature

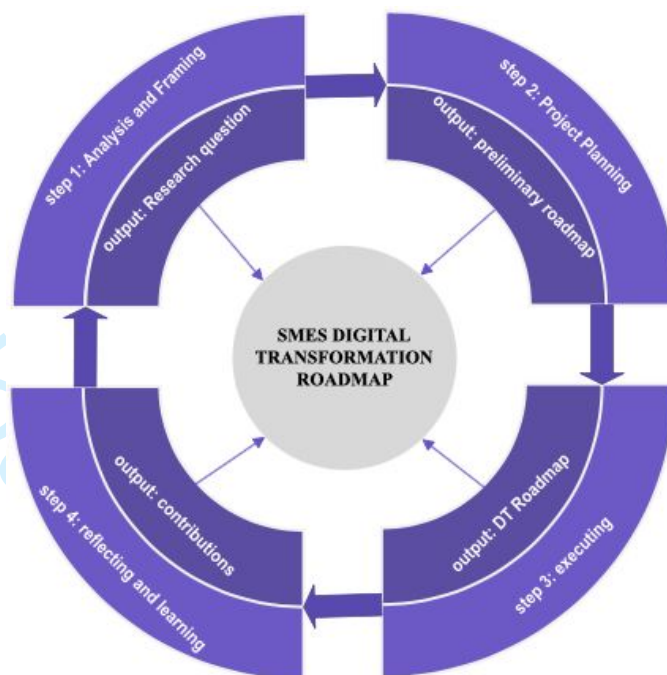


Figure 2 Action Innovation Management Research Model for the SMEs' digital transformation roadmap (Authors' elaboration)

	SCANNING	TESTING	ADOPTION	INTEGRATION & ALIGNMENT	PERMANENT TRANSFORMATION
Task	<ul style="list-style-type: none"> Scan surrounding environment Perform scouting of new digital business models and solutions Identify relevant use cases and digital solutions 	<ul style="list-style-type: none"> Articulate business problem Validate effectiveness of identified digital solutions Assess potential business impacts (business case) Develop Minimum Viable Product (MVP) Run Proof-of-Concept (PoC) Fine-tune solution 	<ul style="list-style-type: none"> Define scale-up strategy Develop detailed implementation plan Perform assessment of resources Identify funding needs Identify implementation partner Develop solution at scale 	<ul style="list-style-type: none"> Secure leadership commitment Set up centralized governance & control mechanism Refine business & operating model Align internal organization and capabilities Manage change 	<ul style="list-style-type: none"> Nurture an agile organizational culture Set-up permanent mechanisms to secure engagement of internal resources to continuous evolution Foster internal/external collaboration and innovation practices
Output	<ul style="list-style-type: none"> Long list of most attractive use cases/digital solutions 	<ul style="list-style-type: none"> Business case Minimum Viable Product Digital solution 	<ul style="list-style-type: none"> Implementation Plan Resource Plan including funding sources Implementation partner identified and engaged Solution go-live 	<ul style="list-style-type: none"> Governance & control mechanism Updated business & operating model 	<ul style="list-style-type: none"> Continuous evolution mechanisms in place Open-innovation and collaboration strategy

Figure 3 SMEs' Digital Transformation Roadmap (Authors' elaboration)

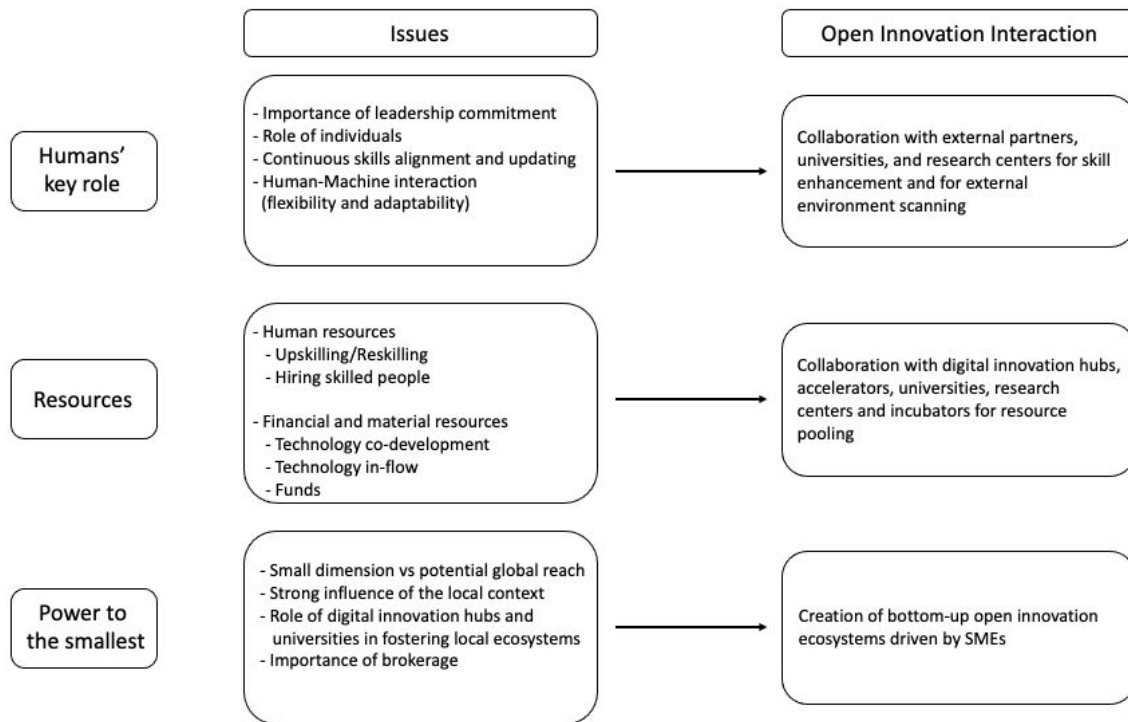


Figure 4 Digital Transformation paradoxes and Open Innovation framework (Authors' elaboration)

Tables

Table 1 Firms and interviewees involved in the study

Firm	Main Business activity	Interviewee	Duration (minutes)
A	Consultancy and strategic management	Co-Founder	120
B	HR management specialist	Founder & CFO	80
		Co-Founder	50
		Co-CEO	65
C	IT services and consultancy	Co-Founder	45
		Chief Marketing Officer	50
D	IT services and consultancy	Founder & CEO	60
		Co-Founder	70
E	Legal services	Founder	60
		Data Protection Specialist	40
		CIO	50
F	Consultancy and strategic management	Managing Partner	100
		Senior Analyst	50
G	IT services and consultancy	Sales Director	90
H	Consultancy and strategic management	Senior Analyst	45
I	Web Marketing services	Digital Marketing Officer	60
L	Consultancy and strategic management	Managing Director	70
		Senior Partner	60
		Senior Founding Partner	60