



Enhancing digital transformation in SMEs: The dynamic capabilities of innovation intermediaries within ecosystems

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ABSTRACT

While the dynamic capabilities framework discusses the sensing, seizing, and transformation capabilities of organisations, we lack knowledge of the specific dynamic capabilities of intermediaries that support collaborations leading to the digital transformation of small and medium enterprises (SMEs). The specific role of intermediaries supporting collaboration between SMEs and the ecosystem, the unique barriers confronted by SMEs, and the long-term focus required for digital transformation suggest that intermediaries should deploy specific dynamic capabilities. By conducting in-depth interviews with innovation intermediaries, SMEs, and other ecosystem actors in the Ostrobothnia region of Finland, we make three original contributions to the dynamic capability framework. First, while the literature has discussed spotting opportunities and bringing partners together as *sensing* dynamic capability, we make an original contribution by demonstrating the ‘*ancillary opportunity spotting capability*’ of intermediaries. This includes intermediaries spotting opportunities to develop digital technologies to address business, environmental, or social challenges of ecosystem actors (e.g. developing carbon-neutral solutions) where SME digital transformation is only indirectly achieved: hence, this is described as an ancillary opportunity. Second, while the literature has discussed that the *seizing* capability involves exploiting opportunities by using resources, we identified that intermediaries leverage ‘*business model co-creation capability*’ for seizing. This predominantly consists of them co-creating – with the stakeholders of SMEs (i.e. customers, suppliers, and competitors) – the business models of SMEs for digital transformation. Third, as a *transformation* capability, intermediaries leverage ‘*ecosystem revamping capability*’ for continued and scaled-up SME digital transformation, the capabilities associated with which include altering opportunity and ecosystem structures, bridging inter-ecosystem collaborations, and deploying international best practices. Our finding has implications for intermediaries, SMEs, and policymakers keen to enhance SME digital transformation by enabling intermediaries to develop required dynamic capabilities.

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1. Introduction

Digital transformation has compelled ecosystem actors¹ to deploy new digital technologies (e.g. blockchains, Internet of Things, artificial intelligence, and robotics) to achieve operational efficiency and respond to changing market needs (Sestino et al., 2020; Imran et al., 2021; Shahzad et al., 2024a,b; Shahzad and Hafeez, 2022). Innovation intermediaries – key actors supporting collaboration among ecosystem actors – (De Silva et al., 2022; Howells, 2006; Kivimaa et al., 2019) increasingly offer support for the digital transformation of ecosystem actors by way of supporting collaborations aimed at the development and adoption of new technologies (Rossi et al., 2022). Compared with the rest of the ecosystem actors, small and medium enterprises (SMEs)² struggle to keep up with digital transformation since they lack internal R&D facilities, access to innovation networks, and cognitive abilities (Rossi et al., 2020, 2022) required for innovation. Therefore, collaborating with different actors in an ecosystem is perceived as crucial for SMEs to develop and deploy innovative solutions (Järvi et al., 2018). Still, they need support to form collaborations and use the collaborative output for SME digital transformation. Considering the role of intermediaries (Adner, 2017; Adner and Kapoor, 2010; Jacobides et al., 2018; Lingens et al., 2021), they are better placed to support ecosystem collaborations (Garengo, 2019; Randhawa et al., 2022) that would enable SMEs with their digital transformation. Such a role would require intermediaries to establish collaborations that generate value for partners and enable SMEs in their digital transformation process.

Past research has indicated that to coordinate digital knowledge exchange processes and facilitate the digital transformation of SMEs, intermediaries should leverage specific capabilities (Crupi et al., 2020), and different mechanisms (Sassanelli and Terzi, 2022; Prodi et al., 2022; Li et al., 2023). The general literature about the capabilities of intermediaries has highlighted the importance of (a) technological, marketing, and collaboration capabilities to enable clients' open service innovation (Randhawa et al., 2018); (b) innovation search process and technology transfer to build absorptive capacity of collaborators (Garengo, 2019); (c) knowledge-based practices for long-term survival of intermediary function (De Silva et al., 2018); and managing resource inflow and outflow between collaborating parties (De Silva et al., 2022; Järvi et al., 2018) to build purposeful innovations (Randhawa et al., 2016) and shape an innovation ecosystem (Randhawa et al., 2022). Despite these efforts, there is a lack of understanding of the distinct capabilities intermediaries may leverage to mobilise resources and coordinate ecosystem collaborations to support the digital transformation of SMEs.

The specific role of intermediaries supporting collaborations between SMEs and the ecosystem, the unique barriers confronted by SMEs, and the long-term focus required for digital transformation suggest that intermediaries should deploy specific dynamic capabilities (Crupi et al., 2020; Sassanelli and Terzi, 2022; Prodi et al., 2022; Li et al., 2023). Therefore, this paper builds on the dynamic capability's framework (i.e. higher-order idiosyncratic form of organisational and strategic capabilities) that discusses opportunity spotting (sensing)-, integrating and building (seizing)-, and reconfiguring (transformation)- capabilities of organisations (Teece, 2007). The relevance of the dynamic capability's framework is further justified by prior research on digital transformation, as these studies (Warner and Wäger, 2019; Scutto et al., 2021, 2023; Khurana et al., 2022; Soluk et al., 2023; Soluk and Kammerlander, 2021; Teoh et al., 2023) have confirmed the importance of dynamic capabilities for the digital transformation. However, previous research has given limited attention to the specific dynamic capabilities of innovation intermediaries that coordinate and facilitate collaborations supporting the digital transformation of SMEs. Therefore, it is extremely important to study how the dynamic capabilities of intermediaries enable them to form and support collaborations among ecosystem actors (Hernández-Chea et al., 2021) for the digital transformation of SMEs.

Against this backdrop, we ask the following research question: “*How do innovation intermediaries leverage their dynamic capabilities to facilitate the digital transformation of SMEs within an ecosystem?*” to answer the research questions, we conducted 33 in-depth interviews with different ecosystem actors i.e., innovation intermediaries, SMEs (who are interested in digital transformation), and their collaborating actors such as micro firms, and large firms located in the Ostrobothnia region of Finland. Such a qualitative research design helped us to retrieve rich information on how intermediaries use their dynamic capabilities for collaborations leading to SMEs' digital transformation.

We make three key original contributions to the dynamic capability framework (Teece, 2007) by identifying specific dynamic capabilities of innovation intermediaries (Foss et al., 2023; Randhawa et al., 2022; Abi Saad et al., 2024; De Silva et al., 2022) required to enable SME digital transformation. First, while the literature has discussed spotting opportunities and bringing partners together (i.e. *sensing*) as a dynamic capability of organisations (Teece, 2007) and intermediaries (Randhawa et al., 2022), we make an original contribution by demonstrating that to achieve SME digital transformation, intermediaries should leverage capabilities to spot opportunities to develop digital technologies that address business, environmental or social challenges of ecosystem actors (e.g. developing carbon-neutral solutions). Even though the aim is to achieve SME digital transformation, the identified opportunities only indirectly achieve the digital transformation of SMEs. Identifying such a common challenge of ecosystem actors as the primary objective of the collaboration was important to make these actors collaborate with SMEs. It is through these collaborations; that SME digital transformation is materialised. Hence, we name this capability of intermediaries required at the *sensing* stage as ‘*ancillary opportunity spotting capability*’. Especially at the stage of spotting opportunities, intermediaries' ability to secure public funding for such projects is key due to the resource scarcities of SMEs, and identifying collaborators, who are likely to continue interactions with SMEs beyond the project lifetime, is important since digital transformation is a long-term process. Second, we find that the capabilities of

¹ A key feature of an ecosystem is interdependent actors connected for value creation, which we mean by the use of the term “ecosystem” in this study (Adner, 2017; Scaringella and Radziwon, 2018).

² SMEs are defined as those organisations with less than 250 employees (BEIS, 2023).

intermediaries to exploit the identified opportunities for SME digital transformation (*seizing*) predominantly consist of them co-creating new SME business models in collaboration with stakeholders of SMEs (i.e. customers, suppliers and competitors). Thus, we named this capability of intermediaries at the *seizing* stage '*business model co-creation capability*'. This finding extends the literature that has discussed the capabilities of intermediaries to actively engage in collaborative projects (De Silva et al., 2022; Randhawa et al., 2016) by outlining how they support SMEs to integrate the output of the collaboration by bringing together other relevant stakeholders to achieve long-term digital transformation. Third, the paper contributes to the literature by identifying the capabilities of intermediaries that ensure continued and scaled-up SME digital transformation. These capabilities include altering opportunity and ecosystem structures, bridging inter-ecosystem collaborations, and deploying international best practices that are crucial for SMEs to scale up digital transformation. Therefore, we named this capability of intermediaries at the *transformation* stage '*ecosystem revamping capability*'. As such, our paper contributes to the dynamic capability framework (Teece, 2007) by demonstrating the capabilities of intermediaries – in terms of the stages of the SME digital transformation process – in spotting ancillary opportunities (i.e. sensing capability), in co-creating SME business models (i.e. seizing capability) and in moving from organisational influence on ecosystem influence (i.e. transformation capability), which ensures continuous and scaled-up SME digital transformation.

Our finding has implications for intermediaries, SMEs, and policymakers keen to enhance SME digital transformation by enabling intermediaries to develop required dynamic capabilities. We recommend that intermediaries develop these capabilities, and SME management shall engage in meaningful and strong collaborations with innovation intermediaries to access new knowledge and seize opportunities. Our findings suggest that long-term collaborations with strategic goals can help SMEs to truly materialize collaboration benefits. We recommend that policymakers support intermediaries in developing those capabilities, and projects and initiatives that drive the co-creation of solutions, which indirectly leads to capacity building of collaborating actors.

The paper is structured as follows. In the following section, we briefly present the theoretical background and current state of the literature on barriers to SME digital transformation and the roles and dynamic capabilities of innovation intermediaries. This is followed by the methodology section including case introductions, data collection, and data analysis. Then the paper demonstrates the results of the study, and the last section discusses the theoretical, practical and policy implications of our results, limitations, and future research directions.

2. Theoretical background

2.1. Barriers to SME digital transformation and intermediaries

Digital transformation is defined as the use of digital technologies to improve a business's operations, products, services, and business models (Soluk and Kammerlander, 2021). Digital transformation has introduced disruptive innovation in the contemporary business landscape. As a result, businesses are compelled to deploy new digital technologies. However, most SMEs work hard to keep up with rapid technological advancements, as they struggle to understand the paradigm of digital transformation and its requirements to transform their activities. This phenomenon is linked to SMEs' innovation dilemma of lacking internal R&D facilities and access to innovation networks, limited cognitive abilities, and resource barriers in their innovation processes (Rossi et al., 2020, 2022). Besides their traditional innovation challenges, SMEs also face additional challenges in configuring ways to implement and utilise digital technologies in their business operations and processes (Kumar et al., 2023). For instance, SMEs in general lack the awareness and knowledge resources required to implement Industry 4.0 technologies in their organisational processes (Benitez et al., 2020; Masood and Sonntag, 2020; Stentoft et al., 2021). Their lack of awareness and knowledge of Industry 4.0 technologies can be partially explained by their focus on cost-cutting and short-term benefits (Masood and Sonntag, 2020).

Moreover, digital transformation requires integrating different emerging technologies (e.g. Internet of Things, robotics and artificial intelligence), which necessitates expertise and knowledge of various domains and the possible merging of these with the organisational settings to offer a complete solution (Benitez et al., 2020). Similarly, Cugno et al. (2021) have discussed that the implementation and integration of Industry 4.0 technologies require organisations to upskill their employees and develop new organisational capabilities, which are challenging for SMEs due to their limited resources. Research also suggests that SMEs have limited ability to spot opportunities related to emerging technologies (Cugno et al., 2021). Other limitations and other barriers, such as high cost and lack of resources, inhibit SMEs from engaging in digital transformation (Cugno et al., 2021; Stentoft et al., 2021).

Past research has suggested that SMEs form external collaborations to complement their existing knowledge bases, increase awareness and knowledge of technology implementation and utilisation and spot business opportunities related to emerging technologies (Benitez et al., 2020; Ricci et al., 2021). However, the literature on SMEs' external collaborations indicates that they struggle to find relevant partners and engage in productive collaborations due to a lack of knowledge of industrial networks and a tendency to engage in less successful transaction-based collaborations instead of building strategic, long-term collaborations. Also, many business organisations are reluctant to share technological knowledge due to the fear of losing competitive advantage (Shahzad et al., 2024a,b). Therefore, neutral actors such as intermediaries that connect SMEs to more extensive and productive networks and act as bridging partners in overcoming hurdles play a key role (Blanka and Traunmüller, 2020). Innovation intermediaries are considered organisations that create value for other actors in the ecosystem (Ritala et al., 2022). Prior research on innovation intermediaries, however, has been focusing on the complex roles of such organisations in terms of facilitating technology transfer by developing absorptive capacity (Garengo, 2019) and forming networks to exchange knowledge between collaborating parties within the ecosystem (De Silva et al., 2022). However, for innovation intermediaries to perform their crucial role in the ecosystem, they are required to utilise their embedded dynamic capabilities for the digital transformation of SMEs. Thus, the need to explore the capabilities of intermediaries within an ecosystem to engage in collaborations contributing to SME digital transformation (Dąbrowska et al., 2022) has been an

emerging interest in recent literature (Hernández-Chea et al., 2021).

2.2. The role of intermediaries in an ecosystem in enabling SME digital transformation

The literature has discussed the general contributions of intermediaries such as orchestrators, hub firms, or ecosystem leaders in designing and aligning structures of the ecosystem for joint value proposition (e.g. Adner, 2017; Jacobides et al., 2018; Lingens et al., 2021). Intermediaries are considered significantly important organisations in an ecosystem: they support systemic and firm-level collaborative innovation by developing connections between different organisations, helping parties to develop and adopt emerging technologies, facilitating knowledge-intensive services, offering support in policymaking (Howells, 2006; Kivimaa et al., 2019; Rossi et al., 2022) and creating value for other actors of the ecosystem (Randhawa et al., 2016; Ritala et al., 2022). The extant literature also provides useful insights into varying roles and characteristics exhibited by innovation intermediaries in ecosystems during different phases of the innovation process. For instance, Albats et al. (2022), Hayter et al. (2020), and O’Kane et al., 2021 consider research institutes, transfer offices (TTOs), and knowledge transfer offices (KTOs) as innovation intermediaries due to the providing support in knowledge brokering, acting as innovation catalysts, and facilitating collaborations for innovations in the ecosystem. Similarly, industry associations as innovation intermediaries stimulate and enable the production and circulation of technological knowledge among different ecosystem actors (Geels and Deuten, 2006). Innovation consultants assist firms in scanning and foresight technological opportunities and advise acquiring technological information and solutions (Albats et al., 2022). Such intermediaries assist firm-level innovations by facilitating knowledge-intensive services and co-creation between different ecosystem organisations, offering policy-making support (Howells, 2006).

In the context of SMEs, intermediaries facilitate collaboration by connecting different actors through matchmaking and facilitating inter-organisational relations (Blanka and Traummüller, 2020). They also help SMEs increase their innovation and influence regional policies for supporting SMEs with localised open innovation (Leckel et al., 2020). Furthermore, intermediaries facilitate knowledge development, dissemination and diffusion processes of SME’s ecosystem-based collaborations (Kivimaa et al., 2019). Therefore, intermediaries can help SMEs overcome resource and cognitive barriers by providing them with access to knowledge, networks and resources.

Intermediaries’ support of SMEs in their digital transformation efforts would be extremely useful since digital transformation is a complex and multidimensional concept (Warner and Wäger, 2019). Creating business and customer value through digital technologies requires various kinds of configurations and new knowledge that may exist outside organisational boundaries (Scaringella and Radziwon, 2018). In such a context, intermediaries become relevant for SME digital transformation as they can form ecosystem-based collaborations and strategically mobilise resources to help SMEs in their digital transformation process.

2.3. Theoretical framework

2.3.1. Dynamic capabilities of intermediaries and SME digital transformation

The complex roles played by intermediaries in an ecosystem require them to leverage their high-order dynamic capabilities of sensing (i.e. capabilities for spotting opportunities), seizing (i.e. capabilities for exploiting opportunities using resources to generate value), and reconfiguring (i.e. capabilities for continuous renewal) (Randhawa et al., 2022). Yet, the dynamic capabilities of intermediaries have rarely been studied. There have only been a handful of studies that have discussed the dynamic capabilities of intermediaries, and these have focused on specific contexts, such as the service ecosystem (e.g. Randhawa et al., 2022) and international social purpose organisations (De Silva et al., 2021). These findings might not be directly applicable to the context of intermediaries contributing to SME digital transformation owing to the uniqueness of SMEs and digital transformation (Kumar et al., 2023), which may require intermediaries to use a specific set of dynamic capabilities. Similarly, the literature on the organisational dynamic capabilities for digital transformation (Verhoef et al., 2021) might not be applicable since intermediaries play a unique coordination role (De Silva et al., 2022; Järvi et al., 2018) concerning SME digital transformation. In particular, how one organization’s dynamic capabilities (i.e. intermediaries’) enable the digital transformation of another organization (i.e. SMEs) has not been discussed. Therefore, it is important to explore how intermediaries leverage their dynamic capabilities for the digital transformation of SMEs, and this paper contributes to that exploration.

The literature places the dynamic capability framework at the core of helping organisations navigate through disruptive times (Teece, 2007; Warner and Wäger, 2019). The dynamic capability framework introduced by David Teece (2007) in his seminal work explained a set of three distinct capabilities: sensing, seizing, and reconfiguration. According to Teece, these capabilities enable organisations to sense and seek new opportunities, translate those opportunities into business offerings (new products, services, or processes), and continuously align organisational structures and assets to capitalise on opportunities arising in their business environment. The current business landscape is continuously evolving due to the implementation and utilisation of digital technologies. Digital transformation involves enhancing customer experience, process, and operational efficiency (Hafeez et al., 2021), new revenue streams, and competitive advantage (Warner and Wäger, 2019) by using digital channels (technologies), which can bring about business model transformation (Dąbrowska et al., 2022; Khanagha et al., 2014). The biggest challenge organisations, especially SMEs, face is the technological advancements that happen at a breakneck pace and create market and digital disruptions (Warner and Wäger, 2019).

Sensing capability allows organisations to scan, monitor, learn, and constantly seek new opportunities (Iansiti and Lakhani, 2014; Teece, 2007). The sensing capability requires knowledge of organisational processes, changing environment, and ecosystem actors (Wang and Ahmed, 2007; Teece, 2007) to sense, and react to, change (Soluk and Kammerlander, 2021). Intermediaries, as anchor

institutions in an ecosystem, have a better understanding and knowledge of different actors in an ecosystem, the evolving technological landscape, and associated opportunities (De Silva et al., 2018). They are thus better prepared to identify the needs of SMEs for technology adoption and entrepreneurialism, required for SME digital transformation. Therefore, intermediaries are likely to be better equipped to sense opportunities for collaboration between SMEs and other ecosystem actors that would support SME digital transformation.

The seizing capability relates to translating a recognized opportunity into a new product, service, or process by matching the opportunity with resources (Iansiti and Lakhani, 2014; Teece, 2007; Wang and Ahmed, 2007). Seizing capabilities are integral for new technological knowledge integration for the development of technological solutions, the value proposition from collaborative digital innovations, and redesigning digital business model innovation through value creation (Teoh et al., 2023). Especially for SMEs the integration of disruptive technologies within ecosystem-based business models (Scuotto et al., 2023) is key for the digital transformation (Scuotto et al., 2021). Since intermediaries are well connected in an ecosystem, capable of knowledge integration, and have experience in helping their clients with business model innovation (De Silva et al., 2018; Blanka and Traummüller, 2020), they are better able to source resources required to seize identified opportunities for collaborations leading to SME digital transformation. In particular, considering the resource barriers confronted by SMEs (Benitez et al., 2020; Masood and Sonntag, 2020; Stentoft et al., 2021), intermediaries can bring together a complementary set of actors with relevant resources required to seize opportunities for SME digital transformation.

Transformation capability allows organisations to reconfigure established resources and operations (Iansiti and Lakhani, 2014; Teece, 2007). The transformation capabilities of intermediaries could enhance the ecosystem value proposition by adding new members, altering ecosystem configurations to align the goal with newly admitted actors, and figuring out the new governance mechanisms (Randhawa et al., 2022). Especially concerning SME digital transformation, intermediaries are likely to be in a position to alter the ecosystem in support of the scalping-up of SME digital transformation.

Despite the growing interest in this area, there is a notable lack of studies analysing the dynamic capabilities of key actors, such as intermediaries. Understanding how these dynamic capabilities of intermediaries facilitate the digital transformation of other organisations, particularly SMEs, is a crucial area for exploration. This study aims to address this research gap by examining how intermediaries leverage their dynamic capabilities to support the digital transformation of SMEs. Specifically, we seek to contribute to the literature by focusing on the unique roles of innovation intermediaries and the specific digital transformation needs of SMEs.

3. Methodology

3.1. Research design

We have adopted a qualitative research approach to understand how intermediaries use their dynamic capabilities for collaborations leading to SME digital transformation. Such an approach becomes appropriate when scholars aim to study a real-world case to frame a broader picture of the phenomenon under consideration (Graebner et al., 2012) and understand a context-specific, complex experience (Phillips and Ritala, 2019). Furthermore, a qualitative approach is considered appropriate for theory building (Yin, 2009), given the need to explore how the dynamic capabilities of intermediaries enable SME digital transformation. As a complex real-world phenomenon is examined, the case of a specific ecosystem is beneficial (Eisenhardt, 1989). Our approach to studying collaborations supported by intermediaries for SME digital transformation builds on prior seminal scholars (e.g. Garri, 2021; Penttilä et al., 2020; Phillips and Ritala, 2019; Planko et al., 2017) who have studied collaborations in an ecosystem from different viewpoints.

3.2. Empirical base

Our selected research design helps to gather data from collaborating actors within an ecosystem in the Ostrobothnia region of Finland, involving intermediaries, SMEs, micro firms, public-sector organisations and large firms working together on projects leading to SME digital transformation. The selected ecosystem of the Ostrobothnia region of Finland serves well for a case study where different ecosystem actors interact to develop innovative solutions, stimulate the sharing of knowledge and learning and promote new ways of working. Therefore, it could be stated that the selected ecosystem is known for its collaborative and innovative nature and represents a ‘strong case’ of engaging in collaboration (Dyer Jr and Wilkins, 1991). Additionally, the selected ecosystem can be considered to be in line with the ‘conceptual dimension’ of the study design of an ecosystem presented by Phillips and Ritala (2019), who argued that the conceptual dimension of an ecosystem is based on the boundaries and perspectives of the studied ecosystem. The boundaries of the conceptual dimension of the ecosystem determine the ecosystem type (i.e. which, in this case, includes actors working together and supported by innovation intermediaries) and scope (i.e. which, here, involves collaborative projects leading to SME digital transformation), while perspectives of the conceptual dimension ask how to address differing perspectives of the actors, ecosystem and environment (i.e. which, in this case, are the dynamic capabilities of intermediaries leading to SME digital transformation) (Phillips and Ritala, 2019: 3). Furthermore, the selected ecosystem as a case for this study becomes appropriate since it enables accessibility and information richness (Voss et al., 2002) and the ability to identify this ecosystem purposefully, which supports replicating or extending emergent theory from the case, in which the process of interest is ‘transparently observable’ (Eisenhardt, 1989).

3.3. Study sample and data collection

The purposive sampling technique was employed to select innovation intermediaries, SMEs (Eisenhardt, 1989; Guest et al., 2006), and their partner organisations involved in SME digital transformation (Yin, 2009). The study sample contains 34 interviews with intermediaries (14), SMEs (10 interviews), and their collaborating micro firms (7 interviews), large firms (2 interviews), and public-sector organisations (1 interview) that have been working together in different projects leading to SME digital transformation. A majority of SMEs operate in the service sector and some in the manufacturing sector. Intermediaries offer various support activities for all collaborations in terms of coordination, technological development, internationalisation, and consultation for policymaking. Interviewing the key actors in the ecosystem involved in projects leading to SME digital transformation offered a comprehensive picture of how intermediaries use their dynamic capabilities in these projects.

With the help of key informants, we identified the potential respondents and sent personal emails which included a brief introduction to the research project and an invitation to an interview. A similar process has been utilised by Scuotto et al. (2024) when conducting direct elicitation interviews to find relevant interviewees. The use of key informants enabled us to gain access to different perspectives and insights, thus limiting the risks of convergent retrospective sensemaking and impression management (Gioia et al., 1994). The majority of the participants in our sample included top- and middle-level managers who possessed key strategic information about the firm's operations as well as their collaborations and interactions with intermediaries (see details in Table 1). Similarly, the participants from intermediaries held top management positions in their respective organisations and had an in-depth knowledge of how they used their dynamic capabilities when supporting collaborations leading to SME digital transformation (see details in Table 2).

We developed two separate sets of semi-structured interview protocols to gain a rich understanding of the dynamic capabilities of intermediaries from the perspectives of intermediaries (see Appendix 1) and SMEs and their collaborators (see Appendix 2), respectively. The interviews with intermediaries were used to gather data on how they used their dynamic capabilities in facilitating collaborations leading to SME digital transformation. The intermediaries were asked about the capabilities, collaborations, interactions, and support activities that they provided to SMEs and their collaborators. The interviews directed at SMEs and their collaborators were mainly used to elicit information regarding the collaborations for the digital transformation of SMEs, and particularly their views on how intermediaries used their dynamic capabilities in helping the collaboration, which also offered an opportunity for triangulation. There was a greater consistency between the two types of participants concerning their views on intermediaries and how they used different types of capabilities during the sensing, seizing, and transformation stages of the projects. The interview guide was piloted and evaluated through internal testing within the research team (via commenting on questions back and forth), as suggested by Kallio et al. (2016). The pilot test provided us with crucial information on the interview guide and helped us update the content of the questions (e.g. removing any ambiguous wording) to circumvent redundancy and attain specific information about emerging findings related to our core themes.

We conducted all the interviews online semi-structured interviews using Zoom and MS Teams during late 2021- early 2022, and they lasted, on average, about 60 min. All interviews were recorded and yielded a total of 402 pages of transcription. Our approach of conducting semi-structured interviews in innovation-related studies aligns with that of Forsman (2021) and Scuotto et al. (2024). For each phase of interviews, we continued interviewing relevant experts until we reached the saturation point. Reaching and defining

Table 1
Description of interviews with ecosystem actors.

Interviews	Position	Experience (Years)	Sector	Products/services	Gender
SMEs who were the recipients of digital transformation					
1	CEO (CEO1)	30	Services	Building maintenance	Female
2	Head of Business Intelligence (HBI1)	4	Manufacturing	Energy and district heating solutions	Male
3	CEO (CEO5)	11	Services	Games, software and user experience	Male
4	Software Engineer (SE)	1	Services	Educational consultancy	Male
5	Project Manager (PM1)	4	Services	Educational consultancy	Male
6	Group Manager (GM)	8	Services	Wind power consulting	Male
7	CEO (CEO8)	5	Services	Peer-to-peer service platform	Male
8	Managing Director (MD1)	9	Manufacturing	Metal supply	Male
9	Chief Technology Officer (CTO)	15	Services	IT services and consulting	Male
10	CEO (CEO9)	12	Services	IT services and consulting	Male
Collaborating micro firms					
1	CEO (CEO2)	14	Services	Distributors	Male
2	CEO (CEO6)	3	Services	Marketing consultancy	Female
3	CEO (CEO7)	12	Services	Research and consultancy	Female
4	CEO (CEO3)	5	Services	Software solutions	Male
5	Head of Business Development (HBD)	4	Manufacturers	Lights manufacturers	Male
6	Automation Engineer (AE)	2	Manufacturers	Moveable power plants	Male
7	CEO (CEO4)	5	Services	Digital games	Male
Collaborating large firms					
1	Operations Centre Manager (OCM)	11	Manufacturing	Energy production and distribution	Male
2	CEO (CEO10)	4	Manufacturing	Cruise interior design	Male
Collaborating public-sector organization					
1	Communication Manager (CM)	21	Manufacturers	Environmental services	Female

Table 2
Description of intermediaries.

Interviews	Position	Experience (years)	Organization agenda and role	Gender	Nature of intermediaries
1	CEO (CEO11)	4	Focuses on small and medium companies and developing their influence in the region and supports SMEs with relevant information as well as connecting them with the relevant businesses and educational institutions for specific niche programmes	Male	Private sector -Consultants and technology providers
2	Head of Digital transformation (HD)	3	Offers a wide range of services and expertise to enhance technology-based innovations, improves business processes and productivity of SMEs and facilitates co-creation and open innovation among business and other actors of region	Male	Public-private sector -Technology transfer centre
3	Project Manager (PM2)	2	Offers a wide range of services and expertise to enhance technology-based innovations, improve business processes and productivity of SMEs and facilitate co-creation and open innovation among business and other actors of region	Male	Public-private sector - Technology transfer centre
4	Incubator Manager (IM)	3	Provides support activities to entrepreneurs, SMEs and micro firms in their digital transformation and internationalisation processes	Male	Public sector -Incubation centre
5	Project Manager (PM3)	10	Plays a greater role in providing operational and strategic level support to all actors of regional business, develops and facilitates mechanisms for enhancing regional growth and innovations and facilitates technology transfer and open innovation paradigm in SMEs	Male	Public sector – Strategy and market provider
6	Executive Director (ED)	8	Offers user-centric and cost-effective solutions to collaborative partners and communicates and lobbies for interests and growth of small firms at local and national levels	Female	Private sector - Cooperative association
7	Development and Business Manager (D&BM)	5	Offers policy-level guidelines, sets strategic directions and facilitates co-creation among different stakeholders of the region	Male	Public sector- Govt association
8	Senior Specialist (SS1)	1	Acts as a catalyst for innovation and the ecosystem, strengthens innovation and commercialisation activities, promotes the university's innovation culture and supports entrepreneurship and is an active player in regional ecosystems	Male	Public sector – Research institute
9	Senior Specialist (SS2)	1	Acts as a catalyst for innovation and the ecosystem, strengthens innovation and commercialisation activities, promotes the university's innovation culture, supports entrepreneurship and is an active player in regional ecosystems	Male	Public sector – Research institute
10	Senior Specialist (SS3)	1	Acts as a catalyst for innovation and the ecosystem, strengthens innovation and commercialisation activities, promotes the university's innovation culture, supports entrepreneurship and is an active player in regional ecosystems.	Female	Public sector – Research institute
11	Director 1	8	Connects companies and researchers for joint innovation projects, supports the identification of funding, provides advice on patent applications and encourages aspiring entrepreneurs.	Female	Public sector - University Technology Transfer Centre
12	Director 2	14	Connects companies and researchers for joint innovation projects, supports the identification of funding, provides advice on patent applications and encourages aspiring entrepreneurs.	Male	Public sector - University Technology Transfer Centre
13	R&D Manager	13	Connects companies and researchers for joint innovation projects, supports the identification of funding, provides advice on patent applications and encourages aspiring entrepreneurs.	Female	Public sector - University Technology Transfer Centre
14	Dean	2	Connects companies and researchers for joint innovation projects, supports the identification of funding, provides advice on patent applications and encourages aspiring entrepreneurs.	Male	Public sector – University Knowledge Transfer Centre

saturation in qualitative research is imperative (Eisenhardt, 1989), which was also the case in our study: in this research, we simultaneously conducted interviews and analysed data until we reached a saturation level, where respondents' insights became repetitive and no additional insights could be found (Guest et al., 2006). Our data collection strategy thus aimed at limiting bias by including diverse informants who viewed the focal phenomena from different perspectives and by involving three researchers who independently coded and subsequently discussed and agreed upon a coding structure (Mezger, 2014).

Finally, two validation events with the interview participants and a broader group of actors in the same ecosystem who were involved in SME digital transformation projects were conducted to further verify the study findings (Gummesson, 2001). Each event

lasted for about 1 h, and its purpose was to present and verify the initial findings and gather any additional contextually specific relevant insights. The validity of the findings was evident, and more importantly, some important additional information was discussed, including how intermediaries collaborated with wider stakeholders of SMEs, such as competitors and suppliers, during the seizing stage.

3.4. Data analysis

Data analysis began with thematic analysis, since the technique is most suitable for sorting and identifying trends embedded in qualitative data (Braun and Clarke, 2006). We structured our coding process into three phases, as suggested by Gioia et al. (2013). Initially, two researchers read the full transcripts of eight representative interviews (two manufacturing and two service sector SMEs; two intermediaries and two micro firms) to become familiarised with the data. Subsequently, they independently read all the interview transcripts line by line to develop a good understanding of the full set of interview transcripts. In the second step, both researchers shared their insights on the interview data with each other to build a common understanding. We applied an iterative process to identify key insights emerging from all interviews. For this purpose, we used NVivo 12, which facilitated coding and enabled us to keep track of emerging concepts and their relationships. Initially, an open coding approach was used for the analysis and categorisation of raw textual data but within the theoretical framing of the literature on dynamic capabilities. The first-order themes contained the interviewees' original thoughts. Additional codes were added to the NVivo coding scheme during this stage, as respondents cited new ideas. In the second stage, we linked axial coding (first-order themes) to higher shared property-level themes (13 themes). We redefined the labelling and categorisation of second-order themes based on the continuous search for new fragments of data, and we consulted existing literature on the intermediaries and their associated dynamic capabilities (De Silva et al., 2021; Howells, 2006; Randhawa et al., 2022; Rossi et al., 2020). We followed an iterative process to refine the second-order categories based on the insights from the conceptual background and emerging data (Gioia et al., 2013). As these categories emerged, we further sought coherence among the second-order categories. Additionally, the research team also discussed and reached an agreement on consistency and coherence among second-order themes.

During the final stage, we structured these 13 s-order themes into 4 key aggregated themes: opportunity spotting (i.e. sensing), integrating resources and building ecosystem collaborations (i.e. seizing), revamping ecosystem structure and scaling up digital opportunities (i.e. transformation), and contextual factors. We have used contextual factors to understand context-specific elements influencing how intermediaries leverage dynamic capabilities for SME digital transformation. These factors include the barriers faced by SMEs with their digital transformation efforts. When discussing findings, these contextual factors of barriers faced by SMEs enabled us to make a stronger case as to why and how the use of dynamic capabilities by intermediaries enabled SME digital transformation. These aggregated themes represent the abstract dimensions of the analysis. Table 3 demonstrates the data structure of our study and illustrates the coding and the process of reasoning that we followed to derive the second-order and aggregate themes.

The reliability and validity of our results were ensured through triangulation. The authors individually reviewed the transcription of primary data and workshop notes to verify the validity of information and reduce the risk of ambiguous interpretation. This was followed by cross-verifying the analysis and findings among the authors to develop a shared understanding of the collected information. In addition, a two-step procedure was followed to perform triangulation; we cross-verified our results with the notes taken during the workshops and secondary data obtained from several sources, such as organisational webpages, blogs and organisational reports, that supported refining the theoretical setting.

4. Results

4.1. Significance of intermediaries in collaborative projects leading to SME digital transformation

Our findings suggest that intermediaries provide various types of support across multiple projects related to the digital transformation of SMEs. They have an extensive portfolio of projects and facilitate the technological and economic advancements of regional businesses.

In relation to SMEs, it has been evident in our analysis that the key drivers for the digital transformation of SMEs is the changing customer requirements and emerging digital technologies with proven financial and efficiency gains. Despite these triggers, SMEs and their ecosystem have faced several barriers. Our findings suggested that SMEs had internal barriers of the lack of strategic thinking in digital transformation due to their focus on short-term benefits and the expensive and complicated process of digital transformation. Similarly, the ecosystem of SMEs has faced specific barriers that hinder SME digital transformation. First, there has been a lack of ability for the ecosystem to spot opportunities for SME digital transformation and identify and bring together relevant competencies, technologies, resources, and ecosystem actors. Second, there has been a lack of collaboration skills, knowledge, experience, network, and resources benefiting SMEs digital transformation. Third, there was a lack of scaling up opportunities for ecosystem collaboration for enhanced SME digital transformation.

Our findings suggest that intermediaries' contribution to the ecosystem by way of SME digital transformation was of significant value in overcoming these specific barriers. We found that intermediaries operate at the system level as well as at the organisational level. At the system level, they facilitate collaborations and engage with different stakeholders to align the long-term developmental goals of organisations. At the organisational level, they provide direct support (funding, skill development, guidance and consultation) to organisations and promote collaborations to develop new technological solutions, innovative processes and products.

Table 4 illustrates some exemplary collaborative projects led by intermediaries that resulted in SME digital transformation. It is

Table 3
Data structure.

First-order themes	Second-order themes	Aggregated themes
<ul style="list-style-type: none"> Spotting opportunities that would simultaneously achieve digital transformation needs of SMEs and other business, environmental and social needs of their collaborators Outlining technological and operational needs of SMEs Envisioning opportunities offered by digital technologies to SMEs (e.g. enhancing process efficiency, competitive advantage and customer satisfaction) Mapping and scanning digital competencies for SMEs Highlighting the benefits of disruptive technologies for SMEs Spotting opportunities to develop digital technologies to meet operational needs of ecosystem actors Identifying specific actors with technological knowledge and resources for SMEs Collaborating with other ecosystem actors to identify expert and knowledgeable partners on technical matters Determining the nature of activities to facilitate collaboration and technological knowledge exchange process Envisioning collaboration activities that create long-term interdependencies between actors Identifying needs, expectations and requirements of SMEs for ecosystem collaboration Identifying and sourcing human resource needs (i.e. skills and competencies, talent and workforce) for SME-ecosystem collaboration for digital transformation Searching for relevant funding instruments for such collaborations Developing collaboration for co-creation and knowledge exchange projects Connecting relevant stakeholders with mutually beneficial digital technologies Demonstrating good practice case studies of collaborating for digital transformation to generate digital awareness for less experienced SMEs Connecting with technology providers and research experts to help SMEs understand and process externally acquired technological knowledge Maintaining close collaborations beyond the project life cycle to support SMEs in absorbing digital transformation outcome Understanding the business model of closely collaborating SMEs Suggesting business model-level configurations to SMEs for exploiting externally explored knowledge into digital transformation and business opportunities Financing co-creation projects (providing in-house funding and preparing for external funding applications) Providing training and consultation for leadership competencies development for SME digital transformation Upskilling organisational workforce for digital transformation through training, consultations and demonstrations Influencing technological disruption and needs to offer further opportunities for SME digital transformation Reshaping the ecosystem structure and the underlying interactions and activities of different actors enabling collaborations, leading to SME digital transformation Connecting SMEs to other regional ecosystems to enhance their learning and scale up co-creation opportunities to implement digital technologies Being an active member of international alliances, learning best practices of international ecosystems and deploying them to benchmark local ecosystem Redefining the strategic goals and directions of the ecosystem Lack of spotting opportunities, competencies, technologies, resources and ecosystem actors and activities for SMEs digital transformation Lack of collaboration skills, knowledge, experience, network and resources benefiting SMEs digital transformation Lack of scaling up opportunities for collaboration for enhanced SME digital transformation Lack of strategic thinking due to the focus on short-term benefits Expensive and complicated process Changing customer requirements Emerging digital technologies 	<p>Capabilities to scan digital opportunities, competencies and technological trends for SMEs</p> <p>Capabilities to identify relevant ecosystem actors and activities</p> <p>Capabilities to search for financial/non-financial resources</p> <p>Capabilities to enact identified digital opportunities and technological trends</p> <p>Capabilities to develop collaboration for capacity building for SMEs</p> <p>Capabilities to co-innovate business models for SMEs</p> <p>Capabilities to mobilise financial/non-financial resources and knowledge recombination</p> <p>Reconfiguring opportunity and ecosystem structures</p> <p>Bridging inter-ecosystem collaborations</p> <p>Benchmarking international best practices and ecosystem restructuring</p> <p>Barriers in ecosystem collaboration</p> <p>SMEs' internal barriers to digital transformation</p> <p>Triggers for digital transformation</p>	<p>Opportunity spotting for SME digital transformation</p> <p>Integrating resources and building ecosystem collaborations, leading to SME digital transformation</p> <p>Revamping ecosystem structure and scaling up digital opportunities for SME digital transformation</p> <p>Contextual factors</p>

Table 4
Innovation intermediaries' role in illustrative project.

Project	Project description	Project opportunities	Type of actors involved	Project activities	Digital transformation outcomes
A	Enhance innovation and technological implementation in metal-supplying companies	<ul style="list-style-type: none"> - Innovative products and processes - Exchange of technological knowledge and increase technological learning - Development of technology solutions 	Metal production companies (SMEs, large firms, and intermediary organisations)	<ul style="list-style-type: none"> - Seminars, workshops, and information sessions - Arranging funding and expertise for collaborations - Prototyping (showing best practices on technology implementation) - Co-creating technological solutions 	<ul style="list-style-type: none"> - Enhanced technological learning - Implementation and utilisation of emerging technologies in collaborating SMEs - Process efficiency - Product innovations
B	Open innovation platform to develop technological innovations	<ul style="list-style-type: none"> - Increased managerial awareness of industrial networks for collaborations - Enhanced ability to meet customer requirements and environmentally sustainable goals - Co-creating technological solutions - Opportunity to learn best industrial practices on technology implementation 	Large companies, SMEs, micro-firms, intermediary organisations and technology solution providers	<ul style="list-style-type: none"> - Finding the right partners to facilitate the exchange of technological knowledge and enhance - Managing cooperation in the collaborations - Configuring best mechanisms to collaborate one-to-one and ecosystem-based collaborations - Co-creation of solutions development 	<ul style="list-style-type: none"> - Enhanced technological capability. - Integration of new digital solutions into company systems - Enhanced process efficiency - Improved sustainability performance
C	Develop carbon-neutral energy solutions	<ul style="list-style-type: none"> - Co-creating environmentally friendly energy solutions - Technological development - New business models - New products and services development-related to carbon-neutral energy solutions 	Large companies, SMEs, investment companies, technology providers, govt institutes, and intermediary organisations	<ul style="list-style-type: none"> - New knowledge generation - Prototyping and commercialisation of new technologies in renewable energy systems - Finding out the best collaborative models - Ecosystem development - Identifying new stakeholders and technology providers during the process 	<ul style="list-style-type: none"> - Knowledge and technological learning on emerging technologies in renewable energy systems - Utilising emerging technologies in the co-creation process of energy solutions
D	Emerging technologies for circular economy	<ul style="list-style-type: none"> - Identification and orientation on circular business practices - Business model-level configurations - Building a strategic perspective on circular business models - Connecting actors and companies with a common interest 	SMEs and intermediary organisations	<ul style="list-style-type: none"> - Workshops, seminars, and brainstorming sessions - Showcasing best-case examples - Exchange of knowledge on transformation towards circular business models 	<ul style="list-style-type: none"> - Technological knowledge and learning on implementing emerging technologies for sustainable business models - Identification of opportunities offered by emerging technologies for circular business practices

evident that the main aim of these projects was not SME digital transformation, but they did have a wide array of specific aims to innovate digital technologies for the manufacturing industry, related to carbon-neutral energy solutions and for the circular economy. It has been the case that, during such projects associated with the core expertise of SMEs, intermediaries have enabled SMEs' digital transformations. The following sections of the paper discuss how intermediaries – during these projects – leveraged their dynamic capabilities to enable SMEs' digital transformation.

4.2. Ancillary opportunity spotting capability

In response to the lack of abilities for the ecosystem to spot opportunities for SME digital transformation, intermediaries utilise their sensing capability to spot opportunities for their agenda and other collaborating actors (Randhawa et al., 2022; De Silva et al., 2022; Rossi et al., 2020). While the literature suggests that the sensing capability allows organisations to scan, monitor, learn, and constantly seek new opportunities (Iansiti and Lakhani, 2014; Teece, 2007), our findings have identified a unique sensing capability of intermediaries that enables SMEs' digital transformation.

A core sensing capability of intermediaries identified in our study was to spot opportunities to develop digital technologies to address business, environmental, or social challenges of ecosystem actors (e.g. developing carbon-neutral solutions). Yet, the main aim of these opportunities is not SME digital transformation; however, through SME engagement in developing these digital technologies, SMEs engage in their digital transformation process. Some exemplar opportunities, highlighted in Table 4, include collaboratively

innovating digital technologies for the manufacturing industry, for carbon-neutral energy production, and for a circular economy. Such opportunities should also attract public funding, predominantly to overcome the financial constraints of SMEs. Therefore, these projects often address sustainable development goals in order to increase access to funding. The capabilities of intermediaries to spot partners with greater interdependence who are likely to collaborate beyond the funded life cycle of the project were found to be also key. This specific nature of opportunity spotting in which SME digital transformation was only indirectly achieved while achieving another shared key objective of partners was crucial to ensuring that the project satisfied the needs of all the partners and created long-term relationships, which are essential for SME digital transformation. Therefore, we named this capability of intermediaries ‘*ancillary opportunity spotting capability*’. Some exemplar quotations that indicate the nature of opportunities spotted by intermediaries are as follows:

‘We are involved in larger projects to support companies in developing carbon-neutral energy solutions. These projects are not necessarily directly created for SMEs’ digital transformation, but these days technologies are important specially for new solutions in the energy sector, so we designed these projects so that collaborating in these projects definitely increases technological learning of SMEs required for digital transformation’. (PM2)

‘We operate on the system level and work with different actors and projects to develop the environment and strategies for innovation development. We always keep long-term strategic goals in our vision and support projects accordingly ... supporting digital transformation in small companies is one of our aims’. (HBI)

The capabilities of intermediaries to incorporate SME needs with opportunities were found to be crucial to ensuring SME digital transformation. Therefore, the ancillary opportunity spotting capability of intermediaries also includes supporting SMEs in matching their technological and operational needs with the digital technology development of the opportunity and clearly understanding how to use the engagement for SME digital transformation. Due to their vast experience in collaboration and iterative interactions with different regional actors (De Silva et al., 2018; Howells, 2006; Randhawa et al., 2022), intermediaries have a broader view of the opportunities offered by emerging digital technologies to SMEs operating in diverse sectors. Furthermore, our results highlighted that mapping and scanning digital technologies and competencies are complex processes requiring further collaboration between intermediaries and other ecosystem actors with expertise and knowledge on technical matters. As one respondent mentioned:

*‘Our team at V**** [public sector market intermediary] mainly consists of expertise from business and the soft side of technology. So, to map digital competencies, we worked with V** [public sector research organisation]. They have expertise in the technical side of technology, and we have a good overview of the collaborations and companies, so we did a map and investigation into digital transformation capabilities and opportunities, (particularly) in the SMEs context’.* (PM3)

The ‘Ancillary opportunity spotting capability’ of intermediaries also included identifying actors who can provide technological knowledge and resources and form interdependence with SMEs beyond the project lifetime. Therefore, the capabilities of intermediaries to satisfy multiple needs from a single project and provide relevant ecosystem actors were key. Interviewees mentioned that knowledge of digital transformation remains within different ecosystem actors. We found that intermediaries utilise their capabilities to identify knowledgeable partners to determine activities such as complementing the collaboration process and facilitating the technological learning of SMEs, as the interdependence between these partners leads to long-term collaboration. Once the actors are identified, intermediaries collaboratively define the needs, expectations, and requirements of different ecosystem actors, leading to the achievement of both the main objective of the project and digital transformation of SMEs. As one respondent noted:

*‘For the digital transformation, we have engaged with SMEs that we think would be interested in learning about how V**** [large firm] utilises robotics in their production to show them [SMEs] what benefits such technology could bring to them. So, we contacted 30 to 40 [SMEs] to get involved in collaborations with universities, large companies and other actors that we think work together beyond this project’.* (PM2)

Finally, in addition to identifying specific actors, we found, that intermediaries leverage their capabilities to assess the needs and resources required for collaboration. They have assessed the SMEs’ internal barriers such as lack of skilful employees, competencies, and financial resources to digital transformation (contextual factors) and bottlenecks in their collaborations such as lack of knowledge on innovation networks, inability to find the right contacts in other organisations (contextual factors). Therefore, we found that the ‘ancillary opportunity spotting capability’ of intermediaries involves identifying and assessing sources that can particularly bring in necessary financial and non-financial resources (e.g. human resource needs such as skills, competencies, talent, and workforce) to support SMEs in their digital transformation. Three respondents explained it as follows:

‘Digital transformation is not an easy task for companies. Sometimes, it requires financial resources, and many other times, it requires integration with universities to utilise external knowledge and integration of the digital solutions within the company’s bigger system, especially to collect the data and make solutions out of it. Most SMEs cannot do this independently because of limitations. Finding the right collaborators is difficult. In this case, we search for the right collaborators for them and the right person from the university side to collaborate with, and also, we search for funding institutes.’ (HD)

‘We help companies in identifying human resource needs, skills and managerial capabilities required to stay competitive, especially in the context of digital transformation, because digital transformation is changing everything in different industries. Since SMEs lack financial resources, we should make sure that these projects, at least initial stages, are funded’. (CEO11)

In most projects, funding comes from the public sector, like regional, national and EU funding. However, if the project is commercial, then large companies also invest their money in it'. (HD)

Appendix 3.1 presents additional statements from respondents concerning the 'ancillary opportunity spotting capability' of intermediaries.

4.3. Business model co-creation capability of intermediaries

In response to the lack of collaboration skills, knowledge, experience, network, and resources of the ecosystem benefiting SMEs digital transformation, intermediaries use seizing dynamic capability. The dynamic capabilities enable organisations to seize the spotted opportunities into concrete offerings (Teece, 2007; Soluk et al., 2023; Randhawa et al., 2022; De Silva et al., 2022). The seizing capability relates to translating a recognized opportunity into a new product, service, or process by matching the opportunity with resources (Iansiti and Lakhani, 2014; Teece, 2007; Wang and Ahmed, 2007).

Our findings demonstrate that after opportunity spotting, intermediaries utilised their 'business model co-creation capability' to realise the SMEs' digital transformation. In addition to the collaborations, they established in the previous stage to achieve the objectives of the main project, during this stage, intermediaries-built collaborations with competitors, customers, and suppliers of SMEs to co-create new business models required for the SMEs' digital transformation. Suppliers and customers had a direct interest in co-creating SME business models due to the possibilities of achieving increased demand for their products/services and satisfaction from the products/services of SMEs, respectively. However, co-creating with competitors was not straightforward. Therefore, the 'business model co-creation capability' of SMEs includes developing innovative ways to collaborate with competitors of SMEs. Intermediaries have encouraged competitors to work with SMEs by outlining the ability to generate more value together, to have different market positioning for the SME and their competitors through the new business model for less competition, and to help these competitors achieve their own objectives through the other projects of intermediaries. One project manager stated:

'We then identified customers, suppliers, and competitors of these SMEs to co-create new business models. Customers and suppliers have direct interests, and thus, co-creation was easy. In relation to competitors, we had to find more innovative ways such as by outlining the possibilities to together develop digital technologies and competencies.' (PM2)

We found that the 'business model co-creation capability' of intermediaries also includes showcasing to SMEs how to progress new business models. For instance, in project A (see Table 4), the intermediary initiated the collaborations to showcase actual case demonstrations to less digitalised SMEs to increase their technological knowledge on implementing and utilising emerging technologies in business operations and processes. Since implementing emerging technologies due to a lack of knowledge on technological implementation is found to be an internal barrier to digital transformation in most of our sample SMEs, such a case demonstration-based knowledge exchange was found critical for them to generate the learning experience required to implement co-created business models. To put it in one respondent's words:

'Many SME managers and owners realise the importance of digital technologies and are willing to implement them in their business. But digital transformation is so complicated and complex that they do not know where to start.' (PM3)

Similarly, for example, another SME highlighted:

'Digital transformation can bring many opportunities for our company, and we are looking into different possibilities. But the problem is digital transformation is a horrible jungle for us, too much messy and complicated when it comes to implementing and integrating emerging technologies with our existing systems.' (MD1)

Through such practices, intermediaries increase digital awareness among SMEs required to implement co-created business models. For example, a respondent stated:

'We try to help the low-digitalised SMEs by taking them to visit the companies who have successfully implemented technologies in their processes. For example, our recent initiative is to take robotics with us to the production companies and illustrate how they can benefit by utilising it.' (PM2)

'We have seen after this showcase many companies contacted us and shown interest in knowing more about technologies and ask for more help about customisation of those solutions to fit in their organisational existing systems.' (PM3)

Furthermore, our analysis shows that the 'business model co-creation capability' of intermediaries also involves them enhancing the capacity of SMEs associated with the changes made to the business model. This capability of intermediaries involves them engaging closely throughout the collaborative projects to enable SMEs to absorb the digital transformation outcomes and capacities required to integrate these with the new business model. For instance, one respondent mentioned:

'Our main motive is to support companies in their strategic and operational matters, and for that reason, we connect them to collaborative projects to make them self-dependent on learning about the latest technological trends and market opportunities. However, some companies struggle to understand how new knowledge can be integrated into their business models. Here, we help them understand how they use external knowledge and if they need any business model-level changes ... Of course, we do not do it with all regional companies. Instead, this process goes with companies [SMEs and micro firms] collaborating closely and frequently on the projects, and we have a good understanding of their business model and changes required for digital transformation.' (PM3)

The findings indicated that while the business models were co-created with SMEs' customers, suppliers and competitors, SMEs needed to develop additional capabilities to analyse, process and understand the technological knowledge required for the continuation of these new business models, for which additional collaboration with technology providers and value chain actors was necessary. Hence, the business model co-creation capability of intermediaries is also involved in connecting SMEs with the right technology provider to assimilate technological knowledge and complement the organisational-level resources and skills required for the continuation of their new business model. One respondent explained:

*'We work in two stages. The first part was making the SME managers aware of and connect them to bigger networks. We show them the new robotic solution and their benefits implemented in P**** [company name]. SMEs learned and started thinking how they benefit from these technologies and how to use them ... This leads to thinking about changes required to their existing business models and introducing new business models to be able to utilise digital transformation ... During the second phase, each SME planned to have a customised solution according to their system requirement. Here, we connected them with specific actors with the skills and expertise to work on ideas practically and help them implement these technologies. As intermediary actors, we ensured the project completion and tried to enhance SMEs' digital transformation capabilities.'* (PM3)

We found that intermediaries systematically designed the collaborations that lasted beyond the project life cycle and contributed to SMEs' capacity development. Engaging SMEs in ecosystem-based collaborations helped them find the right partner fit and encouraged them to acquire knowledge and develop their internal capabilities. As explained by one respondent:

'Most companies face problems with digital transformation, which is integrating new digital solutions to the company's existing big systems, especially to collect data and make solutions out of it. We helped companies solve this technical issue through an open innovation paradigm. We connected them to university technical experts [professors and leading researchers] and helped them find external consultants with technical skills and knowledge. The university experts helped them start the process, and the consultant guided them to implement it practically ... this way, we aim at helping SMEs not only to look at current opportunities but build a way forward for their future collaborations and capabilities.' (HD)

Appendix 3.2 supports our findings on the 'business model co-creation capability' of intermediaries with additional statements from different respondents.

4.4. Ecosystem revamping capability of intermediaries

In response to the lack of scaling-up opportunities for ecosystem collaborations for enhanced SME digital transformation, intermediaries use their transformation skills. While sensing and seizing capabilities enable intermediaries to spot and seize new opportunities through business model creation, scaling up of opportunities requires reconfigurations and revamping of ecosystem and opportunity structures (Foss et al., 2023; Schmidt and Foss, 2023; Guerrero and Siegel, 2024).

Our findings show that intermediaries ensure continued and scaled-up SME digital transformation by using their 'ecosystem revamping capability.' This capability of intermediaries includes utilising their capabilities to alter opportunity and ecosystem structures by bridging and connecting different ecosystems and benchmarking and restructuring ecosystems. While the literature has discussed this capability (Iansiti and Lakhani, 2014; Teece, 2007; Randhawa et al., 2022), our findings shed light on the unique features of this capability of intermediaries in relation to the scaling-up of SME digital transformation. Our sample indicates that the mandate of intermediaries encourages them to increase regional competitiveness and economic growth through innovation and commercialisation. They thus develop strategies and provide operational support for the continuous growth of the SMEs through their digital transformation.

The results show that intermediaries actively search for new complementary actors, align their activities, and restructure the ecosystem to ensure scaled-up and continued SME digital transformation. Especially unlike the other two capabilities, 'ecosystem revamping capability' was something these intermediaries continuously developed through their international interactions. For instance, we found that intermediaries were involved in international collaborations to further develop this capability and then leveraged it for continued and scaled-up SME digital transformation in the local ecosystem. They used such newly acquired 'ecosystem revamping capabilities' to benchmark the standards and best practices to revamp the local ecosystem structure as per international standards. We found that intermediaries collaborate and participate in various ecosystems operating in the region where they extend their role by facilitating inter-ecosystem collaborations. In doing so, intermediaries facilitated collaborations and connected actors of different ecosystems to complement knowledge and resources. For instance, an intermediary that facilitated collaborations and connected actors of the regional knowledge ecosystem to a large firm-led innovation ecosystem stated:

'We also travelled to many countries and took part in different training programs where we learned about different best practices for ecosystem collaborations and how to manage ecosystems ... We did benchmarks and then applied learned knowledge to the local ecosystem. This way we try to improve collaborations in local ecosystems.' (SS3)

'Since the collaborations are quite high in the region and so many actors are doing the same thing in their ecosystems, I think communication and a holistic view were missing. There, we as intermediaries, tried to bridge between different ecosystems to avoid reinventing the wheel and set a shared vision for most of the regional actors.' (D&BM)

Furthermore, our results have identified that the 'ecosystem revamping capability' of intermediaries also resulted in them supporting SMEs to reconfigure internal resource bases and skills to capitalise on the new business models as well as new opportunities

created by emerging technologies. One intermediary representative explained that they supported SMEs in strengthening their organisational digital assets by finding new, skilled employees who can complement their capabilities to integrate externally explored technological opportunities. It helped SMEs configure internal strategies, changes, and mechanisms necessary to scale up digital opportunities. To put it in the respondent's words:

'Most of the time, these companies [SMEs] already have basic skills and competencies which can be enhanced and polished by training to integrate new technologies into their existing systems. But if they need an external consultant or need to hire an expert with specific IT skills, we also help them with finding employees with the right skillset and qualifications.' (PM2)

Additionally, in projects where issues arise hindering the potential for continuation, intermediaries use their 'ecosystem revamping capability' to restructure the collaboration to ensure continuation. For instance, we found that when some actors decided to exit the collaboration due to secrecy issues, intermediaries utilised their capabilities to reconfigure the ecosystem structure and search for a new actor to fill the vacuum created by the ones who left. As one respondent highlighted:

'We initially built the project with an ecosystem approach where large companies were the main partners bringing knowledge and resources for the co-creation. However, it turned out that some of the companies cannot work in the coopetition because of competitor's knowledge leakage, and they don't want their competitors to know what are their plans ... So, with the existing companies, we reconfigured ways to continue SME digital transformation by especially bringing in other companies who are likely to continue the collaboration due to the value it generates for them, and as a result, we could achieve continued SME digital transformation.' (PM3)

Appendix 3.3 supports our findings on the ecosystem revamping capability of intermediaries with additional statements from different respondents.

5. Discussion

This research analyses the dynamic capabilities of innovation intermediaries that enact ecosystem-based collaborations for the digital transformation of SMEs. The paper, by conducting semi-structured interviews with intermediaries, and SMEs and their collaborating ecosystem actors, answered the research question "How do innovation intermediaries leverage their dynamic capabilities to facilitate the digital transformation of SMEs within an ecosystem?". Our findings have identified three distinct dynamic capabilities of innovation intermediaries, i.e., (a) Ancillary opportunity spotting capability (b) Business model co-creation capability, and (c) Ecosystem revamping capability.

While the extant literature has outlined (A) dynamic capabilities of organisations (Teece, 2007; Warner and Wäger, 2019), (B) dynamic capabilities of intermediaries (Abi Saad et al., 2024; Randhawa et al., 2022) and (C) dynamic capabilities of SMEs required for digitalisation (Warner and Wäger, 2019; Scuotto et al., 2021, 2023), there's a lack of our understanding of how the dynamic capabilities of intermediaries enable SME digital transformation. Especially the barriers faced by SMEs (Rossi et al., 2020, 2022) suggest that they are better able to achieve digital transformation through collaborations with ecosystem actors formed by intermediaries (Järvi et al., 2018). Considering the role of intermediaries as core facilitators of ecosystem-based collaborations (Adner, 2017; Adner and Kapoor, 2010; Jacobides et al., 2018; Lingens et al., 2021), they are better placed to support ecosystem collaborations (Garengo, 2019; Randhawa et al., 2022) leading to the digital transformation of SMEs. Intermediaries as neutral actors have a broader agenda to address economic, social, and environmental challenges (Kivimaa et al., 2019). Therefore, the dynamic capabilities of intermediaries should enable them to identify, seize, and transform opportunities for SME digital transformation by generating value for all the actors involved in the collaboration but not just for SMEs. Therefore, our findings illustrate specific dynamic capabilities of intermediaries that enable them to facilitate SME digital transformation.

The literature has discussed that the sensing capabilities (Teece, 2007) of intermediaries involve capabilities to map skills and competencies gaps, identify actors with complementary skills (Randhawa et al., 2022), and conceptualise coordination mechanisms along with addressing potential issues that can emerge in the process (Foss et al., 2023). Our findings extend these past studies by demonstrating "ancillary opportunity-spotting capability" that enable intermediaries to identify opportunities that are predominantly aimed at achieving the needs of ecosystem actors, in which the objective of SME digital transformation is secondary. This capability thus enable intermediaries to ensure that they bring together right partners, whose objectives are achieved while also indirectly achieving SME digital transformation.

The literature argues that intermediaries utilise their seizing capabilities (Teece, 2007) to realise the spotted opportunities by matching these with resources. For this purpose, they enact collaborations by connecting different ecosystem actors (De Silva et al., 2022; Baldwin et al., 2024), placing coordination and governance mechanisms, and integrating actor resources, knowledge, and networks (Noviaristanti et al., 2023). Through seizing capability thus intermediaries practically form ecosystem collaborations and execute co-creation-based projects (Randhawa et al., 2022) and resolve coordination and collaboration issues (Foss et al., 2023). Our results extend this past research on the seizing capabilities of intermediaries by identifying specific 'business model co-creation capability' of intermediaries, which is leveraged to co-create new business models for SMEs in collaboration with SME's customers, suppliers, competitors and technology providers. Intermediaries utilise business model co-creation capability to additionally facilitate SMEs to build relevant capabilities to enact the business model innovation. It also involves outlining the possibilities to generate more value together, and to have different market positioning for the SME and their competitors through the new business model for reduced competition.

Once the ecosystem collaborations are enacted and spotted opportunities have been realised collaborating actors need to adapt to leverage emerging opportunities (Teece, 2007; Randhawa et al., 2022). Reconfiguration of ecosystem structure and scaling up of

opportunity structure are thus critical for the longevity and relevancy of ecosystems (Baldwin et al., 2024). Intermediaries can take up the task of re-organising the ecosystem actors and reshaping governance structures (Randhawa et al., 2022), as they have system-level knowledge and often act as leading organisations in knowledge-based ecosystems (Foss et al., 2023). Especially in relation to the phenomenon of digital transformation, the advancement in new technologies happens at a breakneck pace, compelling organisations to constantly upgrade their technological capabilities and technology implementation strategies (Soluk et al., 2023). Our results extend these arguments made in the literature on the transformation capability (Teece, 2007) by introducing the ‘ecosystem revamping capability’ of intermediaries, which they leverage to simultaneously restructure ecosystem collaborations and scale up the digital transformation of SMEs. They utilise this identified capability to alter ecosystem structure and spot emerging technological opportunities. Considering the fast pace of technological change in relation to the digital transformation, such a capability is developed by participating and learning from international collaborations, particularly engaging in the learning process with successful international ecosystems. The ecosystem restructuring also includes establishing collaboration and possible mergers of activities between different regional ecosystems to align set strategic directions, avoid reinventing the wheel, and bring in learning from each other. Such learning is then leveraged for continued and scaled-up SME digital transformation in the local ecosystem.

6. Conclusions

6.1. Theoretical implications

The significance of digital transformation has become evident, and intermediaries play a crucial role in helping less advantageous players such as SMEs in their digital transformation. We make an original contribution to the dynamic capability framework (Teece, 2007) by identifying distinct dynamic capabilities of innovation intermediaries enabling SME digital transformation. In particular, demonstrating how one organization’s dynamic capabilities (i.e. intermediaries) allows another organization (i.e. SMEs) to achieve digital transformation is a key contribution that we make.

While past research has discussed the capabilities of intermediaries (De Silva et al., 2018; Howells and Thomas, 2022; Kivimaa et al., 2019; Randhawa et al., 2022; Rossi et al., 2020), there is a lack of focus on understanding the specific capabilities of intermediaries that support collaborations leading to SME digital transformations. The specific role of intermediaries supporting collaboration between SMEs and the ecosystem, the unique barriers confronted by SMEs, and the long-term focus required for digital transformation suggest that intermediaries should deploy specific dynamic capabilities (Crupi et al., 2020; Sassanelli and Terzi, 2022; Prodi et al., 2022; Li et al., 2023). Thus, we make an original contribution by identifying three novel and specific capabilities of intermediaries at different stages of the process, as differentiated by Teece (2007): sensing, seizing, and transforming. While our findings confirm the proposition offered by Teece (2007) of the significance of dynamic capabilities for sensing, seizing and transformation, we extend the findings of Teece’s (2007) study by demonstrating that innovation intermediaries (as important actors) in SMEs’ external environment, can support business organisations (such as SMEs) in their innovation and digital transformation process, by deploying certain dynamic capabilities. These three novel and specific capabilities of intermediaries introduced by our study include spotting ancillary opportunities (i.e. sensing capability), co-creating SME business models (i.e. seizing capability), and transitioning from organisational influence to ecosystem influence, which ensures continuous and scaled-up SME digital transformation (i.e. transformation capability). First, at the initial sensing stage, the ‘*ancillary opportunity spotting capability*’ of intermediaries enables them to identify opportunities that simultaneously achieve the needs of ecosystem actors and SME digital transformation. More importantly, the main aim of the identified opportunity is to address a common goal of ecosystem actors, whereas SME digital transformation is indirectly achieved. The ‘*ancillary opportunity spotting capability*’ of intermediaries includes: (A) identifying opportunities to develop digital technologies to address sustainable development goals that would increase access to public funding and attract resourceful partners with whom SMEs could collaborate and learn (i.e. to overcome financial and non-financial constraints of SMEs); and (B) supporting SMEs in identifying the needs, technologies, resources and additional partners required to develop the additional capabilities and technologies required for SME digital transformation through their involvement in the project. While the literature has discussed spotting opportunities and bringing partners together as a sensing capability Teece (2007) of intermediaries (Garengo, 2019; Järvi et al., 2018; Randhawa et al., 2022; Abi Saad et al., 2024), we make an original contribution by introducing “*ancillary opportunity spotting capability*” of intermediaries, in which intermediaries should leverage capabilities to spot opportunities to develop digital technologies that address business, environmental or social challenges of ecosystem actors (e.g. developing carbon-neutral solutions), and SME digital transformation should be an ancillary objective linked to this key objective.

During the next seizing stage (Teece, 2007), intermediaries leverage ‘*business model co-creation capability*’ to establish new collaborations with suppliers, customers, and competitors of SMEs to co-create new business models for SMEs required for digital transformation. Since SME digital transformation is only ancillary in the initial collaboration opportunity, ‘*business model co-creation capability*’ is crucial for intermediaries to help SMEs incorporate the output of the project to achieve digital transformation. This capability involves actions by intermediaries that include (A) collaborating with SME stakeholders (e.g. customers, suppliers, and competitors): to develop new business models; (B) showcasing good practice case studies to raise awareness; (C) capacity building of SMEs associated with the changes made to the business model; and (D) developing further collaborations with technology providers and value chain actors in order to ensure that newly formed business models continue beyond the life cycle of the project. This finding extends the literature that has discussed the seizing capabilities (Teece, 2007) of intermediaries to actively engage in collaborative projects (De Silva et al., 2022; Randhawa et al., 2016; Baldwin et al., 2024) by outlining how they co-create new business models with SMEs and their stakeholders to integrate the output of the collaboration to achieve long-term digital transformation.

During the final transformation stage (Teece, 2007), intermediaries further develop and use ‘*ecosystem revamping capability*’ to alter

opportunity and ecosystem structures, create links with international ecosystems, and benchmark and restructure ecosystems to ensure continued and scaled-up SME digital transformation. Unlike the other two capabilities, ecosystem revamping capability is something intermediaries continuously develop through their international interactions, especially to understand international best practices and develop new useful international networks supporting scaled-up SME digital transformation. This finding makes an original contribution to the literature that has discussed the capabilities of intermediaries to shape innovation ecosystems (Randhawa et al., 2022) by showcasing how intermediaries develop their interactions with international ecosystems to further develop ecosystem revamping capability and leverage the capability in support of scaled-up and continued digital transformation of SMEs.

6.2. Practical and policy implications

We offer several important practical and policy insights in this research. Our findings suggest a set of dynamic capabilities of intermediaries for SME digital transformation. In particular, the ‘ancillary opportunity spotting capability’, ‘business model co-creation capability’, and ‘ecosystem revamping capability’ of intermediaries during the sensing, seizing, and transformation stages (Teecce, 2007) of the SME digital transformation process outline unique and original capabilities that intermediaries should strive to develop and leverage. Their strategic approach of bringing in different stakeholders at different stages using three different capabilities is instrumental. For instance, first, intermediaries should use ‘ancillary opportunity spotting capability’ to bring together potential collaborators and work with them to develop digital technologies to address common economic and social environmental challenges that could result in SMEs learning and developing digital transformation skills and technologies. Second, intermediaries should leverage ‘business model co-creation capability’ to bring together customers, suppliers, and competitors of SMEs to specially co-create business models required to incorporate developed digital technologies for SME digital transformation. Third, intermediaries should use ‘ecosystem revamping capability’ to develop interactions with international ecosystems for continued and scaled-up SME digital transformation. Additionally, we have highlighted several other sub-capabilities covering these three main capabilities, which intermediaries could aim to develop and leverage for SME digital transformation. As suggested by Teecce (2007) environmental conditions, such as the presence of supportive innovation intermediaries can boost the knowledge assets of SMEs, therefore, we recommend that top management of SMEs interact with intermediaries to develop strategic collaborations and actively look for ecosystem actors who can support them in forming and sustaining these collaborations.

Government and policymakers aimed at supporting SME digital transformation could play a crucial role in helping intermediaries develop specific dynamic capabilities identified in our study. These capabilities, as outlined by Teecce (2007), are essential for sustaining superior enterprise performance in rapidly changing environments. Hence, governments fostering the development of these, intermediaries can enhance their ability to innovate and adapt when enabling SME digital transformation, thereby driving more significant impacts from public funding. Our findings on the nature of the specific stages of the collaborations formed by intermediaries for SME digital transformation (i.e. initially with ecosystem collaborators, then with the stakeholders of SMEs, and finally with international collaborators) will be useful when public funders deciding to fund projects among intermediaries, SMEs, and other ecosystem actors. In particular, at the sensing stage government funding the intermediary-led collaboration aimed at developing digital technologies to address business, environmental, or social challenges of ecosystem actors (e.g. developing carbon-neutral solutions) where SME digital transformation is only indirectly achieved is required. At the seizing stage, we identified that intermediaries co-create – with the stakeholders of SMEs (i.e. customers, suppliers, and competitors) – the business models of SMEs for digital transformation. At the transformation stage, intermediaries engage in continued and scaled-up SME digital transformation, by also bridging inter-ecosystem collaborations. Since dynamic capabilities enable long-term sustainable growth (Teecce, 2007) government policy and funding offering support to intermediaries to engage in these relevant collaborations at different stages of the process would result in ecosystem-wide sustainable economic growth. In particular, this strategic alignment ensures that public funds are directed towards initiatives that not only achieve digital transformation but also contribute to broader sustainable development goals.

6.3. Limitations of the study and future research

We acknowledge that our research is subject to some limitations, which offer avenues for future research. We conducted an exploratory study in a specific ecosystem. Future research could replicate this study in different other ecosystems and include different types of SMEs and digital transformation areas to offer a more nuanced understanding of the capabilities of intermediaries supporting SME digital transformation. Our study predominantly focused on the intermediary’s side, and thus, future studies could focus on SMEs’ perspective to better understand this process of SME–intermediary interactions and the specific capabilities of SMEs leading to SME digital transformation through ecosystem-based collaborations. Although researchers followed research protocol, two research members of the team independently analysed interview data, and then the research team reached a common agreement about results through the coding process, yet our results can be subjective to the bias of researchers’ subjectivity since we utilised thematic analysis, that can potentially limit the reliability of the results. Our findings are based on cross-sectional data collected through semi-structured interviews in 2021–2022. Future research should consider investigating how our findings may have evolved with the time-sensitive changes. As such, future research could conduct a longitudinal study to further understand the development of these different capabilities. Additionally, future research could conduct a wider quantitative study to improve the generalisability of the findings of this study.

CRediT authorship contribution statement

Shahid Hafeez: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Khuram Shahzad:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Funding acquisition, Data curation, Conceptualization. **Muthu De Silva:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization.

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Appendix 1. Interview Guide: Intermediaries

General questions:

- Can you briefly tell us about your organization?
- And your role in the organization?

Sensing related questions:

- How do you see the urgency for digital transformation in SMEs you have collaborated/worked with?
- What is your organization's role in realizing the urgency for digital transformation among SMEs?
- Does your organization provide support to SMEs in their digital transformation process? If yes how?
- Did the collaborating SME approach your organization, or did you approach them? If (SMEs) were approached, what would be their main challenge regarding their digital transformation?

Seizing related questions:

- Can you please explain the process of solving the challenge? (How are the best action plans chosen from a different set of actions? What is your organization's role in this process)?
- Which technologies are implemented during this digital transformation process?
- What is the purpose of digital transformation from an SME perspective? What benefits do you think digital transformation brings to SMEs?
- What kind of resource integration is required to implement digital technologies? How did your organization help them in implementing digital technologies?
- How do you involve other actors in the ecosystem in facilitating the digital transformation of SMEs?
- What value and benefits do different actors bring in the process? Also, what do they achieve by participating in collaboration?
- Did the collaboration involve any competitors (what kind of challenges were faced due to having competitors in the same collaboration?) What was your role in managing the tensions among competitors?

Reconfiguration related questions:

- What kind of changes were made during the collaboration as compared to the initial plan? What kind of changes were made to realign collaboration goals?
 - Were there any new collaborators identified during the co-creation phase?
 - How the learned knowledge from a specific collaborative project is shared and transferred to other relevant actors?
-

Appendix 2. Interview Guide: SMEs and their Collaborators

Introduction questions	<ul style="list-style-type: none"> • Can you briefly tell us about your organization? • And your role in the organization?
Collaboration with intermediary organisations	<ul style="list-style-type: none"> • Do you collaborate with intermediary organisations? If yes, how can your organization be more active in this collaboration to achieve your digital transformation goals? • What kind of challenges and benefits do you see in this collaboration? What kind of support do you get from intermediaries to achieve your digital transformation goals? • How much does your organization collaborate with intermediary organisations on the following resources/projects? <ul style="list-style-type: none"> o Co-creation o Research facilities o Workshops o Training and seminars
Collaboration with other partners	<ul style="list-style-type: none"> • With what ecosystem actors do you collaborate regularly? • What kind of challenges and benefits do you perceive in collaboration with your ecosystem partners to learn about and implement emerging technologies? • How much do you collaborate with ecosystem partners to share lessons learned in emerging technological trends? • Do you think ecosystem collaboration increases your organization's competitive advantage? What are the obstacles and facilitators of such collaborations?

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- How emerging technologies (e.g. IoT, AI, robotics, additive manufacturing, etc.) are challenging current business practices and business models in your industry?
- What are the key factors that facilitate your organization to enhance its digital transformation?

Appendix 3. Additional quotations for three types of dynamic capabilities of intermediaries

Appendix 3.1. Ancillary opportunity spotting capability

Sensing	Representative statement
Capabilities to spot opportunities that will generate economic and environmental value for ecosystem actors while also enabling SMEs to engage in digital transformation	‘Sustainability and environment-related standards are increasingly making companies think outside the box and collaborate. For instance, in a recent project, we have been part of a project where companies worked together to find out opportunities offered by emerging technologies for the circular economy.’ (PM3)
Capabilities to scan digital opportunities, competencies, and technological trends for SMEs in order to ensure that the project enables SMEs to engage in digital transformation	‘One of our key strategic areas is to help SMEs in their digital transformation by forecasting their digital transformation needs, and technologies available and provide funding for [such] collaborative projects. We thus wanted to make sure that SMEs achieve digital transformation while achieving the main objective of the project.’ (D&BM) ‘We are continuously in touch with a network of companies [both micro firms and SMEs] that we feel are relevant and need help with digital transformation. We provide support to them in assessing their current level of digital transformation, and if they need to upgrade their existing technologies or need to implement a new [technological] system ... In addition, we also contact other companies that we feel are most promising and relevant to the digital transformation options we are proposing ... this is very important for SME digital transformation.’ (PM2) ‘There is a need to improve digital competencies. It is always good to know what new technologies provide opportunities. However, to improve digital transformation capabilities, more collaborations are required from a third party [intermediaries].’ (CM)
Capabilities to identify relevant ecosystem actors and activities	‘More cooperation would be useful for the SMEs’ digital transformation. Through digital transformation, [SMEs] can become competitive. But doing digital transformation is complicated and hard for some companies. Only cooperation among SMEs is not enough. Having a pool of experts would help find good solutions related to SME digital transformation.’ (SME representative, Workshop 1) ‘We look for projects to fund which can bring benefits and solve issues of the companies. Universities and different research consortiums are the ones who apply funds from us, but we try to choose projects that enhance collaborations, business competitiveness, digital transformation and provide an innovation environment.’ (D&BM) ‘Everyone [all ecosystem actors] has a very important role, but we must specify those roles because one actor cannot do everything. Also, it does not always work that an actor’s role is always to give and receive nothing ... We have taken huge leaps in developing how the ecosystem can collaborate.’ (PM3) ‘We have a long history of collaborations which makes us foresee which actors will fit a specific project. Most importantly, how can the collaboration go beyond the project lifetime because it is important to find natural collaborations among companies [SMEs].’ (HDI)
Capabilities to search for financial/non-financial resources	‘When it comes to thinking about resources generally, we try to find a resourced person (expert on the issue) who can cooperate with the relevant company and have the necessary skills and knowledge. So, this way, we already know many from existing networks, but we also search for experts if they are not in our existing list of experts.’ (PM2) ‘Regarding funding, we do not directly provide funding for the projects, but we have good information about different funding sources, especially regional, national, and EU funding agencies. So, we also help them [SMEs] in preparing their funding application.’ (PM3)

Appendix 3.2. Business model co-creation capability of intermediaries

Seizing	Representative statement
Capabilities to co-create new business models for SMEs	<p>'We discussed with companies to understand their problems and then identified the relevant actors from companies and universities having expertise, skills, and knowledge to solve the problem. Together with companies, they worked on co-creation and bringing business model-level changes. (PM3)</p> <p>'The collaboration between companies and universities in our ecosystem is great, and they collaborate on co-creating technological solutions, innovation and business value creation ... Recently, we have tried to connect SMEs on similar collaborations to help them jointly explore new business opportunities and work on their business models to stay competitive. (PM2)</p>
Capabilities to enact identified digital opportunities and technological trends	<p>'Digital transformation is one of the important practical matters for the companies and us [intermediary]. We are helping companies in increasing their competencies to implement new technologies and develop products, or increase process efficiency in their production systems to remain competitive' (HD)</p> <p>'We [as an intermediary] do not offer immediate solutions to the companies [SMEs]. Instead, we contact and attract the SMEs to join the collaborations and follow the whole program. In this program, companies collaborate and exchange knowledge on their digital transformation success and failure journey. This not only gives them an overview of the technological opportunities available but also the knowledge on implementing emerging technologies in their business processes and operations. However, innovation and invention happen in their own individual capacity and depends on many internal factors.' (HD)</p> <p>'We list the companies with good practices on digital transformation, for example, any company utilising automation and robotics in their production facility. We show those good examples to entrepreneurs or the manager [s] of SMEs so that they find practical information and know-how on the possibilities to implement in their organisations. The problem is every company has its different existing systems, so one ready-made solution is not feasible ... Therefore, our main aim is to equip companies with knowledge and skills on understanding the digital transformation process, which they use in finding multiple solutions to their digital transformation problem'. (PM3)</p> <p>'The co-creation and open innovation are the cost-effective way to utilise digital technologies in our business processes. For example, in augmented reality-based projects, the technology is not developed within the company, but it is augmented and utilised from the outside of the company'. (GM)</p>
Capabilities to develop collaboration for capacity building for SMEs	<p>'Our main work is to provide strategic guidelines for the development of regional economic actors and SMEs are one of them important actors ... We look for the long-term developments which require capacity building of regional actors. So, basically, in our projects we focus on capacity building and making companies self-sufficient to carry out their innovation journey.' (D&BM)</p> <p>'One of our learnings in the process of forming and supporting the collaborations has been to look for partners that are interested in bringing real changes and innovations. So, we connected like-minded companies to collaborations which give us good examples where companies kept collaborating after the official duration of the project. By doing so, companies were able to co-create solutions and develop capabilities important for innovation and technology development'. (SS2)</p>
Capabilities to mobilise financial/non-financial resources and knowledge recombination	<p>'Majority of SMEs struggle with skills required for digital transformation ... we arrange training and consultations on the building of managerial and employees' skills and capabilities related to digital technologies and automation'. (PM3)</p> <p>'We help SMEs and start-ups [this term is used by interviewee to denote micro firms] in prototyping and connect them with different companies to build collaboration. Also, they offer visualisation services to companies which help companies in overcoming their challenge'. (IM)</p> <p>'We provide consulting services on planning the digital marketing strategy to micro firms and SMEs, and guidance on implementing digital technologies in different processes, for example, in manufacturing and logistics, if they are production companies.' (CEO11)</p>

Appendix 3.3. Ecosystem revamping capability of intermediaries

Concept	Quotations
Reconfiguring opportunity and ecosystem structure	<p>'There are so many things that live throughout the collaboration process. There are new opportunities that arise during the ecosystem collaborations, and then we reidentify the actors that need to be added, or some actors want to exit because they cannot share such knowledge or information because of their secrecy that needs to be maintained for competitive advantage.' (PM2)</p> <p>'In the collaboration process, we found that some technologies were missing, and owners of those technologies were then contacted to be part of collaborations. The identification of such actors is not entirely our responsibility, so we do it together with other actors.' (PM3)</p>
Bridging inter-ecosystem collaborations	<p>'As a part of a wider strategy to support SMEs and regional businesses, we remain in contact with different ecosystems and their actors ... A recent big development that happened is W***S*****P***** [large firm-led ecosystem name]. This is a really big initiative and drastically changes the way collaboration in regional ecosystems is done, especially in the SME situation ... So we are part of this new initiative, and we connect interested SMEs having good collaboration experience to this newly established ecosystem [W***S*****P*****]. This is one of the examples of how collaborations are changing, which means we are involved and connected to different ecosystems of the region.' (PM2)</p>

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Concept	Quotations
Benchmarking international best practices and ecosystem restructuring	<p>'I think that everyone has realised that they have a bigger role besides their daily business routine and also that the business world has changed in that direction [collaboration models]. This aspect is essential and can be seen from the initiative of the new management of W***** to take a bigger and more important role for the energy utility company in collaborations. Now they are thinking big and taking SMEs under their wings as well. This change in thinking is creating opportunities for SMEs to take part in different ecosystems and benefit greatly by getting to know about business opportunities, and technologies and meet sustainability challenges.' (PM3)</p> <p>'Our team tries to help small companies and entrepreneurs in commercialisation of innovative ideas and to utilise technologies for innovation. But we also meet large companies and try to take big companies on university-led projects. This role helps us to have a good view of collaborations and know about actors' technologies and skills. Most often, we try to connect companies from one ecosystem to another. For example, recently we took small companies from a university-based ecosystem and set their meeting with A*** [company name]-led innovation ecosystem. This way we are working to increase regional growth and competitiveness.' (S1)</p> <p>'We also learn from international collaborations, and we with other stakeholders and actors participated in International G****T*** A***** [name of alliance] for developing ecosystems, and it was done together with I*** [name of country] and a N****M***** [name of country's alliance]. So, it was all about how to develop the ecosystem mapping of the stakeholders included in the ecosystem and finding their role and what they can give and take. How they can support the ecosystem, so this learning has also provided ways for benchmarking international ecosystem standards. So, we see that everyone has a very important role, and we kind of help companies to specify the role that they have and what [value and resources] they can receive and give.' (PM3)</p>

Data availability

The authors do not have permission to share data.

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