Exploring the relationship between entrepreneurial ecosystem inputs and outcomes: the role of digital technology adoption

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Abstract

Purpose – This work aims to explore the relationship between entrepreneurial ecosystems' (EEs) inputs and outcomes within a digital-technology-driven EE. Specifically, it focuses on how being part of an EE enhances digital technology adoption (DTA) and consequently facilitates EE outcomes.

Design/methodology/approach – This paper employs a single-case study approach, focusing on Italian EE. The data analysis is based on the researchers' direct observations and semi-structured interviews with the EE founders' teams and the top management of the small- and medium-sized enterprises (SMEs) operating therein. Given the novelty of the topic and the lack of a clear research framework of analysis, a qualitative method is well suited for studying digital-technology-driven EE, thus gaining rich data about the phenomenon in a real-life context.

Findings – The findings of the study reveal that when specific eco-inputs (financial, knowledge, social and institutional assets) are correctly exploited to enhance DTA, important outcomes, namely, SME competitiveness and new technology-based venture creation and development, are generated.

Originality/value – The paper contributes to a relatively unexplored topic in the existing literature on EEs and digital technology. Specifically, through the proposition of a conceptual model, it sheds light on the relationship among EE inputs, DTA and EE outcomes.

Keywords Small to medium-sized enterprises, Digital technology, Entrepreneurial ecosystem, Digital technology adoption

Paper type Research paper

1. Introduction

The concept of entrepreneurial ecosystems (EEs) has gained enormous popularity in research due to its pivotal role in fostering economic growth and explaining high-growth entrepreneurship. This has shifted the focus of analysis from the individual entrepreneur to the collective entrepreneurial activities that occur in a specific and spatially defined territory, thus addressing entrepreneurship as a complex phenomenon that embraces and

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overcomes both social and economic dimensions (Nicotra *et al.*, 2018; Wurth *et al.*, 2022). In this regard, the literature on EEs has traditionally highlighted the interdependencies among its constitutive elements, such as early investments, organisations, human capital, resources and capabilities, infrastructure and social networks (Spigel, 2017), which enable social and economic value creation (Stam, 2015; Stam and Van de Ven, 2021). Spigel (2017) indicated that successful EEs lead to high rates of entrepreneurship, which is the main output of an EE (Stam, 2015; Spigel, 2017). However, despite drawing on ancient and well-established economics, business and social theories, the mechanism behind EEs' entrepreneurial process and the relationships between the critical success factors and the EE's outcomes appear under-theorised. In defining the results of the entrepreneurial activity within an EE, the literature appears to be highly fragmented, with different authors talking about different concepts, namely, output (e.g. Stam, 2015), outcome (e.g. Brown and Mason, 2017) or performance.

Moreover, in recent years, the boundaries and the nature of EEs have been completely revolutionised by new digital technology advancements (Colombo *et al.*, 2019; Parente *et al.*, 2019), which are no longer restricted to high-tech sectors (Zahra and Nambisan, 2012). Digital technologies have not only profoundly changed firms' ways of doing business and reshaped organisational processes and structures but also affected entrepreneurial performances (Kallinikos, 2007; Yoo *et al.*, 2012; Nambisan, 2017). Indeed, they have changed customer and supplier relationships, led to more data-driven decision-making processes and leveraged sustainable management models, thereby contributing to the creation and development of new competencies and knowledge (Boland *et al.*, 2007). However, despite its importance, the literature has allocated little attention to the role of digital technologies within EEs (Elia *et al.*, 2020). In addition, there is a lack of evidence to support the idea that digital technology within an EE boosts entrepreneurial activities and outcomes in a geographically defined context (Von Briel *et al.*, 2019). Nambisan (2017) stated that "limited effort has been made on theorising the role of specific aspects of digital technologies in shaping entrepreneurial opportunities, decisions, actions and outcomes". Specifically, previous literature on EE and digital technologies have either focused on studying digital technologies as a driver of EEs' formation processes and outcomes or on the concept of digital EE (Elia *et al.*, 2020). The purpose of these studies is to explore the ways by which digital technologies enhance the dynamics and relationships between participants in the EE and how they impact the processes of establishing new ventures. In doing so, the literature disregards the case in which the technology is not only a driver to create digital platforms or even digital ecosystems but also the core of the entire ecosystem and its solutions.

In this scenario, our paper aims to address the aforementioned gaps by exploring the relationships between the EE inputs and the EE outcomes of a digital-technology-driven EE and how these outcomes can be generated. Specifically, our study focuses on exploring how participation in an EE can facilitate the development process of new digital technology solutions through access to specific assets. Guided by the aforementioned literature, we developed a conceptual model aimed at uncovering the role of EE and its critical success factors – which we called eco-inputs – in fostering digital technology adoption (DTA) (Shen *et al.*, 2022; Blichfeldt and Faullant, 2021) and, consequently, facilitating the EE outcomes.

The paper adopts a qualitative approach based on a single case study of an Italian EE, FermoTech, which has been chosen for its revelatory potential. FermoTech has been previously defined as an innovation-based, technological-driven EE (Marinelli *et al.*, 2022) whose core mission is to increase the competitiveness of small- and medium-sized enterprises (SMEs) operating in the Le Marche Region and stimulate new venture creation and entrepreneurship in the area. The findings of this paper reveal that when specific eco-inputs (financial, knowledge, social and institutional assets) are effectively exploited to enhance DTA, important outcomes are generated, that is, SME competitiveness and new technology-based venture creation and development.

The article is structured as follows. First, the theoretical background reviews the literature on EE. Then, the conceptual model is presented, followed by the applied methodology. Finally, findings, theoretical and practical implications and conclusions are discussed.

2. Theoretical background

2.1 EE and digital technology

The "ecosystem" metaphor has been widely adopted in business literature to help firms navigate the current competitive scenario (Moore, 1993; Nicotra *et al.*, 2018). Being part of a system in which a set of interdependent organisations interact within a specific context allows firms within the ecosystem to jointly co-evolve, acquire knowledge, develop skills and innovate (Sussan and Acs, 2017). In this scenario, scholars have started to apply the ecosystem concept to investigate different phenomena, resulting in a vast number of ecosystem types, such as organisational ecosystems (Mars *et al.*, 2012), innovation ecosystems (Jiang *et al.*, 2022), knowledge ecosystems (Bereznoy *et al.*, 2021) and digital business ecosystems (Crupi *et al.*, 2022). Among these, the concept of EE has started to elicit attention from both scholars and practitioners in the previous decade (Malecki, 2018; Stam, 2015), guided by the necessity to better define entrepreneurship not as the result of an individual entrepreneur's behavior but as the sum of social, cultural and economic forces (Van de Ven, 1993). In this way, entrepreneurship is seen as a complex phenomenon that requires an ecosystem perspective (Nicotra *et al.*, 2018; Wurth *et al.*, 2022; Sussan and Acs, 2017). An EE can be defined as a set of interdependent actors and factors coordinated in such a way that enables productive entrepreneurship within a particular territory (Stam, 2015, 5). What distinguishes an EE from other types of ecosystems is its focus on entrepreneurial activity and the creation of new ventures as a result of the interdependencies and connections among its main components, such as entrepreneurial actors and organisations (e.g. firms, venture capitalists, business angels, banks), institutions (universities, public sector agencies, financial bodies) and entrepreneurial processes, which increase the performance of the local entrepreneurial environment (Cavallo *et al.*, 2019; Mason and Brown, 2014). Overall, the ecosystem's metaphor acknowledges that entrepreneurship stems from a community of interdependent actors, individuals, entities and regulatory bodies within a given geographic area (Cavallo *et al.*, 2019).

Recently, the digital revolution, marked by the development of innovative technologies, applications, processes and services, has significantly impacted the realm of EEs (Autio, 2017). Digital technologies have not only profoundly changed firms' ways of doing business and reshaped organisational processes and structures but have also affected entrepreneurial performances (Kallinikos, 2007; Yoo *et al.*, 2012; Nambisan, 2017). Innovative technologies have reshaped the relationship between EE elements (Bouncken *et al.*, 2021) by acting on causal mechanisms and downward and upward relationships (Wurth *et al.*, 2022). This stream of research on the relationship between EE and digital technologies appears to be mainly focused on studying digital technologies as drivers in EEs' formation processes and outcomes (Zahra *et al.*, 2023). As a matter of fact, the digital revolution has allowed EE to seize new business opportunities by leveraging and combining the different levels of specificity (DeSanctis and Poole, 1994) and relationality (Kallinikos *et al.*, 2013) characteristics of digital technologies (Von Briel *et al.*, 2019). In this sense, the digital technologies within an EE could lead to more efficient execution of actions and greater resource optimisation (Leonardi, 2011), increased availability of resources within the environment, a different breadth of inputs and outputs, as well as the creation of new artifacts, such as devices and functionalities (Endres *et al.*, 2021), by bundling resources and capabilities. Steininger (2019) argued that new technologies could act as facilitators, mediators or outcomes of entrepreneurial operations or

the entire business model. In addition, technologies in EE also empower entrepreneurs to find new ways to create, deliver and capture value, thereby pursuing entrepreneurial opportunities (Autio *et al.*, 2018) through the concept of digital affordances deriving from the technical architecture of digital infrastructures. Overall, these studies aim to understand how digital technologies facilitate the nature and interactions among the actors of EE and ultimately influence the new venture creation processes. Studies on the recent concept of digital entrepreneurship EEs (Elia *et al.*, 2020; Sussan and Acs, 2017) also fall under this category. This new trend in research is mostly based on studying the peculiar traits of systems, such as e-commerce marketplaces, crowdfunding platforms, crowdsourcing initiatives and competition platforms (Zheng *et al.*, 2014), with a specific focus on the birth of digital startups (Elia *et al.*, 2020). Considered as an expression of productive entrepreneurship, digital venture creation has been at the centre of this stream of research, disregarding that it should not be taken for granted that every digital new venture is innovative and, contrarily, that everything that is not digital is not innovative. As pointed out by Cavallo *et al.* (2019), since "digital EEs" and "EEs" are not the same, scholars should consider pointing out the differences among these concepts by overcoming the focus on digital startups only. Therefore, although we acknowledge the importance of the aforementioned literature in better understanding how EEs and digital technologies are intertwined and can influence each other, there is a dearth of studies that focus on how being part of an EE can foster the creation and evolution of new digital technology solutions that can be beneficial for all the actors involved in both traditional and modern industries (Zahra *et al.*, 2023). Consequently, understanding the effective way to manage and develop specific technological solutions within EEs by exploiting EEs' characteristics and factors to achieve outcomes that are beneficial for the entire system is worth studying. Specifically, the literature lacks studies in which technology is not only a driver to create digital platforms or even digital ecosystems that lead to the birth of digital startups but is the core of the entire ecosystem and of its solutions. In this scenario, the paper adopts a different perspective in trying to investigate how being part of an EE based on the development of technological solutions for incumbent firms can yield significant outcomes.

2.2 EE inputs and outcomes

As mentioned above, an EE consists of all the elements necessary to sustain entrepreneurship in a particular territory and generate economic wealth and prosperity (Marinelli *et al.*, 2022; Prahalad, 2005). However, despite the growing interest in this field, the elements that contribute to the development of a successful EE, as well as the expected outcomes, remain ambiguous to date (Nicotra *et al.*, 2018). In addition, there is a lack of clear reasoning on the relationships between EE inputs and EE outcomes (Stam and Spigel, 2016; Alvedalen and Boschma, 2017; Cavallo *et al.*, 2019).

2.2.1 EE's inputs. Defining EE's inputs that lead to EE outcomes is not a straightforward process since the literature focuses on different aspects by sometimes referring to them as either components (e.g. Cohen, 2006), critical ecosystem factors, attributes or enablers (Spigel, 2017; Muñoz *et al.*, 2022). According to Stam (2015) and Nicotra *et al.* (2018), the existing research offers an extensive list of relevant ecosystem factors that are neither exhaustive nor clearly interconnected, providing little explanation of their coherence or their interdependence effects on entrepreneurship. Moreover, empirical evidence on EE emphasises that different ecosystem configurations lead to different entrepreneurial outputs (Suresh and Ramraj, 2012; Dilli *et al.*, 2018; Xie *et al.*, 2021; Brown and Mason, 2017).

As one of the first scholars who studied the components that contribute to a sustainable EE, Cohen (2006) considered networks (formal and informal), universities, the government,

professionals, support and capital services, as well as talent pools. Spigel (2017) identified 11 cultural (supportive culture, history of entrepreneurship), social (worker talent, investment capital, networks, mentors and role models) and material (policy and governance, universities, support services, physical infrastructure, open market) attributes that provide benefits and resources to entrepreneurs. He also acknowledged the importance of relationships among the different attributes. For example, material attributes, such as entrepreneurial support organisations, state-financed startup investment schemes or new university technology and knowledge transfer programmes are unlikely to succeed if not underpinned by complementary social and cultural attributes. Accordingly, Muñoz *et al.* (2022) found that material enablers (i.e. finance and policy) are neither dominant nor necessary for the development of strong entrepreneurial activity. However, despite the prominence of social and cultural enablers over material enablers, they found that a combination of these three attributes can generate high-growth entrepreneurial activity. This confirms Spigel's (2017) assertion that an "ecosystem's attributes do not exist in isolation" (p. 55). More recently, Corrente *et al.* (2019) detected through a stochastic multicriteria acceptability analysis (SMAA) the most important factors that enable and boost the birth and activity of high-growth startups, impacting technology, economy and society: cultural and social norms, government programmes and internal market dynamics. A different approach was taken by Nicotra *et al.* (2018), who were able to identify how critical eco-factors lead to eco-outcomes by providing four different types of eco-inputs and assets: financial capital, institutional capital, knowledge capital and social capital. Financial capital refers to the internal earnings generated by entities or the funds provided by investors to businesses for purchasing real capital equipment or services, producing new goods and/or services and accessing large-sized markets (Sato *et al.*, 2012). This capital is especially crucial in the early stages of venture creation (Kelly and Kim, 2018), as well as in the genesis of the EE itself (Marinelli *et al.*, 2022). Knowledge capital, defined by Nicotra *et al.* (2018) as the amount of know-how within an EE, mostly resides in the availability of qualified human resources and is closely related to the presence of high-quality research universities in a territory (Neck *et al.*, 2004). Besides the relative abundance of entrepreneurial human capital in the EE area (Isenberg, 2011), EEs also attract other entrepreneurial talents from other locations or research entities (Neck *et al.*, 2004; Diaconu and Duțu, 2015), translating into major abilities of searching and exploring new successful opportunities (Roundy and Fayard, 2019). In addition, an important role in knowledge creation and sharing is played by shared cultural values and mindsets, as well as education and training programmes that seek to stimulate entrepreneurship (Bager, 2011; Martin *et al.*, 2013). Indeed, knowledge is a crucial resource that enables firms and systems to gain a competitive advantage (Rajabion *et al.*, 2019), achieve innovation and create value (Del Giudice and Della Peruta, 2016; Zapata-Cantu *et al.*, 2023), ultimately strengthening the relationship with entrepreneurship outcomes. Recently, in open innovation literature, the rise of successful startups has been linked to the possibility of accessing different knowledge sources and the intertwining of knowledge sharing within an ecosystem (Del Sarto *et al.*, 2022, 2023; Fischer *et al.*, 2021; Magliocca *et al.*, 2022). Institutional capital can be considered as the presence of institutions—defined as a set of rules that could either encourage or disincentivise economic activities (Isenberg, 2011; Roundy, 2017a)—and support structures in the form of public organisations supporting the growth and success of firms through either complex business and service support resources (Goswami *et al.*, 2018) and networking relationships (Roundy, 2017b)—within an EE. Incubators, startup centres, co-working areas and accelerators are deemed to participate in the accumulation process of institutional capital in a territory (Romano *et al.*, 2014; Schillaci *et al.*, 2008). As Nicotra *et al.* (2018) pointed out, these organisations act as catalysts that accelerate the entrepreneurial process, thereby enhancing the growth and productivity of new firms, especially in their formative years. This, in turn, has a broader impact at the

ecosystem level by incentivising the creation of new firms. Social capital, viewed as a collective resource, refers to features of social organisations, such as networks, norms and trust, that facilitate action and cooperation for mutual benefit (Putnam, 2001). In the management literature, social capital typically describes the set of relationships and social ties between individuals, organisations and networks that provide rules, values, interactions and opportunities for the members. Social capital has been proven to boost both entrepreneurial initiatives (Bosma *et al.*, 2012) and entrepreneurial culture (Del Giudice *et al.*, 2017).

2.2.2 EE outcomes. The literature on EE outcomes appears as fragmented as that of EE inputs. Overall, there is no consensus on how to define either what a successful EE is or what we should expect in terms of EE outcomes. The reason behind this issue is that different authors refer to different concepts: output (e.g. Stam, 2015), outcome (e.g. Brown and Mason, 2017) or impact (Audretsch and Belitski, 2021). One of the most important outcomes generated by EEs is productive entrepreneurship (Stam, 2015), a concept also used to distinguish EEs from other types of innovation ecosystems. Productive entrepreneurship involves any entrepreneurial activity that directly or indirectly contributes to the net output of an economy or the capacity to produce additional output in a given territory (Stam and Spigel, 2016). Some authors (e.g. O'Connor *et al.*, 2018) simply talked about a general entrepreneurship outcome as an aggregate EE's value while others tried to provide more specific outcome measures, such as the birth of high-growth firms (Henrekson and Johansson, 2010; Stam and Bosma, 2015) or catalyst ventures (Davidsson, 2005), the number of jobs created (Acs and Mueller, 2008; Baptista *et al.*, 2008) and the rate of startups and venture capitalist-backed startups (Cefis and Marsili, 2005; Coad and Rao, 2008; Lerner *et al.*, 2012; Kelly and Kim, 2018). In addition, other authors have evaluated outcomes in terms of the innovations generated (Cefis and Marsili, 2005) based on the granted patents per employee, new markets accessed or new knowledge created (Agarwal *et al.*, 2010). Recently, Audretsch and Belitski (2021) stated that an EE needs to fulfil two different tasks: generate value for the ecosystem and distribute the value among the members of the ecosystem (Clarysse *et al.*, 2014; Vargo and Akaka, 2012; Vargo and Lusch, 2010). To this end, an EE generally has three different types of impact: economic, technological and social. From an economic perspective, the presence of some local factors and resources, along with the exploitation of the associated spillover effects, can contribute to a region's vibrancy, sustainability and viability. This also generates competitive advantages and value for individual firms and sectors within a specific region (Cunningham *et al.*, 2018). The presence of EEs also generates important technological impacts related to regional innovation mechanisms, such as the efficient transformation of ideas and inventions, which translates into technology transfer and innovation processes that spark entrepreneurial activities (Kuratko *et al.*, 2017). Moreover, societal impacts refer to the collective value creation and public good impacts generated by EE, such as the delivery of new products and services that are beneficial for society. In line with this, Nicotra *et al.* (2018) asserted that the ultimate eco-impact of an EE is to create new value in society. To achieve this impact, EEs generate productive entrepreneurship, leading to key eco-outcomes, such as job creation, new ideas and innovation, new methods of commercialisation and increased market efficiency through competition, resulting in a greater variety of goods that better match customer preferences. According to Nicotra *et al.* (2018), these eco-outcomes can operate at different levels, such as the firm level or at a more aggregated level. However, further research is needed to unravel how to create added value in a territory, thereby strengthening the EE and generating a virtuous circle. This highly fragmented literature about both EE inputs and outcomes and their relationships seems to perfectly reflect the multidimensionality of the entrepreneurship concept that does not allow for the identification of a universal approach and requires the effort of studying and combining different streams of research.

3. Conceptual model

Building on the aforementioned literature gaps, this paper aims to explore the relationship between EE inputs and EE outcomes within a digital-technology-driven EE. Specifically, it focuses on how being part of an EE can foster the creation and evolution of new digital technology solutions, which can be beneficial in terms of outcomes for all the actors involved, owing to the availability of specific assets and resources. To address this research question, we develop a conceptual model that mostly draws on Nicotra *et al.*'s (2018) framework (Figure 1). With regard to eco-inputs, we consider financial, institutional, knowledge and social assets as the main EE attributes that can generate potential outcomes. However, different from Nicotra *et al.* (2018), we introduce the important role of DTA, an intermediary output. Defining DTA as the process by which companies develop access to new technologies and transform their potential application into technology breadth and depth (Shen *et al.*, 2022; Blichfeldt and Faullant, 2021), it seems reasonable to assume that, within a technology-driven EE, the entrepreneurial outcomes could be enhanced by facilitating DTA for the participating firms. Digital technologies improve how firms create and deliver products and service innovations, particularly guiding manufacturing industries to adapt to competitive pressures and realise the potential for gaining a competitive advantage based on digital technologies (Shen *et al.*, 2022). Moreover, by joining a technology-driven EE, entrepreneurs can exploit new knowledge developed in R&D units or laboratories that might otherwise remain unexploited. They can also leverage knowledge spillover effects that can significantly impact their future success. In addition, entrepreneurs benefit from learning activities by observing the actions (Spigel, 2017) and behaviors of other entrepreneurs in the ecosystem (Rae, 2004; Roundy, 2016), thereby reinforcing their resource base through expansion, substitution, combination and generation mechanisms and boosting venture creation processes in the light of digital technologies (Von Briel *et al.*, 2019).

4. Methodology

4.1 Research method

Understanding the relationship between the EE inputs and EE outcomes of a digital-technology-driven EE is a relatively new topic that requires deeper investigation. Given the exploratory nature of our research, we employ a qualitative method to conduct an in-depth analysis, thereby obtaining a richer and more in-depth understanding of a complex phenomenon within its real-life context (Eisenhardt, 1989; Yin, 2009). Specifically, we focus on a single case of an Italian EE, FermoTech, that has been purposefully chosen (Patton, 1990) for its revelatory potential (Siggelkow, 2007). A previous study (Marinelli *et al.*, 2022) already identified FermoTech as an innovation-based EE with the primary goal of fostering the design and development of innovative IT technological solutions that help SMEs and Made-in-Italy products compete at an international level. Consequently, FermoTech appeared to represent the appropriate context for our research. In addition, case studies are particularly well-suited for such cases as they offer in-depth insights into the "how" and "why" research questions. Therefore, they are considered one of the most appropriate methods to study EEs as complex systems (Roundy, 2017a).

4.2 Case description

FermoTech is a collaborative applied research platform designed to contribute to and enhance the technological development of local businesses. This EE is located in the Le

Source(s): Authors' elaboration

Figure 1.
Conceptual model of the paper

Marche Region and operates through a fully equipped physical laboratory with cutting-edge hardware and software technological tools. FermoTech is deeply rooted in the regional territory where it originated, an area in central Italy characterised by its high concentration of manufacturing SMEs, many of which operate in strategic "Made-in-Italy" sectors, such as mechatronics and fashion. FermoTech serves as an EE resulting from collaborative relationships among various actors, including a university, two technology supplier companies, the municipality hosting the laboratory and an initial group of "end user" SMEs that have been able to test and implement the first technological development projects. These projects are carried out in a collaborative context in which the end-user companies present their needs and problems to the dedicated team of university researchers who, together with the technology providers, propose and then implement ad hoc technological solutions based on the needs of each company. Each of these projects represents a "use case". Specifically, FermoTech's activities are organised into three strategic technological macro-areas for the technological advancement of manufacturing companies: eXtended Reality, Additive Manufacturing and Data Science. Notably, within the FermoTech ecosystem, a new venture—also named FermoTech—has recently emerged. This entrepreneurial initiative includes some of the same participants from the original project, such as the universities' researchers and technological providers, and now operates in the market with its own business model, with the mission of designing and selling technological solutions based on those created for end users.

4.3 Data collection and analysis

The data were collected through different sources: semi-structured interviews with key informants, direct observation and secondary data. Specifically, the interview process started in November 2022, following the selection of appropriate informants and the development of a semi-structured interview guide. Given that the study aims to uncover the role of EE inputs in generating EE outputs through the development of high-tech solutions, we chose to interview informants from the two most crucial actors within the EE, namely, the researchers and the end users. We selected the actors who have been involved in the creation and development of the EE from the beginning, thereby having an organic and holistic view of the entire process, leading to the expected outcomes. Specifically, we selected two end-user SMEs (E1 and E2), which were the first two companies to join the EE and opt to implement the developed technological solutions. They also represent two of the most important use cases developed so far by FermoTech. Table 1 presents the profiles of the key informants.

The use of semi-structured interviews was appropriate for the exploratory nature of this study as it provided a structured framework while allowing interviewees the flexibility to share their experiences and opinions (Yin, 2009). Each interview lasted for approximately an hour, was

N	Role	Actor	Interview span
E1	General Manager	End-User Company	90
E2	R&D Manager	End-User Company	45
R1	Researcher from the Department of Industrial Engineering and Mathematical Sciences	University	60
R2	Researcher from the Department of Information Engineering	University	50
R3	Researcher from the Department of Management	University	70

Source(s): Authors' elaboration

Table 1. The interviewees' profiles

conducted in Italian, audio-recorded and manually transcribed. The interviews were based on open-ended questions, guided by a semi-standardised protocol, to balance the direction and consistency in the interviewing style with ample freedom in responses. The protocol was crafted considering the extant literature on EEs, digital technologies, EE inputs and EE outcomes. The topics covered during the interviews included the role of companies within the EE, their expectations in terms of DTA, achievements in technological solution development, FermoTech members' approach to digital technologies, work methods and the relationship system used to achieve results. The interviewees were also invited to discuss their educational and professional backgrounds, their role within the FermoTech ecosystem and their expectations.

The interview data were complemented by additional documents, including email exchanges, meeting reports and the author's field notes from their direct participation in FermoTech (all data sources are outlined in Table 2). This approach allowed the researcher to go beyond mere observation of the phenomena, engaging in a comprehensive examination of the entire system of interactions among the involved actors. Such direct involvement not only facilitated knowledge acquisition but also enriched it through active engagement (Ripamonti *et al.*, 2015; Siggelkow, 2007; Yin, 2009). Specifically, the researcher who was directly involved in the process chose to include only the official correspondence among the various actors participating in the project.

All the collected data were entered into NVivo12 software for deductive coding (Miles *et al.*, 2013) by applying the conceptual model discussed in the previous section. Specifically, we searched for the EE inputs (financial assets, institutional assets, knowledge assets, social assets) that contribute to the generation of EE outputs (SME competitiveness and new venture creation) by fostering the process of DTA within the ecosystem.

5. Findings

The findings help shed light on how being part of an EE can help firms generate important outcomes. Specifically, following the proposed conceptual model, it is possible to identify the nature of EE inputs fostering DTA and, consequently, the types of outcomes generated in this context. Furthermore, the results contribute to the understanding of how these elements interact with one another.

5.1 The role of EE inputs in fostering DTA

The findings shed light on some important key aspects of the role played by EE in fostering and facilitating the adoption process of the technological solutions offered by FermoTech ecosystem, which eventually turns out to increase the level of SME end users' competitiveness and new venture creation. First, financial assets appear to be crucial in developing technological solutions within the EE. Specifically, the interviewees refer to three areas in which financial assets occurred. The first is represented by the budget for the purchase of the technology (hardware and software) to be used within FermoTech and allocated to the development of different projects with the company involved. The second is represented by additional

Data sources	Items
Email exchanges	32 emails with 19 different people
Project documents	n. 6 documents
Face-to-face interviews	n. 5 interviews
Direct meeting participation	n. 9 meetings

Source(s): Authors' elaboration

Table 2.
Data sources for the case study

resources allocated to the Municipality of Fermo for the establishment of the physical headquarters of the EE. The third concerns the budget allocated to marketing and communication activities, such as the development of the company's website, aimed at the launch and promotion of the new venture born within FermoTech.

However, all the subjects agree that the most valuable thing about being part of FermoTech is not the technology *per se*, such as the machinery, the physical tools or even the software needed to implement the technological solution, which can be bought through financial assets, but rather lies in the possibility to get access to a "*variety of assets that gravitate around the technology and really allows you to go through a digitalisation process without risking falling into cliches"* (E1). Specifically, FermoTech is perceived by end-user companies as a sort of laboratory where they can benefit from the knowledge and guidance of highly qualified professionals with different backgrounds and skills who operate in an open-innovation environment. As E1 pointed out: "*The 3D printers FermoTech has in its lab are not quite useful for us because we mostly work with metals, such as brass, aluminium and steel. However, we are interested in the general knowledge and competencies that FermoTech can provide about additive manufacturing. We can buy our facilities, but in the end, what we really need in the technology's development and implementation process are the knowledge, skills and competencies gained by participating in such an ecosystem as FermoTech*". Notably, the EE is formed by different actors (university, technological providers, SME end users, municipality) with different backgrounds, skills and competencies. Specifically, university and technological providers play a major role in the development of the technology solutions created by FermoTech. First, the involvement of the university's researchers in each of the three technological areas guarantees a certain level of quality and commitment to the cause, as well as the possibility of continuously developing and improving the technology. The presence of the university as a partner in FermoTech was one of the main factors that drove end users to join FermoTech (Marinelli *et al.*, 2022); however, it also appears to be a critical point in the success of the developed use cases. Having academics and researchers deeply and continuously involved in studying the latest technology solutions ensures that end-user companies are always at the forefront of innovation, thereby also improving their ability to better address any change in the market. Quoting E2, "*FermoTech's structure and way of doing business is certainly a plus. Remarkably, it facilitates the creation of strong relationships and cooperation between end users and academic researchers. For Italian firms, this is not always an easy process because university projects usually involve collaboration contracts that do not always properly reward the researchers who, consequently, are not able to express their full potential"*. The fact that FermoTech employs full-time academic researchers in its labs represents a key aspect for end users. Moreover, it contributes to guaranteed stability to the single projects that are ongoing and, in general, to the EE itself. The assistance of trusted and experienced technological providers, working side by side with researchers, was critical for creating the right environment to ease the process of technological adoption, especially for SMEs. Something that the end users struggled with before entering the EE was dealing with the scouting and selection process of the right technological providers. As E1 said: "*Nowadays, a medium firm like us does not have the proper know-how to navigate the market of technological solution providers, which is fragmented and constantly changing, without guidance. Certainly, you may find high-profile partners that can follow you in the implementation of a single specific technology. However, … I mean, what is the right technology? How can we determine and evaluate what is the right offer?[. . .] So, FermoTech acts as an intermediary between us and the world of technologies.*" Likewise, E2 stated: '*For us, FermoTech is a sort of search engine. In FermoTech, you can find the right partner you need to speak to and get access to the right competencies and expertise without losing time to search for them one by one by yourselves"*. Overall, SMEs are taking advantage of participating as end users in the EE because they are followed and guided during the whole adoption process.

According to the interviewees, the social asset appears as a framework in which projects are developed. It is interesting to consider the perspective of an end-user company, where relationships have guided the adoption of technology. As E1 said: "*Honestly, at the beginning, we were interested in exploring only two out of the three technological solutions: additive manufacturing and extended reality. We operate in B2B markets, so digital marketing and data science solutions seem to not quite fit with our core business activities. However, meeting up with the data science team and seeing what they have been doing with other companies changed our perspective and made us realise some interesting applications regarding how we may exploit this technology in the near future with our customers*".

5.2 The role of DTA in creating EE outcomes

Following the conceptual model, this section highlights how adopting new digital technology solutions created within the FermoTech ecosystem generates important outcomes for all the actors involved in the EE. When asked about the primary benefits of adopting the customised technological solutions developed by FermoTech, end-user companies agreed that these solutions enabled them to better understand how to leverage this new technology for a competitive advantage, thereby also improving their adaptation to competitive pressure. As E1 said: "*FermoTech allowed us to create different solutions for each technological area (additive manufacturing, extended reality and data science). All these solutions have been developed to address specific market gaps, enabling us to adopt them and gain a competitive advantage"*. As also stated by R1, "*SMEs often lack the know-how and resources to pursue complex innovation projects that involve the adoption of specific technologies. However, the adoption of FermoTech solutions has taken these companies to a level of technological advancement that allows them to compete not only with other SMEs but also with larger enterprises. As a matter of fact, SMEs in our territory are forced to compete with larger companies or multinational corporations with well-structured R&D departments"*. From the interviews, it also became evident how DTA enabled SMEs to improve their relationships with both customers and suppliers, streamline operations and deliver innovative products and services. In addition, the adoption process of these solutions by the end users led to the development of a series of use cases that constitute the foundation of the new entrepreneurial initiative of FermoTech. This new venture that has emerged can operate in the market as a provider of technological solutions precisely due to the experience gained with the end-user companies. At the core of the new venture lies the adoption of digital technology, as cited by R3: "*The inspiring principles of the FermoTech EE, combined with the experience gained in the field of digital technologies, now constitute the value proposition with which the new venture is positioning itself in the market"*. All the interviewees agree that the creation of use cases has been the most significant factor in shaping the new venture. This not only provides validation for its solutions, as stated by R3, but also offers a history of data and case studies that make the new venture particularly appealing in the market. The use cases are defined by the interviewees as "*those pilot projects that have led to the creation of the first technological solutions for companies*" (R3). According to R2 and R1, these use cases, made possible by the presence of an EE and involving the joint action of all the main players (universities, technology providers and companies), are one of the aspects that contribute the most to the development of FermoTech as an entrepreneurial reality and its market success. The reasons given by the interviewees vary. The first concerns the fact that they represent "*the first real tangible proof of the activities carried out within the framework of FermoTech*" (R2). According to R1, having generated the first outputs in terms of development and application of technological solutions in companies also contributes to the validation of the FermoTech business idea and its business model. As R1 pointed out, "*One of the main strengths of developing use cases is to make companies aware of the potentiality that lies behind a certain technology. Let me give you an example. Take the 3D printing solution. In my many years of experience in this business, I can tell you that users do not trust these*

tools because they see them as sort of a 'toy', something you can play with for a while but doesn't actually help you improve your performance. Therefore, having the possibility to present the use case of E3, in which we use our 3D machines to print spare parts no longer available in the market, allows us to help other businesses understand how 3D printing can be used to create high-performance components both aesthetically and operationally". In fact, it appears that SMEs are sometimes not even aware of their needs or that there might be a technology that can actually help them reduce production costs, shorten their time to market or improve customer services. In an EE, especially one like FermoTech, where all the actors constantly interact by exchanging knowledge and past experiences, the overall technology adoption process appears easier and more trustworthy from an SME perspective because of its "demonstrative effect". R3 also emphasised the role of use cases in adopting new solutions, stating, "*The use cases already adopted in other industries not only give companies an idea of the technology's potential but also inform them about the resources they may need, issues they may face and feasible solutions to these issues. This is a tipping point in companies' adoption decision process because they feel more inclined to trust you if they have something working to look at*". Moreover, use cases developed with end-user companies within the EE contribute to the creation of technological solutions and validate the business idea of the EE. They also provide valuable information on timing, resources and cost structures, helping define pricing policies for complex solutions. Finally, use cases serve as references to showcase the portfolio of solutions to potential customers, supporting the market entry of the new venture as an innovative technological provider.

6. Discussions

6.1 Theoretical implications

The findings of this study have significant theoretical implications, shedding light on the role of EEs in the development of new technological solutions that can be beneficial in terms of outcomes for all the actors involved (Zahra *et al.*, 2023). In line with the literature and adopting an ecosystem perspective (Nicotra *et al.*, 2018; Wurth *et al.*, 2022; Sussan and Acs, 2017), this study contributes to a detailed understanding of the presented conceptual model in different ways.

The research findings identified the EE inputs that guided the technological adoption processes of all the actors participating in the EE. Based on the classification by Nicotra *et al.* (2018), financial, knowledge, institutional and social assets were identified, whose interconnection created the conditions for effective DTA, which is fundamental for achieving the outcomes. Notably, the findings show how these EE factors are closely intertwined and that clearly distinguishing the importance of each in facilitating the DTA process is difficult. For example, financial-related aspects appear to be crucial (Sato *et al.*, 2012; Marinelli *et al.*, 2022) since they enable the acquisition of cutting-edge technology and the availability of suitable physical spaces, which is the heart of the FermoTech ecosystem and the basis for the development of technological solutions. However, as evident from the findings, having at hand the possibility to use a wide range of different technological equipment (such as 3D printers, data science servers, devices) allow the researchers to increase and constantly update their knowledge and skills, which eventually flow into more personalised and successful solutions for the end users. Hence, through researchers' knowledge acquisition, the financial aspects also indirectly affect the technology adoption process. Consequently, a major role in the DTA process is attributed to knowledge assets, which can be considered in two different ways: the initial know-how that each actor brings to the table and the one generated within the ecosystem as a result of the EE activities over time (Østergaard and Marinova, 2018). Specifically, the first form of knowledge assets comprises the know-how and skills of the FermoTech research team, which are important drivers of DTA among end users and probably the most important ones. The possibility of getting access to highly skilled and qualified employees (De Carolis and Saparito, 2006) eases the

process of adopting new technological solutions since SMEs are provided with guidance throughout the entire process, allowing themselves to accumulate new knowledge, skills and competencies regarding the digital solutions offered inside the ecosystem. In addition, this knowledge, which is also conveyed in the form of training by the research teams, appears to be crucial in raising the awareness of SMEs regarding digital technology opportunities. Therefore, knowledge assets allowed for the proper selection and introduction of these technologies (Del Giudice and Della Peruta, 2016; Arias-Pérez *et al.*, 2021). This occurred within an institutional framework that supported the creation and realisation of individual initiatives (Goswami *et al.*, 2018) by regulating the dense network of relationships among the actors represented by the social asset (Del Giudice *et al.*, 2017). As the case shows, the role of institutions is quite prominent in FermoTech. In particular, the university, with its researchers, represents the engine of technology development processes (Hackett and Dilts, 2004) and the hub of relationships between the EE actors (Roundy, 2017b). However, the institution is also understood as the institutionalisation of roles and processes. Consistent with what was observed by Isenberg (2011) and Roundy (2017a), FermoTech has been able to create and develop the right technological solutions owing to the definition of standard work procedures that describe the ways in which the actors should interact. This approach has also proven particularly effective in avoiding the lack of coordination that could have occurred in an open and decentralised co-design context, like that of the EE under study. This finds concrete expression in the realisation of the use cases.

Furthermore, the study sheds light on how the DTA process in the context of an EE generates important EE outcomes, thus supporting Audretsch and Belitski (2021) implications about how an EE should generate economic, technological and social values for both the entire ecosystem and all its members (Clarysse *et al.*, 2014; Vargo and Akaka, 2012). First, this process increases the competitiveness of firms within the EE through technological development. Second, it promotes the birth of a new entrepreneurial initiative where the use case developed—based on the DTA of end users—represents the core of the value proposition. In the context of an EE, where the technology is at the centre of the EE's value proposition and activities, one of the main outcomes to consider is the increased competitiveness harnessed by the companies who joined the EE. Considering that SMEs are vectors for job and wealth creation, enhancing their competitiveness becomes a major priority in the current scenario and a well-expected outcome. In addition, an EE that fosters DTA within a certain territory will also favour the likelihood of entrepreneurs pursuing new entrepreneurial opportunities, thus impacting another important outcome, namely, the creation and survival of new ventures. Third, considering the DTA as a process by which companies develop their access to new technologies and transform their potential application into technology breadth and depth (Shen *et al.*, 2022; Blichfeldt and Faullant, 2021), we show in this study how the potential of customised technological solutions generated by specific EE inputs can be used to generate important entrepreneurial outcomes. Specifically, we highlight the important role of developing use cases as a first form of DTA since they not only help SMEs understand how to use the technology to better compete in the market but also allow the FermoTech entrepreneurial reality to acquire experience in terms of workflow, operations and market approach. However, the outcomes in terms of creating new ventures and SME competitiveness are achieved by the entire EE only if the right EE inputs are put into place. In conclusion, the present paper contributes to the existing literature on EE by shedding light on the existing relationships between EE inputs and EE outcomes (Stam and Spigel, 2016; Alvedalen and Boshma, 2017; Cavallo *et al.*, 2019). Specifically, we not only identified the role of specific EE inputs in fostering the DTA processes but also defined two important EE outcomes: SME competitiveness and new venture creation. Figure 2 summarises what we have just discussed by highlighting the relationship among EE inputs, DTA process and EE outcomes.

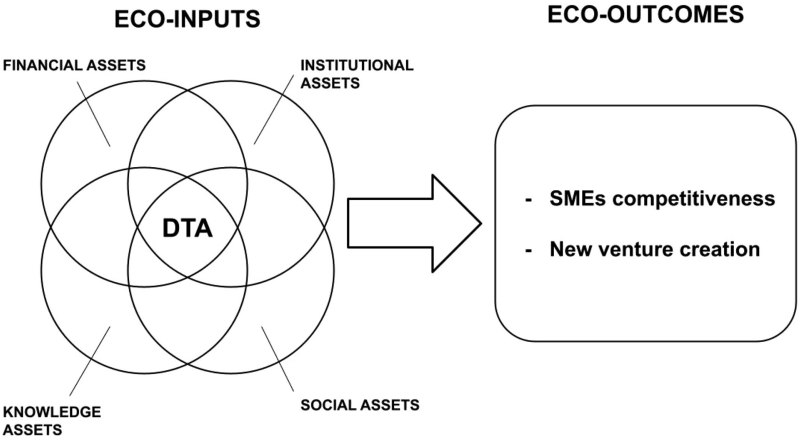

Figure 2.
The role of EE inputs and DTA in generating EE outcomes

Source(s): Authors' elaboration

6.2 Practical implications

The findings of this study have important practical implications for EE stakeholders. The study emphasises the significance of financial resources, technological assets and knowledge in achieving the desired outcomes. It highlights the need for adequate financial investments to acquire cutting-edge technology, which serves as the backbone of the ecosystem and supports new venture creation. Policymakers, investors and ecosystem builders should recognise the importance of providing financial support to facilitate technology adoption by SMEs and encourage the growth of new ventures. Moreover, the study underscores the value of knowledge exchange and collaboration within the ecosystem. Ecosystem builders should facilitate interactions between research teams, SMEs and new ventures to promote knowledge transfer and skill development. Implementing mechanisms that enable SMEs to access highly skilled employees and receive guidance throughout the technology adoption process can enhance their competitiveness. Similarly, providing training opportunities and entrepreneurial knowledge to new ventures can help them refine their business models and succeed in the market. The study also emphasises the crucial role of institutions within the ecosystem. Universities, as key institutional actors, are central to technology development processes and act as hubs for relationships among ecosystem actors. Establishing standard work procedures and clear roles within the ecosystem can promote effective coordination and mitigate potential coordination challenges. Policymakers and ecosystem builders should focus on institutionalisation processes and encourage the definition of standardised procedures to facilitate collaboration and maximise the benefits of the ecosystem. Furthermore, the study highlights the importance of technology management within the EE. While digital technologies are often viewed as instrumental, the findings emphasise the management aspects of technology as functional elements for the outcomes of the EE. This suggests that ecosystem actors should prioritise the proper management of digital technologies, including access, study and design. Orchestrating the efforts of various actors within the ecosystem is crucial for achieving the desired outcomes, such as creating new ventures and driving digital technology.

7. Conclusions, limitations and future research

Digital technologies have profoundly changed firms' ways of doing business, reshaped organisational processes and structures and ultimately affected entrepreneurial performances.

However, despite its importance, little attention has been allocated to understanding the role of digital technology within an EE (Nambisan, 2017). In this scenario, the present paper addresses some important gaps in the EE and digital technology literature through a qualitative case study of the Italian EE FermoTech (Elia *et al.*, 2020). Specifically, it explores the relationships between the EE inputs and the EE outcomes of a digital-technology-driven EE. By proposing a conceptual model, the findings support the idea that digital technology within an EE helps boost entrepreneurial activities and outcomes in a geographically defined context (Von Briel *et al.*, 2019) when specific EE inputs are exploited. Among these inputs, financial, knowledge, institutional and social assets are crucial in favouring the DTA of the firms participating in the EE. Through this intermediary output, the EE's inputs can generate potential outcomes in terms of SME competitiveness and new venture creation.

The study has several limitations, some of which offer interesting avenues for future research. First, the study is exploratory in nature and is based on a single case study within a specific context, thereby limiting the generalisability of the results. Future research should investigate the proposed conceptual model and relationships in other contexts, for example, within EEs settled in different countries, to validate the findings and refine the model. This may also affect the relationship between EE inputs and outcomes; thus, future investigations to validate the proposed conceptual model and offer opportunities for refinements are crucial.

Second, in collecting the findings through semi-structured interviews, we mainly considered some key informants inside the EEs, specifically the researchers and the managers of the end-user companies. Although the informants' reliability was ensured by following an accurate and pre-established methodological protocol, this internal perspective may limit the scope of the analysis. Consequently, we encourage researchers to gather additional insights from a wider range of stakeholders. In doing so, future studies will focus more on the performance of both the SMEs involved and the new venture and may discover other important outcomes generated within EEs.

References

Acs, Z.J. and Mueller, P. (2008), "Employment effects of business dynamics: mice, gazelles and elephants", *Small Business Economics*, Vol. 30, pp. 85-100.

Agarwal, R., Audretsch, D. and Sarkar, M.B. (2010), "Knowledge spillovers and strategic entrepreneurship", *Strategic Entrepreneurship Journal*, Vol. 4 No. 4, pp. 271-283.

Alvedalen, J. and Boschma, R. (2017), "A critical review of entrepreneurial ecosystems research: towards a future research agenda", *European Planning Studies*, Vol. 25 No. 6, pp. 887-903.

Arias-Pérez, J., Velez-Ocampo, J. and Cepeda-Cardona, J. (2021), "Strategic orientation toward digitalization to improve innovation capability: why knowledge acquisition and exploitation through external embeddedness matter", *Journal of Knowledge Management*, Vol. 25 No. 5, pp. 1319-1335.

Audretsch, D.B. and Belitski, M. (2021), "Towards an entrepreneurial ecosystem typology for regional economic development: the role of creative class and entrepreneurship", *Regional Studies*, Vol. 55 No. 4, pp. 735-756.

Autio, E. (2017), "Digitalisation, ecosystems, entrepreneurship and policy. Perspectives into topical issues in society and ways to support political decision making", *Government's Analysis, Research and Assessment Activities Policy Brief*, Vol. 20, pp. 1-12.

Autio, E., Nambisan, S., Thomas, L.D. and Wright, M. (2018), "Digital affordances, spatial affordances, and the genesis of entrepreneurial ecosystems", *Strategic Entrepreneurship Journal*, Vol. 12 No. 1, pp. 72-95.

Bager, T. (2011), "Entrepreneurship education and new venture creation: a comprehensive approach", in *Handbook of Research on New Venture Creation*, Edward Elgar Publishing.

Baptista, R., Escária, V. and Madruga, P. (2008), "Entrepreneurship, regional development and job creation: the case of Portugal", *Small Business Economics*, Vol. 30, pp. 49-58.

Bereznoy, A., Meissner, D. and Scuotto, V. (2021), "The intertwining of knowledge sharing and creation in the digital platform based ecosystem. A conceptual study on the lens of the open innovation approach", *Journal of Knowledge Management*, Vol. 25 No. 8, pp. 2022-2042.

Blichfeldt, H. and Faullant, R. (2021), "Performance effects of digital technology adoption and product and service innovation–A process-industry perspective", *Technovation*, Vol. 105, 102275.

Boland, R.J., Jr., Lyytinen, K. and Yoo, Y. (2007), "Wakes of innovation in project networks: the case of digital 3-D representations in architecture, engineering, and construction", *Organization Science*, Vol. 18 No. 4, pp. 631-647.

Bosma, N.S., Stam, E. and Wennekers, S. (2012), "Entrepreneurial employee activity: a large scale international study", *Discussion Paper Series/Tjalling C. Koopmans Research Institute*, Vol. 12 No. 12, pp. 1-10.

Bouncken, R.B., Kraus, S. and Roig-Tierno, N. (2021), "Knowledge-and innovation-based business models for future growth: digitalized business models and portfolio considerations", *Review of Managerial Science*, Vol. 15 No. 1, pp. 1-14.

Brown, R. and Mason, C. (2017), "Looking inside the spiky bits: a critical review and conceptualisation of entrepreneurial ecosystems", *Small Business Economics*, Vol. 49, pp. 11-30.

Cavallo, A., Ghezzi, A. and Balocco, R. (2019), "Entrepreneurial ecosystem research: present debates and future directions", *International Entrepreneurship and Management Journal*, Vol. 15, pp. 1291-1321.

Cefis, E. and Marsili, O. (2005), "A matter of life and death: innovation and firm survival", *Industrial and Corporate Change*, Vol. 14 No. 6, pp. 1167-1192.

Clarysse, B., Wright, M., Bruneel, J. and Mahajan, A. (2014), "Creating value in ecosystems: crossing the chasm between knowledge and business ecosystems", *Research Policy*, Vol. 43 No. 7, pp. 1164-1176.

Coad, A. and Rao, R. (2008), "Innovation and firm growth in high-tech sectors: a quantile regression approach", *Research Policy*, Vol. 37 No. 4, pp. 633-648.

Cohen, B. (2006), "Sustainable valley entrepreneurial ecosystems", *Business Strategy and the Environment*, Vol. 15 No. 1, pp. 1-14.

Colombo, M.G., Dagnino, G.B., Lehmann, E.E. and Salmador, M. (2019), "The governance of entrepreneurial ecosystems", *Small Business Economics*, Vol. 52, pp. 419-428.

Corrente, S., Greco, S., Nicotra, M., Romano, M. and Schillaci, C.E. (2019), "Evaluating and comparing entrepreneurial ecosystems using SMAA and SMAA-S", *The Journal of Technology Transfer*, Vol. 44, pp. 485-519.

Crupi, A., Del Sarto, N., Di Minin, A. and Kenney, M.F. (2022), "Disentangling the importance of digital platforms and absorptive capacity in digital business ecosystems", in *Handbook on Digital Business Ecosystems*, Edward Elgar Publishing, pp. 40-49.

Cunningham, J.A., Menter, M. and O'Kane, C. (2018), "Value creation in the quadruple helix: a micro level conceptual model of principal investigators as value creators", *R&D Management*, Vol. 48 No. 1, pp. 136-147.

Davidsson, P. (2005), "Methodological approaches to entrepreneurship: past research and suggestions for the future", *Small Enterprise Research*, Vol. 13 No. 1, pp. 1-21.

De Carolis, D.M. and Saparito, P. (2006), "Social capital, cognition, and entrepreneurial opportunities: a theoretical framework", *Entrepreneurship Theory and Practice*, Vol. 30 No. 1, pp. 41-56.

Del Giudice, M. and Della Peruta, M.R. (2016), "The impact of IT-based knowledge management systems on internal venturing and innovation: a structural equation modeling approach to corporate performance", *Journal of Knowledge Management*, Vol. 20 No. 3, pp. 484-498.

Del Giudice, M., Nicotra, M., Romano, M. and Schillaci, C.E. (2017), "Entrepreneurial performance of principal investigators and country culture: relations and influences", *The Journal of Technology Transfer*, Vol. 42, pp. 320-337.

Del Sarto, N., Cazares, C.C. and Di Minin, A. (2022), "Startup accelerators as an open environment: the impact on startups' innovative performance", *Technovation*, Vol. 113, 102425.

Del Sarto, N., Ferrigno, G., Parida, V. and Di Minin, A. (2023), "Do start-ups benefit from coworking spaces? An empirical analysis of accelerators' programs", *Review of Managerial Science*, Vol. 17, pp. 2471–2502.

DeSanctis, G. and Poole, M.S. (1994), "Capturing the complexity in advanced technology use: adaptive structuration theory", *Organization Science*, Vol. 5 No. 2, pp. 121-147.

Diaconu, M. and Duțu, A. (2015), "The role of the modern university in supporting the entrepreneurial ecosystem", *European Journal of Interdisciplinary Studies*, Vol. 7 No. 1, pp. 11-24.

Dilli, S., Elert, N. and Herrmann, A.M. (2018), "Varieties of entrepreneurship: exploring the institutional foundations of different entrepreneurship types through 'Varieties-of-Capitalism' arguments", *Small Business Economics*, Vol. 51, pp. 293-320.

Eisenhardt, K.M. (1989), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

Elia, G., Margherita, A. and Passiante, G. (2020), "Digital entrepreneurship ecosystem: how digital technologies and collective intelligence are reshaping the entrepreneurial process", *Technological Forecasting and Social Change*, Vol. 150, 119791.

Endres, H., Huesig, S. and Pesch, R. (2021), "Digital innovation management for entrepreneurial ecosystems: services and functionalities as drivers of innovation management software adoption", *Review of Managerial Science*, Vol. 16, pp. 135-156.

Fischer, B., Guerrero, M., Guimón, J. and Schaeffer, P.R. (2021), "Knowledge transfer for frugal innovation: where do entrepreneurial universities stand?", *Journal of Knowledge Management*, Vol. 25 No. 2, pp. 360-379.

Goswami, K., Mitchell, J.R. and Bhagavatula, S. (2018), "Accelerator expertise: understanding the intermediary role of accelerators in the development of the Bangalore entrepreneurial ecosystem", *Strategic Entrepreneurship Journal*, Vol. 12 No. 1, pp. 117-150.

Hackett, S.M. and Dilts, D.M. (2004), "A systematic review of business incubation research", *The Journal of Technology Transfer*, Vol. 29 No. 1, pp. 55-82.

Henrekson, M. and Johansson, D. (2010), "Gazelles as job creators: a survey and interpretation of the evidence", *Small Business Economics*, Vol. 35, pp. 227-244.

Isenberg, D.J. (2011), *The Entrepreneurship Ecosystem Strategy as a New Paradigm for Economic Policy: Principles for Cultivating Entrepreneurship*, Paper Presented at the Institute of International European Affairs, Dublin, Ireland.

Jiang, H., Yang, J. and Liu, W. (2022), "Innovation ecosystem stability and enterprise innovation performance: the mediating effect of knowledge acquisition", *Journal of Knowledge Management*, Vol. 26 No. 11, pp. 378-400.

Kallinikos, J. (2007), *The Consequences of Information: Institutional Implications of Technological Change*, Edward Elgar Publishing, Cheltenham.

Kallinikos, J., Aaltonen, A. and Marton, A. (2013), "The ambivalent ontology of digital artifacts", *MIS Quarterly*, Vol. 37 No. 2, pp. 357-370.

Kelly, R. and Kim, H. (2018), "Venture capital as a catalyst for commercialization and high growth", *The Journal of Technology Transfer*, Vol. 43, pp. 1466-1492.

Kuratko, D.F., Fisher, G., Bloodgood, J.M. and Hornsby, J.S. (2017), "The paradox of new venture legitimation within an entrepreneurial ecosystem", *Small Business Economics*, Vol. 49, pp. 119-140.

Leonardi, P.M. (2011), "When flexible routines meet flexible technologies: affordance, constraint, and the imbrication of human and material agencies", *MIS Quarterly*, Vol. 35 No. 1, pp. 147-167.

Lerner, J., Leamon, A. and Hardymon, F. (2012), *Venture Capital, Private Equity, and the Financing of Entrepreneurship: the Power of Active Investing*, John Wiley & Sons, New York.

Magliocca, P., Herold, D.M.M., Canestrino, R., Temperini, V. and Albino, V. (2022), "The role of start-ups as knowledge brokers: a supply chain ecosystem perspective", *Journal of Knowledge Management*, (ahead-of-print).

Malecki, E.J. (2018), "Entrepreneurship and entrepreneurial ecosystems", *Geography Compass*, Vol. 12 No. 3, e12359.

Marinelli, L., Bartoloni, S., Pascucci, F., Gregori, G.L. and Briamonte, M.F. (2022), "Genesis of an innovation-based entrepreneurial ecosystem: exploring the role of intellectual capital", *Journal of Intellectual Capital*, Vol. 24 No. 1, pp. 10-34.

Mars, M.M., Bronstein, J.L. and Lusch, R.F. (2012), "The value of a metaphor: organizations and ecosystems", *Organizational Dynamics*, Vol. 41 No. 4, pp. 271-280.

Martin, B.C., McNally, J.J. and Kay, M.J. (2013), "Examining the formation of human capital in entrepreneurship: a meta-analysis of entrepreneurship education outcomes", *Journal of Business Venturing*, Vol. 28 No. 2, pp. 211-224.

Mason, C. and Brown, R. (2014), "Entrepreneurial ecosystems and growth oriented entrepreneurship", *Final Report to OECD, Paris*, Vol. 30 No. 1, pp. 77-102.

Miles, M.B., Huberman, A.M. and Saldana, J. (2013), *Qualitative Data Analysis : A Methods Sourcebook (Incorporated)*, SAGE Publications, Thousand Oaks, CA.

Moore, J.F. (1993), "Predators and prey: a new ecology of competition", *Harvard Business Review*, Vol. 71 No. 3, pp. 75-86.

Muñoz, P., Kibler, E., Mandakovic, V. and Amorós, J.E. (2022), "Local entrepreneurial ecosystems as configural narratives: a new way of seeing and evaluating antecedents and outcomes", *Research Policy*, Vol. 51 No. 9, 104065.

Nambisan, S. (2017), "Digital entrepreneurship: toward a digital technology perspective of entrepreneurship", *Entrepreneurship Theory and Practice*, Vol. 41 No. 6, pp. 1029-1055.

Neck, H.M., Meyer, G.D., Cohen, B. and Corbett, A.C. (2004), "An entrepreneurial system view of new venture creation", *Journal of Small Business Management*, Vol. 42 No. 2, pp. 190-208.

Nicotra, M., Romano, M., Del Giudice, M. and Schillaci, C.E. (2018), "The causal relation between entrepreneurial ecosystem and productive entrepreneurship: a measurement framework", *The Journal of Technology Transfer*, Vol. 43, pp. 640-673.

Østergaard, A. and Marinova, S.T. (2018), "Human capital in the entrepreneurship ecosystem", *International Journal of Entrepreneurship and Small Business*, Vol. 35 No. 3, pp. 371-390.

O'Connor, A., Stam, E., Sussan, F. and Audretsch, D.B. (2018), "Entrepreneurial ecosystems", *International Studies in Entrepreneurship*, Vol. 38, pp. 1-21.

Parente, R., Rong, K., Geleilate, J.M.G. and Misati, E. (2019), "Adapting and sustaining operations in weak institutional environments: a business ecosystem assessment of a Chinese MNE in Central Africa", *Journal of International Business Studies*, Vol. 50, pp. 275-291.

Patton, M.Q. (1990), *Qualitative Evaluation and Research Methods*, SAGE Publications, New York.

Prahalad, C. (2005), *The Fortune at the Bottom of the Pyramid: Eradicating Poverty through Profits*, Wharton School Publishing/Pearson, London.

Putnam, R. (2001), "Social capital: measurement and consequences", *Canadian Journal of Policy Research*, Vol. 2 No. 1, pp. 41-51.

Rae, D. (2004), "Practical theories from entrepreneurs' stories: discursive approaches to entrepreneurial learning", *Journal of Small Business and Enterprise Development*, Vol. 11 No. 2, pp. 195-202.

Rajabion, L., Shaltooki, A.A., Taghikhah, M., Ghasemi, A. and Badfar, A. (2019), "Healthcare big data processing mechanisms: the role of cloud computing", *International Journal of Information Management*, Vol. 49, pp. 271-289.

Ripamonti, S., Galuppo, L., Gorli, M. and Scaratti, G. (2015), "Pushing action research toward reflexive practice", *Journal of Management Inquiry*, Vol. 25 No. 1, pp. 55-68, doi: 10.1177/1056492615584972/.

Romano, A., Passiante, G., Del Vecchio, P. and Secundo, G. (2014), "The innovation ecosystem as booster for the innovative entrepreneurship in the smart specialisation strategy", *International Journal of Knowledge-Based Development*, Vol. 5 No. 3, pp. 271-288.

Roundy, P.T. (2016), "Start-up community narratives: the discursive construction of entrepreneurial ecosystems", *The Journal of Entrepreneurship*, Vol. 25 No. 2, pp. 232-248.

Roundy, P.T. (2017a), "'Small town' entrepreneurial ecosystems: implications for developed and emerging economies", *Journal of Entrepreneurship in Emerging Economies*, Vol. 9 No. 3, pp. 238-262.

Roundy, P.T. (2017b), "Hybrid organizations and the logics of entrepreneurial ecosystems", *International Entrepreneurship and Management Journal*, Vol. 13, pp. 1221-1237.

Roundy, P.T. and Fayard, D. (2019), "Dynamic capabilities and entrepreneurial ecosystems: the micro-foundations of regional entrepreneurship", *The Journal of Entrepreneurship*, Vol. 28 No. 1, pp. 94-120.

Sato, Y., Tabuchi, T. and Yamamoto, K. (2012), "Market size and entrepreneurship", *Journal of Economic Geography*, Vol. 12 No. 6, pp. 1139-1166.

Schillaci, C.E., Romano, M. and Longo, M.C. (2008), *Hybrid Organizational Forms and Academic Entrepreneurship: The Evolution of Italian University Incubators*, Giappichelli, Torino.

Shen, L., Zhang, X. and Liu, H. (2022), "Digital technology adoption, digital dynamic capability, and digital transformation performance of textile industry: moderating role of digital innovation orientation", *Managerial and Decision Economics*, Vol. 43 No. 6, pp. 2038-2054.

Siggelkow, N. (2007), "Persuasion with case studies", *Academy of Management Journal*, Vol. 50 No. 1, pp. 20-24.

Spigel, B. (2017), "The relational organization of entrepreneurial ecosystems", *Entrepreneurship Theory and Practice*, Vol. 41 No. 1, pp. 49-72.

Stam, E. (2015), "Entrepreneurial ecosystems and regional policy: a sympathetic critique", *European Planning Studies*, Vol. 23 No. 9, pp. 1759-1769.

Stam, E. and Bosma, N. (2015), *Local Policies for High-Growth Firms*, The Oxford Handbook of Local Competitiveness, Oxford, pp. 286-305.

Stam, F.C. and Spigel, B. (2016), "Entrepreneurial ecosystems", *USE Discussion Paper Series*, Vol. 16 No. 13, pp. 1-18.

Stam, E. and Van de Ven, A. (2021), "Entrepreneurial ecosystem elements", *Small Business Economics*, Vol. 56, pp. 809-832.

Steininger, D.M. (2019), "Linking information systems and entrepreneurship: a review and agenda for IT-associated and digital entrepreneurship research", *Information Systems Journal*, Vol. 29 No. 2, pp. 363-407.

Suresh, J. and Ramraj, R. (2012), "Entrepreneurial ecosystem: case study on the influence of environmental factors on entrepreneurial success", *European Journal of Business and Management*, Vol. 4 No. 16, pp. 95-101.

Sussan, F. and Acs, Z.J. (2017), "The digital entrepreneurial ecosystem", *Small Business Economics*, Vol. 49, pp. 55-73.

Van de Ven, H. (1993), "The development of an infrastructure for entrepreneurship", *Journal of Business Venturing*, Vol. 8 No. 3, pp. 211-230.

Vargo, S.L. and Akaka, M.A. (2012), "Value cocreation and service systems (re) formation: a service ecosystems view", *Service Science*, Vol. 4 No. 3, pp. 207-217.

Vargo, S.L. and Lusch, R.F. (2010), "From repeat patronage to value co-creation in service ecosystems: a transcending conceptualization of relationship", *Journal of Business Market Management*, Vol. 4, pp. 169-179.

Von Briel, F., Schneider, C. and Lowry, P.B. (2019), "Absorbing knowledge from and with external partners: the role of social integration mechanisms", *Decision Sciences*, Vol. 50 No. 1, pp. 7-45.

Wurth, B., Stam, E. and Spigel, B. (2022), "Toward an entrepreneurial ecosystem research program", *Entrepreneurship Theory and Practice*, Vol. 46 No. 3, pp. 729-778, doi: 10.1177/1042258721998948.

Xie, Z., Wang, X., Xie, L. and Duan, K. (2021), "Entrepreneurial ecosystem and the quality and quantity of regional entrepreneurship: a configurational approach", *Journal of Business Research*, Vol. 128, pp. 499-509.

Yin, R.K. (2009), *Case Study Research: Design and Methods*, 4th ed., SAGE Publications, New York.

Yoo, Y., Boland, R.J., Jr., Lyytinen, K. and Majchrzak, A. (2012), "Organizing for innovation in the digitized world", *Organization Science*, Vol. 23 No. 5, pp. 1398-1408.

Zahra, S.A. and Nambisan, S. (2012), "Entrepreneurship and strategic thinking in business ecosystems", *Business Horizons*, Vol. 55 No. 3, pp. 219-229.

Zahra, S.A., Liu, W. and Si, S. (2023), "How digital technology promotes entrepreneurship in ecosystems", *Technovation*, Vol. 119, 102457.

Zapata-Cantu, L., Sanguino, R., Barroso, A. and Nicola-Gavrilă, L. (2023), "Family business adapting a new digital-based economy: opportunities and challenges for future research", *Journal of the Knowledge Economy*, Vol. 14 No. 1, pp. 408-425.

Zheng, H., Li, D., Wu, J. and Xu, Y. (2014), "The role of multidimensional social capital in crowdfunding: a comparative study in China and US", *Information and Management*, Vol. 51 No. 4, pp. 488-496.

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