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RESEARCH

Building middle managers' managerial dynamic capabilities through collaborations: exploring the microfoundations in a university–industry consortium

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Abstract
Through a longitudinal study of a university–industry consortium, this paper explores how middle managers' dynamic capabilities (DC) are enhanced through participating in an open innovation (OI) environment. It shows how OI environments significantly expand managers' cognitive DC, critical for a firm's adaptability and competitive advantage. The study employs qualitative methods, including interviews and direct observations within a university–industry Consortium, revealing the identification of mechanisms through which managers develop capabilities in sensing, seizing, and reconfiguring, transitioning from initial knowledge gaps to advanced strategic application and internalization of external knowledge. This work contributes to the understanding of the microfoundations of DC enhancing the pivotal role of middle managers in bridging external knowledge with organizational innovation strategies. It highlights: (1) the progression, the hierarchy and the enablers for the development of cognitive managerial dynamic capabilities in middle managers; (2) routes for the acquisition and renewal of cognitive managerial capabilities beyond what previously highlighted in literature.

Keywords Open innovation · Middle managers · Dynamic capabilities · University–industry collaboration

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1 Introduction

To navigate market complexity, rapid technological changes, and intense international competition, companies engage with various knowledge sources, including external ones (Chesbrough, 2003, 2012; Troise et al., 2022). Integrating external with internal knowledge involves developing methods for acquisition through connections with suppliers, customers, and other actors in the external network (Weber & Heidenreich, 2018). Consequently, there is a clear link between open innovation (OI) and the enhancement of companies' dynamic capabilities (DC) (Ahn et al., 2018; Hutton et al., 2021). Companies effectively engaging in OI show a continual capacity for innovation and the identification of new business opportunities (Chesbrough, 2003; Dahlander et al., 2021; Tsai et al., 2022).

There is a substantial body of literature focusing on the role of dynamic capabilities, particularly in university–industry collaborations, which have gained prominence in academic discourse (Carayannis et al., 2018). These capabilities allow universities and industries to integrate external knowledge, innovate, and sustain competitive advantages. For instance, Teece (2007) and Helfat et al. (2009) demonstrate how dynamic capabilities enable organizations to manage technological innovation and respond to external uncertainties (Borsano et al., 2024). Similarly, recent studies show how dynamic capabilities in university–industry ecosystems facilitate technology transfer and improve innovation performance by aligning strategic assets across sectors (De Wit-de Vries et al., 2019). Underscoring the critical role universities play as sources of innovation, literature emphasizes that effective technology transfer and innovation outcomes depend significantly on organizational commitments and leadership capabilities of the managers involved (Audretsch et al., 2025; Stolze & Sailer, 2022). In particular, the perspective of the actors involved within knowledge exchange processes, such as technical staff, would enrich our understanding of the micro-foundations essential to capability-building and effective knowledge transfer (Noke et al., 2024). Our research builds on these insights by specifically examining the development of middle managers' cognitive dynamic capabilities within collaborative university–industry settings.

While dynamic capabilities are integral to achieving organizational strategic goals, middle managers involved in technology transfer often navigate environments characterized by multiple and conflicting objectives. Previous research highlights how diverse motivations underlying collaborative technology transfer activities, such as those observed in academic spin-offs, can influence goal-setting processes and ultimately lead to heterogeneous performance outcomes (Civera et al., 2024). Thus, understanding the interactions among multiple organizational goals at the managerial level is essential to elucidating the nuanced processes through which dynamic capabilities are developed and leveraged in university–industry collaborations. However, while the meso- and macro-level perspectives are better-researched, there is less focus on the micro-foundations of these processes. Although university–industry collaborations in OI are known to enhance companies' DC (Ahn et al., 2018; Hutton et al., 2021), and alliances and collaborations have been shown to help firms develop both capabilities and competences (Bitencourt et al., 2020), there is still limited understanding of how these capabilities are developed.

Like Ambrosini et al., 2009, we argue that the capabilities of managers involved in such collaborations constitute the micro-foundations upon which companies' DCs are built. These capabilities enable firms to identify new market opportunities and organize resources to address challenges (Teece, 2014). While the role of managers in DC development is

acknowledged (Grimaldi et al., 2013), the processes through which these capabilities are acquired and improved at the micro level remain underexplored. We understand conceptually that DC evolve either incrementally, through renewal, or via complete regeneration (Ambrosini et al., 2009), however there is limited specific evidence on how this process unfolds for those directly involved. First, research tends to focus on organizational outcomes (such as competence or capability transfer) but overlooks the specific managerial practices and daily routines that underpin these capabilities. Understanding how managers identify opportunities or realign resources requires a more granular analysis of their decision-making processes. This gap limits practical guidance on how to cultivate dynamic capabilities effectively (Ariwibowo et al., 2024). Secondly, the literature on knowledge transfer, especially tacit knowledge, remains underdeveloped (Rossoni et al., 2024). Tacit knowledge, which is deeply embedded in personal experiences and organizational cultures, relies heavily on human relationships and informal networks. Yet, little is known about how these interpersonal dynamics are cultivated and maintained. Although trust and relational capital are recognized as critical, studies rarely explore the micro-level practices—such as regular communication, joint problem-solving, or mentorship—that foster these elements (O'Dwyer et al., 2023).

Moreover, much of the university–industry collaboration literature centers on the exchange of competences (e.g., new technologies) via Technology Transfer Offices (Siegel et al., 2003). However, these collaborations often go beyond mere competence transfer, with significant impact stemming from other channels besides technology commercialization. A considerable portion of university–industry exchanges occurs in fields like the Arts and Social Sciences (Hughes & Kitson, 2012), where capabilities, rather than competences, are transferred.

This study seeks to understand how capability transfer occurs within university–industry relationships. While both competence and capability transfers have a significant impact, knowledge transfer related to personal skills—rather than specific product or technological know-how—has been underexplored. A key question arises: *How are industry's managerial cognitive and dynamic capabilities developed through participation in collaborative environments?* This research examines the processes by which middle managers participating in a collaborative university–industry setting develop their cognitive dynamic capabilities. By participating in an environment that encourages continuous learning and adaptation, these capabilities are refined, enabling managers to navigate and leverage complex knowledge landscapes effectively. This nuanced understanding highlights the crucial role of capability-building in driving sustainable innovation and organizational growth.

We focus on middle managers as key facilitators of capability transfer, addressing another gap in the literature. Middle managers, acting as critical intermediaries, are recognized for their role in fostering change and strategic decision-making (Stathakopoulos et al., 2019). While macro-level studies underscore the importance of dynamic capabilities for university–industry collaborations (Teece, 2007; Helfat et al., 2009), the specific contributions of middle managers in these processes remain underexplored.

This study is grounded in a qualitative analysis of interviews and direct observations within a university–industry consortium, a form of OI collaboration aimed at supporting the development and transfer of technology management skills to managers. Through interviews and observations, we collected data on the development of middle managers' cognitive dynamic capabilities across companies of varying sizes, industrial sectors,

and geographic locations. These managers participated in a university-led, cross-sectoral consortium focused on strategic technology and innovation management, facilitated by a renowned institution.

The findings provide a detailed analysis of the mechanisms underpinning the relationship between OI and cognitive managerial dynamic capabilities. They expand the micro-foundations framework of dynamic managerial capabilities and, to the best of our knowledge, are the first to identify a temporal pattern in capability development.

This paper is structured as follows: The second section offers a literature review on DC including the micro-foundations framework proposed by Helfat and Peteraf (2015), specifically for middle managers. The third section describes the research design and methodology. The fourth section presents findings from the interviews. The final section concludes with theoretical and managerial implications, limitations, and suggestions for future research.

2 Theoretical background

2.1 The role of middle managers in the dynamic capabilities framework

DC are fundamental to a company's ability to achieve strategic goals (Teece, 2017). They are distinct from ordinary capabilities, which focus on executing established routines, whereas DC enable firms to anticipate and respond to changes by adapting their resource base (Teece et al., 1997). Designed to address both external and internal challenges, DC support firms in crafting strategies and leveraging resources to maintain competitive advantage. A well-developed DC framework allows organizations to "purposefully create, extend, or modify [their] resource base" (Helfat et al., 2009, p. 4) in response to environmental shifts. The literature on DC has emphasized the role of individuals, particularly managers, in sensing and seizing market opportunities (Teece, 2007). Their ability to acquire new knowledge and interpret information through social networks is critical in this process (Helfat & Martin, 2015). Companies can institutionalize these boundary-spanning activities through structured processes, such as OI (Kaiji et al., 2021), which facilitates external scanning and enhances firms' ability to anticipate technological developments, thereby capturing emerging market opportunities. Recent contributions have highlighted the importance of organizational commitment and clearly articulated leadership vision for leveraging dynamic capabilities in university innovation ecosystems (Audretsch et al., 2025; Stolze & Sailer, 2022). Additionally, expanding the focus to include a broader array of actors involved in knowledge exchange, such as technical staff, is argued to be essential for comprehensively understanding the micro-foundations of these dynamic capabilities (Noke et al., 2024).

Within this strategic framework, managerial networks are instrumental in acquiring technology, knowledge, and intellectual capital, ultimately driving performance (Helfat & Martin, 2015; Singh et al., 2021). These connections not only enhance access to external knowledge but also support internal knowledge development, mitigating risks and addressing firms' capability gaps. Prior research has consistently linked OI to DC (e.g., Ahn et al., 2018; Cano-Kollmann et al., 2016; Hutton et al., 2021; Randhawa et al., 2016; Teece et al., 2016). However, an underexplored aspect is how managers develop these capabilities through active participation in OI initiatives. While microfoundations research has examined individual and project-level attributes in the context of DC and OI, the process-level

mechanisms through which OI fosters the development of managerial DC remain insufficiently theorized. Integrating OI studies within the DC framework offers a promising avenue to uncover how process-level initiatives contribute to firms' resource and capability enhancement (Hutton et al., 2021).

The transition toward OI is complex, particularly for firms traditionally oriented toward closed innovation models, requiring them to adopt progressively open approaches (Enkel et al., 2011; Mortara & Minshall, 2011; Lazzarotti & Manzini, 2009). Senior management plays a critical role in defining an organization's strategic direction and overseeing key organizational transformations, including resource allocation and innovation processes, especially in SMEs (Ahn et al., 2017; Yu et al., 2022). However, the effective execution of these strategic initiatives largely depends on middle managers. Positioned at the intersection of strategic intent and operational execution, middle managers are pivotal in implementing OI strategies (Nakagaki et al., 2012). They facilitate internal transformations, manage frontline employees, and ensure the alignment of top management's strategic vision with day-to-day operational realities.

Middle managers' activities significantly shape organizational processes, often leading to more successful innovation initiatives than those spearheaded solely by senior executives (Heyden et al., 2017). Their direct engagement with frontline employees and deep understanding of operational workflows enable them to effectively translate hierarchical decisions into actionable strategies (Glaser et al., 2021). Additionally, their role extends beyond intra-organizational coordination to fostering external collaborations. By serving as a bridge between top management, operational teams, and external stakeholders—including other firms and university researchers—middle managers facilitate knowledge exchange and promote OI-driven innovation. Their ability to build and sustain these linkages enhances organizational adaptability, contributing to sustainable competitive advantage (Mom et al., 2007; Stathakopoulos et al., 2019).

The cognitive capabilities, intended as microfoundations, of middle managers play a crucial role in reinforcing their dynamic managerial capabilities, particularly in the context of innovation and knowledge integration (Helfat & Peteraf, 2015). Their involvement in identifying external knowledge sources, acquiring expertise from partners, and aligning new insights with organizational objectives constitutes an essential microfoundation of organizational innovation (Glaser et al., 2021; Radaelli & Sitton-Kent, 2016; Stathakopoulos et al., 2019). Scholars such as Felin et al. (2012) have underscored the importance of microfoundations in explaining how capabilities emerge, evolve, and are strategically leveraged. This perspective has been applied to both DC and OI studies, as demonstrated by Hutton et al. (2021), who analyzed how OI contributes to an organization's DC through a microfoundation lens. Building on this theoretical foundation, our study specifically examines the cognitive capabilities of middle managers to deepen the understanding of how OI environments, particularly within university–industry collaborations, shape managerial DC development.

Building upon this line of inquiry, the current study highlights the development of middle managers' cognitive dynamic capabilities, utilizing the framework established by Helfat and Peteraf in 2015. They disentangled the notion of dynamic managerial capabilities to investigate their microfoundations, inspired by Teece's seminal work (2007), and focusing on the cognitive aspects of sensing, seizing, and reconfiguring.

2.2 The managerial cognitive capability

Helfat and Peteraf (2015, p. 835) define "managerial cognitive capability" as the capacity of an individual manager to perform one or more mental activities that constitute cognition. The strategic management literature describes a "capability" as the aptitude to execute tasks or activities upon request, meeting appropriate standards of functionality (Helfat & Winter, 2011). This suggests that capabilities can be enhanced through practice, as individuals or organizations gain new experiences, complete various tasks, and become more proficient performers. The definition of cognitive capability is intrinsically linked to cognitive activities and mental actions, particularly those involving attention, perception, and problem-solving.

Psychological research identifies two primary modes of information processing. The first is largely automatic, enabling individuals to quickly respond to external stimuli and information. The second, often described as "controlled" or "deliberative," involves slower mental activities, yielding more considered responses to external conditions (for an in-depth discussion and connection to psychology literature, see Helfat & Peteraf, 2015, p. 835). Through the latter, more deliberate process, managers process received information and engage in "goal-directed behaviors." Thus, cognitive capabilities can be honed and enhanced through practice and training. Similarly to the learning curve observed in behaviors such as driving, the refinement of capabilities initially relies on controlled mental processing of required goals and actions but may become more automatic over time with training. It is therefore anticipated that managers engaged in acquiring DC within an OI environment will gradually automatise these behaviors.

To further elucidate this transition, the subsequent three paragraphs delve into the microfoundations of managerial dynamic capabilities in sensing (2.2.1), seizing (2.2.2), and reconfiguring (2.2.3).

2.2.1 Middle managers' cognitive capabilities in sensing opportunities

Uncertain and complicated scenarios challenge the capacity to sense changes before they ultimately emerge (Denrell et al., 2003). Such sensing capacity is a crucial element of dynamic capabilities and entrepreneurial success. Being able to recognize opportunities and to anticipate potential threats plays a pivotal role in competitive advantage (Kaplan, 2003; Peteraf & Bergen, 2003). In particular, sensing implies the use of two primary cognitive abilities: *perception* and *attention* (Eisenhardt & Martin, 2000; Gaglio & Katz, 2001).

The first is intended as "the mental activities or processes that organize information and interpret it as having been produced by properties of (objects or) events in the external (three-dimensional) world" (APA *Glossary of Psychological Terms* definition cited in Helfat & Peteraf, 2015, p. 837). Perception supposes the use of several mental activities which are also related to pattern recognition and interpretation of data, so that it also relies on previous knowledge, expectation, and principle. If, on the one hand, prior personal beliefs can mislead real perceptions, especially when information is vague (Powell et al., 2006), context-related knowledge and experience can mitigate the uncertainty and the knowledge acquired from previous experience offers a path-dependency in shaping new experiences. Perception impacts sensing activities, helping managers in identifying emerging patterns in the sce-

nario and interpreting data and information correctly. Perception leads to the creation of new opportunities, allowing organizations to obtain long-term advantages from early moves.

The second cognitive ability– attention– is defined as the "state of focused awareness on a subset of available perceptual information" (American Psychological Association glossary, cited in Helfat & Peteraf, 2015, p. 838). Attention drives managers in identifying and selecting the external stimuli, concentrating their focus only on selected information. Attention can be stimulated and improved by practice and training and creating a source of path dependence. Sensing opportunities and threats in an unclear, intricate, and often unstable scenario requires consolidated cognitive capabilities in terms of the attention that allows managers to focus on critical external insights. Attention leads to better ability to detect and create new opportunities by filtering and exploiting relevant information.

2.2.2 Middle managers' cognitive capabilities in seizing

The second cognitive capabilities dimension and a relevant foundation for dynamic managerial capabilities regards the seizing of the opportunities and the response to incoming threats. Numerous studies focus on top managers' abilities to make strategic investments and to arrange necessary organizational improvements to respond to complex and uncertain scenarios. However, seizing opportunities and responding to threats requires that managers have problem-solving and reasoning abilities (Rouleau, 2005).

Problem-solving is defined as "thinking that is directed toward solving specific problems, and that moves from an initial state to a goal state using mental operations" (APA *Glossary of Psychological Terms* definition cited in Helfat & Peteraf, 2015, p. 840). Therefore, we can assume that problem-solving helps managers in looking for the right solutions to overcome obstacles and problems that affect organizational strategies. On the other hand, reasoning indicates the ability to evaluate and process data and information to reach a decision. These two abilities imply mental processes focused on the use of formal logical rules for solving problems through rational thinking patterns. This is based on short-term memory and fast thinking without recurring to previously learned knowledge-generating situation-driven responses. Problem-solving is founded on the ability to quickly analyze several opportunities, to mentally draw a/multiple solutions, and how to reach them. Managers with a higher level of reasoning and problem-solving capabilities are more prone to taking incisive strategic impacting on long-term organizational performance (Joseph & Gaba, 2020).

2.2.3 Middle managers' cognitive capabilities in reconfiguring and orchestrating assets

The third dynamic capability is the capacity to enhance, combine, and reconfigure organizational assets (Teece, 2007). Managers are hence expected to coordinate and adapt strategic resources by implementing adequate strategies and decisions, sometimes leading to resistance to change in their organizations, which is often due to rigid organizational structures.

In psychology, language is mainly intended as "any system for representing and communicating ideas" (Kolb & Whishaw, 2009, p. 526).The cognitive capability associated with language is comparable to other cognitive capabilities. The domain of language includes several cognitive capabilities regarding verbal and non-verbal behaviour, such as reading, writing, listening, facial expressions, and gestures (Bialystok & Ryan, 1985; Carroll, 1993).

Reconfiguration often relies on managers to communicate ideas and actionable strategies, convincing others in the company to launch new plans. Language can be implemented to share conclusions, envision ideas to convince top management, inspire co-workers, support new initiatives, and push innovation adoption (Swap et al., 2001).

To reconfigure assets, managers should also promote cooperation among organization members, to reach adequate levels of interaction through managers' social skills and cognitive capabilities. These activities rely on relationships and collaborations between people who also imply the ability to understand others' viewpoints. The social cognitive capabilities of managers can help them to influence organizational members and to promote asset reconfiguration, to boost cooperation, and to overcome organizational resistance to change (Helfat & Peteraf, 2015).

This theoretical framework highlights the critical role of middle managers in developing DC within OI. Middle managers leverage their cognitive capabilities—sensing, seizing, and reconfiguring—to grasp and integrate external knowledge into organizational processes. While existing research underscores the link between OI and DC, the specific mechanisms through which middle managers cultivate these abilities remain underexplored. Through our empirical investigation, highlight the learning patterns, cognitive shifts, and boundary-spanning activities that underpin capability development in OI. The following section depicts the methodological approach used to explore these dynamics.

3 Methodology

3.1 The research setting

To empirically respond to the aim of the paper and given the originality of the topic, we relied on an exploratory research approach to obtain a better understanding of how OI can strengthen middle managers dynamic capabilities (De Massis & Kotlar, 2014; Fletcher & Streeter, 2016).

We drew observations from one specific OI context, studying the participants to a community of interest focusing on the sharing and development of Strategic Technology and Innovation Management methods and approaches (STIM Consortium from now on). This observation setting could be described as an OI environment[1] and an enabler of learning for innovation (Pattinson et al., 2016).

OI accelerates internal innovation and expands market opportunities through knowledge inflows and outflows (Chesbrough, 2006), facilitating collaboration across organizational boundaries. Within OI ecosystems, university–industry partnerships serve as essential platforms for integrating external knowledge, adapting resources, and developing new strategic capabilities (Schneider et al., 2019). The coupled OI mode, which combines inbound and outbound processes (Enkel et al., 2009), especially provides an optimal mechanism for

[1] See Crupi et al. (2021) for the description of a university–industry consortium in the technology management field in which participants share experiences and collaborate to solve real-world problems in a non-competitive environment. Also, more information about the STIM Consortium can be retrieved from the following link: https://engage.ifm.eng.cam.ac.uk/strategic-technology-and-innovation-management-consortium/.

As an example, Appendix 1 contains the program proposal for 2021. This document exemplifies the structure of the Consortium in a typical year.

companies to exchange insights, co-develop innovations, and enhance their competitive positioning. This study draws from the firsthand involvement of the authors in a consortium's activities, engaging directly with managers from fifteen companies participating in the STIM Consortium. The STIM Consortium functions as a practice-oriented research and networking platform that fosters collaboration between university researchers and industrial members working on technology and innovation management research. It annually updates its portfolio of projects (typically 10–20) and participants, bringing together about twenty international organizations (amongst Universities and Companies) five times per year. During the meetings and in the intervening time, the interaction between managers and scholars on the projects is encouraged. Whilst researchers outline the key topic at the centre of their research work, managers feed their experience and provide context about carrying out specific technology and innovation management task related to the topic. Managers are often willing to test initial research findings (e.g. prototypes of management tools) and often provide access to other managers in their organisation for the researchers' empirical data gathering.

Given its focus on management innovation, the STIM Consortium's knowledge exchange primarily revolves around management practices rather than scientific discoveries. This aligns with the broader role of OI in pushing collaboration between diverse actors—including research institutions, companies, and communities—to drive knowledge transfer and interdisciplinary learning (Watermeyer, 2012). However, despite the benefits of OI, firms often face barriers in acquiring and transferring knowledge effectively (Verbano et al., 2015). Challenges such as resistance to external insights, reluctance to share proprietary knowledge, and coordination difficulties can hinder integration (Burcharth et al., 2014; Salter et al., 2015). The STIM Consortium mitigates these challenges by providing a structured framework for trust-building, joint problem-solving, and absorptive capacity enhancement, enabling participating managers to refine their cognitive dynamic capabilities in sensing, seizing, and reconfiguring opportunities.

A sample encompassing a variety of organization sizes, geographic locations, and industry sectors was constructed, with Table 1 providing anonymized details about these companies to ensure the confidentiality of managers' identities. We followed the process theory of change (Van de Ven, 2007) and tracked the managers at the STIM Consortium over four consecutive years (2018–2021). Each year the STIM cohort includes managers new to STIM and some repeating their participation, with a few being part of the consortium for over seven years.

3.2 Data collection

We employed a qualitative research methodology, which was instrumental in our active participation and detailed observation within the designated study environment, using a mixed method approach. Throughout the engagement period spanning 2018 to 2021, our active involvement in the Consortium's activities was complemented by gathering data through three primary sources: interviews, documentation, and direct observations at the companies and across nine STIM meetings in 2018 and 2020 (Williams et al., 2019). This approach allowed us to capture the dynamics of knowledge identification and acquisition among managers and scholars during these interactions. From 2018 to 2020, we carried out thirty-eight interviews, ranging in format from face-to-face to conference calls and varying in length

Table 1 Companies' information

Company no.	Industrial sector	Company size (The criteria for defining the size of the companies adopted are those established by the European Commission: Medium-sized: Staff headcount < 250, Turnover ≤ €50 million, Balance sheet total ≤ €43 million. Small: Staff headcount < 50, Turnover ≤ €10 million, Balance sheet total ≤ €10 million)	Years in STIM (Calculated at the time of the first observation (2018–2019))
Company 1	Manufacturing	Large	7
Company 2	Semiconductor	Large	3
Company 3	Energy	Large	8
Company 4	Engineering	Large	3
Company 5	Manufacturing	Large	4
Company 6	Pharmaceutical	Large	8
Company 7	Manufacturing	Large	8
Company 8	Telecommunication	Large	1
Company 9	Chemical	Large	3
Company 10	Agricultural	Large	8
Company 11	Chemical	Large	3
Company 12	Energy	Medium	4
Company 13	Engineering	Large	5
Company 14	Engineering	Large	3
Company 15	Engineering	Large	7

from 30 to 90 min. The data collection focused on exploring companies' and managers' motivations for participating in the Consortium, the challenges faced in knowledge sharing, and the internal processes for innovation development, conducted in stages from November 2018 through March 2020. The managers interviewed were primarily middle managers with an engineering or scientific background, with an average of 5 to 8 years of experience in their current or related roles at the time of the study. Table 2 provides a summary of the information related to the interviewed managers, including their company affiliation and level of seniority. Additional detailed information was omitted to ensure anonymity through data triangulation.

Interviews were organized into three distinct phases to align with the STIM Programme's schedule. The initial phase involved ten interviews with ten managers across four meetings (November 2018, March, July, and November 2019). The second phase consisted of another ten interviews with ten managers during five STIM meetings (November 2019, March, May, July, and November 2020). A third phase, within the extended timeframe of the second phase, entailed eighteen interviews with managers from Company 7 and Company 11, conducted during site visits in July and August 2019. This latter set of interviews was specifically aimed at in-depth exploration of the integration of STIM projects within the companies' operational practices. While many interviews targeted the same managers to track ongoing perspectives, each new cycle included discussions with newly participating managers to incorporate fresh viewpoints on their engagement. Additionally, informal conversations and meetings were held throughout this period. Table 3 provides a summary of the data collection process. The process has been enriched by a continuous interaction, for the evaluation of the findings, with several scholars engaged in the Consortium.

3.3 Data analysis

As previously mentioned, we looked at the microfoundations of dynamic managerial capabilities. Through an exploratory approach, we delineated the "what" and "how" aspects of the context by examining the objectives, undertakings, and levels of involvement within the Consortium. These elements were then connected to the experiences of middle managers.

Following Van de Ven (2007, p. 211), we focus on recognizing "sensing" as instances of perception and awareness, "seizing" as examples of sensemaking or sensegiving, and "reconfiguring," which pertains to the adoption of new language and new forms of communication. In analyzing the data, we employed the Gioia methodology (Gioia et al. 2013) to analyze qualitative data collected through interviews and direct observations. This method is particularly well-suited for inductive research as it emphasizes the development of a structured, data-driven framework that captures participants' lived experiences while linking them to higher-level theoretical constructs (Gioia et al., 2013). Through iterative coding, we identified first-order concepts, which were then grouped into second-order themes and distilled into aggregate dimensions (Gioia et al. 2013). This method allowed us to construct a robust model of middle managers' evolving cognitive capabilities in open innovation environments. The analysis of the collected data illuminated the developmental longitudinal trajectory of the personal managerial capabilities, showcasing how these capabilities mature over time through active engagement in the OI setting and identifying which specific internal actions amplify CDC. The initiatives undertaken within the Consortium, followed by

Table 2 Respondents' information

Year of Obeservation	Company	Respondent	Seniority
2019	Company 9	Manager 1	Junior
		Manager 2	Senior
	Company 13	Manager 3	Senior
	Company 6	Manager 4	Senior
	Company 12	Manager 5	Senior
	Company 4	Manager 6	Senior
	Company 5	Manager 7	Senior
	Company 15	Manager 8	Senior
	Company 11	Manager 9	Junior
	Company 3	Manager 10	Senior
2020	Company 13	Manager 1	Senior
	Company 1	Manager 2	Senior
	Company 12	Manager 3	Senior
	Company 9	Manager 4	Junior
		Manager 5	Senior
	Company 2	Manager 6	Junior
	Company 8	Manager 7	Junior
	Comapny 10	Manager 8	Senior
	Company 14	Manager 9	Junior
	Company 6	Manager 10	Senior
Field Visit 2019	Company 9	Manager 1	Senior
		Manager 2	Senior
		Manager 3	Senior
		Manager 4	Senior
	Company 7	Manager 1	Junior
		Manager 2	Junior
		Manager 3	Senior
		Manager 4	Senior
		Manager 5	Senior
		Manager 6	Senior
		Manager 7	Senior
		Manager 8	Senior
		Manager 9	Senior
		Manager 10	Senior
		Manager 11	Senior
		Manager 12	Senior
		Manager 13	Senior
		Manager 14	Senior

their application within the participating companies, allowed for a nuanced understanding of how capabilities were enhanced and operationalized.

Figure 1 illustrates the Gioia model framework used to analyze the data, demonstrating the relationships between first-order concepts, second-order themes, and the aggregated dimensions.

Table 3 Data collection activity description

Data types and dates	Use in the analysis
Interviews	
First round 10 interviews with 10 managers (Four meetings November 2018, March, July, and November 2019)	Interviews were conducted face-to-face. They lasted between 45 min and one hour Questions in the first round inquired about STIM's engagement model Companies' approach to innovation Managers' approach to the technology management in general and to STIM's meetings
Second round 10 interviews with 10 managers (Five STIM meetings November 2019, March, May, July, and November 2020)	Interviews were conducted face-to-face (November 2019 and March 2020) and from remote (from May to November 2020). They lasted between 45 min and one hour Questions in the second round inquired about the importance of engaging in seminars and workshops for managers "Grand tour" questions allowed the interviewees to discuss what they consider important in terms of acquired experience in relation to the lessons apprehended during STIM's meetings "Follow-up" questions drove managers deeper into the aims of the study by describing how they processed, transformed, and implemented knowledge acquired in STIM on daily bases
Third round 18 interviews with 18 managers of Company 7 and Company 11 during the companies visits in July and August 2019 4 managers Company 7 14 managers Company 11	The interviews lasted from 25 min to 2 h. The development of the questions followed a snowballing approach, initial questions have been defined according to the previous literature and the information previously collected, and the subsequent questions have been developed following a customized approach according to the position covered, the answers provided to the previous questions and any possible interesting insight that needed to be deepened
Observations	
6 direct participations of researchers to STIM meetings in Cambridge	
November 2018 March 2019 July 2019 November 2019 November 2019 March 2020	Direct observation of STIM's dynamics in terms of experiences exchanges, learning activities and exploration of technology and innovation processes; direct observations of the seminars, workshops and focus groups conducting during STIM meetings with the direct involvement of managers
3 online participations of researchers to virtual STIM meetings	
May 2020 July 2020 November 2020	Direct participation in STIM's meetings and coordination of research projects involving managers related to: university–industry engagement Knowledge Sharing Technology Intelligence
Direct involvement of the researcher in the study by managing several research projects in STIM	These observations provided information on managers' engagement evolution, with a particular attention to the improvement of their capabilities and the implementation of new processes
Secondary data	
5 academic journal articles published	

Table 3 (continued)

Data types and dates	Use in the analysis
Article's year 2013 Article's year 2017 Article's year 2019 Article's year 2020 Article's year 2021	Assess the outputs of the engagement in terms of knowledge developed and innovation processes adopted: Tools for sustainable value thinking into technology forecasting Development of technology management toolkits based on collaborations with industry Roadmapping customization Technology Intelligence measurement Knowledge Sharing dynamics
Project Reports	
2013 Programme: 7 projects reports 2014 Programme: 10 projects reports 2015 Programme: 13 projects reports 2016 Programme: 18 projects reports 2017 Programme: 17 projects reports 2018 Programme: 20 projects reports	Contextualize the results of each project, including workshops and seminars conducted during the programme, to track down managers participation and the consequent approaches implemented in companies' routines

4 Results

The analysis of the interview transcripts and the direct observations conducted in the field during the STIM meetings represented how middle managers participating in the Consortium managed to improve their cognitive capabilities considered as microfundations of their dynamic cognitive managerial capabilities. As we described above, such microfundations represent the backbone to reinforce managers' capacity to push innovation within their companies. To do so, managers should be able to explore, identify, acquire, and transfer external knowledge. Through the analysis, we observed that STIM engagement contribution is twofold. On the one hand, the participation in the OI consortium allowed managers to explore external knowledge besides their close network (Granovetter, 1973), on the other hand working in such research-driven collaborative environment fostered managers' cognitive capabilities in promoting the execution of innovation strategies.

The first finding from the analysis is the temporal progression in the enhancement of DC among middle managers. These three distinct stages reflect the evolving engagement of middle managers with the STIM consortium. Specifically, Step 1, which coincides with the 1st year of involvement of the managers with the STIM consortium, in their *Initial Engagement*, focuses offers insight into their baseline DCs. Step 2, coinciding with the *Second Year of Engagement*, includes observations from managers who have become more familiar with the context. During longer engagements, of over two years, an ongoing, iterative process occurred where managers had time to consolidate and standardize their CDCs *(step 3)*.

4.1 The initial engagement with STIM

During the initial phase of the engagement in STIM, managers recognize the existence of a knowledge gap given by their tight embeddedness in their companies' routine (tunnel vision). The data indicate that sometimes ordinary activities carried out during the daily work prevents managers from seeing the whole company innovation strategy. Therefore, OI often fails because managers develop an adverse attitude towards external knowledge,

Fig. 1 Gioia model framework of middle managers' dynamic capabilities in open innovation (Author's own elaboration)

precluding them from sensing possible opportunities of acquiring external knowledge. An exemplary quote from Manager 6 illustrates this: *"Before joining STIM, we perceived innovation as ideating and implementing new technological capabilities. Once we joined STIM, we recognized that managing innovation encompasses a holistic view."*

Indeed, the mechanism of recognizing external opportunities was deemed not always clearly visible within a new and complex environment such as the STIM consortium. This complexity might also affect managers' abilities to recognize relevant sources of knowledge and in transferring external knowledge from the consortium to the company.

Manager 7: "The first time we joined STIM, we felt overwhelmed because of all the "new areas" of knowledge and "technical- academic-vocabulary" to be learned to get the most from the engagement."

In general terms, thanks to their intermediate position, middle managers gather information from different sources that offer them different kinds of knowledge: operational from the frontline, strategic from top management, and scientific from scholars and publications. However, what we observed is that they feel they can rarely organize and prioritize this knowledge by consulting with peers and colleagues. Usually, managers with previous experience in changing markets and organizations are more prone to develop transversal skills that can be implemented in various contexts. However, contrary to our expectations, we observed that in STIM, even inexperienced managers show an initial push toward the activation of cognitive learning paths for attention and perception.

Manager 2: "During workshops and/or panel presentations conducted during the STIM Consortium Meeting Days, we have been able to identify valuable opportunities. One was, for example, the Portfolio Management workshop in which the scholar presented tools that are perfect fit for our company. Another was the SWOT & Roadmap panel, during which the explanation offered us a valuable inspiration to co-create a tailored solution for our needs."

Another critical obstacle, for the realization of OI, concerns the incapacity to acquire external knowledge due to the inability to value and assimilate the knowledge embedded in a different environment. In this sense, the ability to seize opportunities and respond to emerging threats is a crucial asset from middle managers. They can exploit the knowledge acquired by others in different sectors, adapting it to their environment. Through the previous experience shared by other managers in STIM, participants can be able to recognize similar incoming threats implementing similar problem-solving approaches for different problems.

At this stage, middle managers appear more familiar with the context and started absorbing the external information and appropriating new ideas, stimulated by engagement, as part of their identity. Indeed, observations confirm that middle managers become familiar with new knowledge and its potential impact on their personal development and the organization. Also, we observed the learning pattern that drives them to calibrate their attitude toward the new knowledge and foster decisions in line with their background (Raaijmakers et al., 2015). Interestingly, from STIM engagement managers can acquire theoretical knowledge and absorb practical experiences made by other managers. This helps managers to envision a possible implementation strategy suitable for their business unit or company.

Manager 4: "We have been able to select and pursue innovation-related strategic choices, thanks to the holistic perspective acquired during STIM meetings."

4.2 The second year of engagement

At the end of the first year of engagement and the beginning of the second year, managers participated in three research meetings where they had the opportunity to attend poster presentations and workshops where scholars and managers shared their knowledge and prior experiences. Moreover, they had the chance to engage in one-to-one meetings with scholars and to collaboratively organize workshops within their companies to implement different projects. These activities first, stimulated their perception and attention. Indeed, the engagement activated a psychological process whereby middle managers elaborate information according to their background. Second, by interacting with others and hearing from others' past experiences, they start a dialogical process that stimulates seizing cognitive capabilities (reasoning and problem-solving).

Manager 6: "During the first year in STIM, joining the meeting and engaging with scholars and other managers, we started to feel that our initial knowledge gap about the management of innovation was being reduced, allowing us to identify opportunities for projects and fostering our interaction with other team members (academics and industries)."

Managers' previous knowledge and beliefs often determine their ability to perform mental activities since people tend to elaborate information received from the external environment through the lens of their acquired knowledge and values. From what we observed and analyzed in STIM, despite the inclination of managers to filter out the external knowledge, the context represents an enabling factor that triggers new learning paths allowing managers to acquire new knowledge and experience.

Manager 4: "A combination of factors has triggered this learning pattern; we learned new things and improved our general awareness about innovation management. The continuous engagement in discussions with scholars and the experiences shared with other managers provided us with specific skills and capabilities regarding technology management."

The ability to seize opportunities and respond to external threats derives from managers coordinated mental processes in which they apply formal rules and rational thinking to solve real problems identifying the best solutions with the information possessed. We observed how external engagement stimulates the building of dynamic capabilities to foster managers' ability to handle innovation and new technologies. Thanks to their boundary-spanning activity, middle managers not only engage with external knowledge sources but also demonstrate the ability to combine this knowledge with their previous experience according to their background to formulate new reasoning patterns.

Manager 1: "We adapted our way of thinking, building our new mindset, and assuming a unique global perspective regarding innovation. We can now see innovation management not as chaotic initiatives but, rather, as a structured puzzle. Participating in STIM helped us in putting as a first element the understanding of the Technology Management Framework. Then, we connected the other elements such as intelligence management, portfolio management, intellectual property management, knowledge management, and system design".

Previous experience implements this ability according to which people tend to respond to similar threats automatically and to follow the last successful mental path to reach a rational solution. We observed that the participation in others' experiences, the sharing of information with other managers, the learning activities of theoretical constructs could allow managers to define their reasoning better and to activate a more problem-solving mindset.

Manager 9: "We built a detailed customer roadmap with the contribution of the different functions and the company's financial impacts, the way it was managed strongly helped the organization select the key accounts. We did a paramount communication process to ease the strategic decision-making process."

The organization does not automatically exploit external knowledge because it needs to be transferred and internalized. One of the most challenging activities for managers is sharing this knowledge within the organization's boundaries. This pushes managers to reconfigure their knowledge bases to set the right approach to make the knowledge available for their organization overcoming the internal resistance of rigid cognitive mechanisms within the organization. To do so, managers need to develop adequate language and communication skills as social cognitive capabilities.

Manager 7: "Thanks to the workshops, I can now translate the theory embedded in the projects into a practical application for my organization since I can now understand the full potential of the project, and I can transfer it to my team and colleagues."

4.3 The long-term engagement

Interviews beyond the second year of engagement offer a more mature viewpoint in which it clearly emerges that managers possess the ability to properly evaluate the activities conducted, to assess their improvements and the dynamics of the external environment in which they are embedded.

Manager 9: "People in STIM are always open to new ideas and ready to follow different ways to find the right solution to solve our problems. We start engaging with scholars to find tailored solutions according to our needs."

It is particularly interesting to observe the emergence of a learning-by-example experience. In participating to the meetings and sharing previous experiences with their peers, managers extract value from others' experiences. Observing how others reacted to deal with a specific problem triggers managers' attention on two different aspects. The first is an "evaluator" aspect that pushes managers to self-evaluate their current situation to check if their company is experiencing something similar. The second aspect is self-directed. Managers indeed re-adapt others' experience to their everyday activities, trying to adopt similar solutions for different problems.

We also observed that managers rely on others' experience, and their openness is a reliable example to follow rather than consider their situation as different. Of course, transferring this attitude to the rest of their company is challenging, but the reputation of the environment smooths internal knowledge transfer.

Manager 4: "Yes, sometimes we had difficulties to propose new initiative because of possible conflicts regarding the internal strategies of setting the priorities, perceiving the value contribution and similar. But when referring to the initiatives linked to STIM most of the superiors were willing to participate as they were motivated by the reputation."

The reputation of the environment, besides endorsing STIM's activities with external actors, also represents a "seal of excellence" for the participants. Indeed, managers describe how practice and training improved their capabilities in terms of attention and perception, creating a positive trend of learning path dependency. The continuous interaction with academic partners, participation in workshops and seminars, and the sharing of everyday experiences with other managers stimulate managers' knowledge acquisition and identification

capability. The improved capability of recognizing valid sources of external knowledge plays a crucial role in overcoming OI barriers. Indeed, managers' previous experiences trigger cognitive capabilities learning processes. These, on the one hand, help participants exploit and transfer transversal knowledge, and, on the other hand, foster managers' problem-solving skills.

Manager 7 "During the second year, we have been able to co-create solutions and provide recommendations. In particular, the initiative related to "SWOT and Roadmap" has fostered our general knowledge. Thus, we have been able to evaluate and select strategic alternatives for our specific business unit."

In STIM, you engage with very competent people who are very focused on technology management. This can help you to find new ways to solve the internal organization's problems. People in STIM are always open to new ideas and ready to follow different ways to find the right solution to solve my problem.

Managers also had the chance to boost their learning and communication skills helping them in improving their reconfiguring capability. This has been possible also through direct participation in STIM learning activities (such as participating in practice-oriented workshops based on gamification, problem-solving, or design thinking techniques, personally delivering seminars and workshops to collectively find possible solutions for real problems, or new technology testing sessions), which offered the opportunity to gain a certain level of personal knowledge, making managers more confident in transferring the acquired information. By looking at the strategies adopted by middle managers to reconfigure externally acquired knowledge, we observed how middle managers used a public engagement channel to strengthen their knowledge by absorbing information from a well-recognized academic environment. Engaging in such an environment increases the credibility of the information retrieved and favors their efforts to develop communication skills that may ease the knowledge translation in the organization.

The acquisition of such cognitive learning activities requires the activation of a learning process through which managers can acquire and absorb the knowledge, processing it according to their mental processes and logic lens activated by the participation in STIM's seminars and workshops.

Manager 6: "Sharing knowledge and experiences with other colleagues and with scholars who theoretically explore the entire dimension of the innovation management with a broader timeframe helped us connecting dots and in implementing innovative strategies and initiatives. In this framework, we have to do a hard job to adapt to our organizational culture and vocabulary to close that gap."

"The learning pattern was developed within and through STIM during the panel presentation and workshops. In fact, in STIM, we focused on the exchange of knowledge not only with scholars but also with other colleagues. This is one of the most critical consequences of engaging in STIM, the sharing of mutual experiences with colleagues from other companies."

In sum, Fig. 2 depicts the framework derived from the findings of our analysis and observations. The framework was developed from theoretical insights and illustrates a dynamic and evolving learning process in which the engagement of middle managers in STIM activities progressively enhances their cognitive capabilities and their role in facilitating OI within their companies. The figure portrays a cyclical process of cognitive capability development among middle managers through their engagement with the STIM consortium. The three

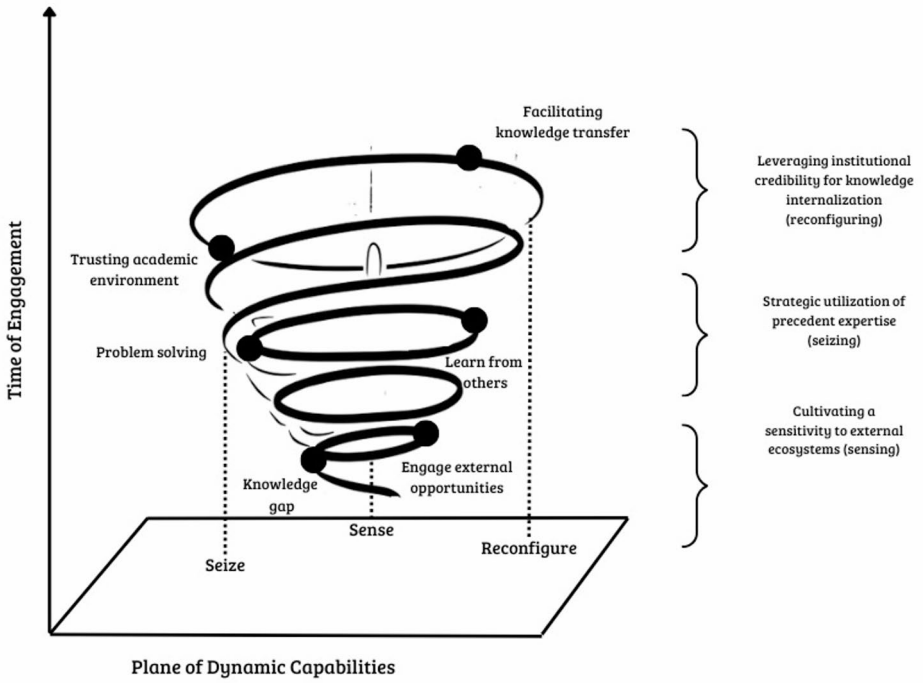

Fig. 2 Evolution of middle managers' dynamic capabilities in open innovation: a three-step engagement model (Author's own elaboration)

core dimensions—*Sensing*, *Seizing*, and *Reconfiguring*—are shown to evolve and improve over different stages of engagement.

In the first year, middle managers develop the *Sensing* capability, specifically through *Cultivating a Sensitivity to External Ecosystems*. At this stage, managers are exposed to new external knowledge networks, learning to recognize opportunities and expanding their understanding beyond their internal organizational routines. The figure highlights the initial challenges faced by middle managers, including overcoming knowledge gaps and resistance to external knowledge. As they engage, they begin to integrate diverse knowledge sources and recognize the importance of adaptive learning in effectively leveraging external knowledge.

By the second year, middle managers further enhance their *Sensing* abilities and develop *Seizing* capabilities, characterized by the *Strategic Utilization of Precedent Expertise*. At this stage, managers learn from their peers' experiences, adapting shared knowledge and expertise to their own organizational contexts through collaborative problem-solving and strategic application of external knowledge. *Sensing* has advanced to a point where middle managers actively engage in perception and attention through collaborative learning, while their learning paths are shaped by both context and preconceptions. *Seizing* capabilities are further enhanced through rational problem-solving and the integration of external knowledge, facilitated by continuous engagement.

In the third year and beyond, while the other capabilities continue to improve, the focus shifts to *Reconfiguring*, captured by *Leveraging Institutional Credibility for Knowledge*

Internalization. At this stage, managers capitalize on the credibility of the consortium and academic expertise to facilitate the internal acceptance and transfer of knowledge within their organizations. The institutional reputation helps managers overcome internal resistance and integrate external insights into their organizational practices, ultimately leading to enhanced innovation strategies.

By looking at the entire impact of middle managers' engagement in STIM on their dynamic capabilities across three key areas (sensing, seizing, and reconfiguring) we observed that managers initially develop what we called the capability of *Cultivating a sensitivity to external ecosystems* that generates the initial shift in managers' perceptions of innovation management from a complex framework to recognizing the need for specific skills and tools. This is critical for identifying valuable external opportunities, showcasing the heightened awareness and understanding that STIM participation fosters.

Moving to the Seizing capability, the focus is on the application of acquired knowledge. The capability demonstrated of the *Strategic utilization of precedent expertise* cultivated with the participation in STIM, allows managers to not only harness knowledge from diverse sectors but also to adapt and apply these insights to their own environments effectively. It underscores a growth in their capability to both seize new opportunities and respond to emerging threats by leveraging the shared experiences and problem-solving techniques of their peers.

Finally, the Reconfiguring capability, expressed in the capability of *Leveraging Institutional Credibility for Knowledge Internalization*, highlights the transformation of communication within the organization. Managers face the challenge of sharing and internalizing external knowledge within their company's boundaries. The continuous engagement in STIM empowers them to develop the necessary language and communication skills, thereby enabling them to reconfigure their knowledge bases and set effective strategies for knowledge dissemination, overcoming the inherent cognitive resistance within their organizations.

Table 4 provides a summary of the key outcomes of middle managers' engagement in the STIM consortium across the three aggregate dimensions: *Cultivating a Sensitivity to External Ecosystems (Sensing)*, *Strategic Utilization of Precedent Expertise (Seizing)*, and *Leveraging Institutional Credibility for Knowledge Internalization (Reconfiguring)*. Each dimension illustrates a distinct phase of capability development and the associated results of participation in the consortium.

5 Discussion and conclusion

5.1 Theoretical contributions

The first contribution of this study relates to the transitional role of middle managers (Phillips et al., 2008) in external knowledge acquisition and the ways in which OI fosters their dynamic capabilities. Our findings provide new insights into how middle managers make sense of external knowledge and position themselves as knowledge translators. This aligns with Beech (2000) and Harding et al. (2014), who emphasize that building relationships helps middle managers refine their identity, thereby establishing a foundation for strategic decision-making. This process strengthens the microfoundations of seizing capabilities and enhances their communication skills, which are crucial for effectively transferring external

Table 4 The results of the engagement

	Results of the engagement
Cultivating a sensitivity to external ecosystems (sensing)	Managers perceived innovation management as a complex framework. This process recognized the importance of acquiring adequate skills and tools to identify external sources for valuable opportunities
Strategic utilization of precedent expertise (seizing)	Through STIM participation, managers exploit the knowledge acquired by others in different sectors, adapting it to their environment. The experience shared by other managers helps participants to recognize similar incoming threats implementing similar problem-solving approaches for various problems. This approach increments, on the one hand, their ability to seizing opportunities and responding to emerging threats. On the other hand, managers exploit others' experiences, re-adapting tailored solutions to their company
Leveraging institutional credibility for knowledge internalization (reconfiguring)	Sharing external knowledge within the organization's boundaries is usually very challenging for managers. Continuous participation in STIM initiatives helps managers acquire adequate vocabulary and improve their communication skills. This pushes managers to reconfigure their knowledge bases to set the right approach to make the knowledge available for their organization overcoming the internal resistance of rigid cognitive mechanisms within the organization

knowledge within organizations. Furthermore, our findings expand the understanding of middle managers' brokerage role in acquiring and assimilating external knowledge (Glaser et al., 2021). By engaging in these activities, middle managers bridge the gap between different knowledge domains, simultaneously enhancing their cognitive abilities and improving their capacity to translate and integrate new insights into their organizational contexts. This dual role—as knowledge brokers and translators—is essential for increasing innovation and organizational adaptability, highlighting the critical contribution of middle managers in leveraging complex knowledge landscapes.

Managers with prior experience in dynamic markets and organizations are typically more prone at developing transversal skills, enabling them to apply knowledge across different contexts (Gavetti, 2012). However, prior research has mostly focused on top managers as the key figures in sensing, seizing, and transforming opportunities (e.g., Nonaka et al., 2016). Given their strategic position, top managers are often seen as the primary drivers of dynamic capabilities, leveraging their broad environmental understanding and accumulated knowledge to develop effective strategies. In contrast, middle managers occupy a distinct intermediary position, bridging the gap between top management's strategic vision and the frontline's specialized expertise (Heaton & Teece, 2013).

Due to this intermediary role, middle managers play a pivotal function in renewing the firm's DC pool, translating external learnings into new organizational routines (Ambrosini et al., 2009). They integrate knowledge from multiple sources—including frontline operational insights, strategic directives from top management, and academic expertise from scholars and publications (Burgess & Currie, 2013; Kucharska, 2022). However, middle

managers often struggle to effectively organize and prioritize this amount of information, particularly in peer interactions, due to concerns about protecting competitive advantages (van Niekerk & Jansen van Rensburg, 2022). By observing and analyzing these mechanisms, our study provides valuable insights into how middle managers absorb, structure, and systematize external knowledge, addressing the gap identified by Radaelli and Sitton-Kent (2016).

We find that while the literature underscores prior experience as a key enabler of managers' sensing capabilities, even inexperienced managers can initiate cognitive learning paths focused on attention and perception. This supports Phillips et al. (2008) argument that middle managers have the potential to adopt new ideas. Our findings further the theoretical understanding of middle managers' transitional roles, showing that even those without extensive experience can successfully engage in knowledge assimilation and dissemination processes. These insights contribute to the broader discourse on middle managers' roles in innovation and organizational learning, underscoring their capacity to bridge diverse knowledge domains within their organizations.

The second contribution expands the microfoundations framework of dynamic managerial capabilities (e.g., Helfat & Peteraf, 2015), emphasizing the importance of social mechanisms and interactive processes in triggering positive learning behaviors. While existing literature acknowledges the role of sensing, seizing, and reconfiguring in dynamic capabilities, it offers little detail on the specific managerial actions driving these processes (Ariwibowo et al., 2024). Our study addresses this gap by illustrating how middle managers' day-to-day routines evolve through their participation in the STIM consortium. Managers progressively develop the ability to sense external opportunities through engagement with new knowledge networks, while seizing is facilitated by adapting peer-shared expertise to their organizational contexts. These findings underscore the importance of managerial actions like peer collaboration and adaptive problem-solving, which are essential for developing dynamic capabilities at the micro level. This offers practical guidance for university–industry partnerships aiming to enhance these capabilities.

While much of the prior work has focused on internal mechanisms, our research highlights how middle managers' perception of external dynamism—specifically their ability to gauge and share their understanding of environmental changes—plays a crucial role in driving capability renewal. This aligns with the theory of weak ties (Granovetter, 1973), which posits that engagement with communities of practice enlarges managers' networks, enabling them to access diverse knowledge and foster intuitive judgment by integrating new perspectives, re-evaluating past experiences, and re-focusing on their current context. Expanding on Crupi et al. (2021), our findings contribute to knowledge management theory by identifying enablers of knowledge acquisition.

Our third contribution introduces a hierarchical structure in the development of dynamic capabilities. While prior studies (e.g., Ambrosini et al., 2009) emphasized the need for renewal and regeneration of capabilities in turbulent environments, our findings show that this process is not solely reactive to external pressures. Instead, it is shaped by the progressive learning mechanisms that middle managers experience over time. We identify microfoundations that support DC development, particularly through continuous interaction with external actors and scholarly communities, where managers progressively enhance their sensing, seizing, and reconfiguring capabilities. This approach illustrates how external

knowledge acquisition and exposure to diverse perspectives enable managers to refine their cognitive and practical skills, ultimately strengthening their firm's competitive edge.

Our study provides new insights into the temporal ranking of capability development, showing that sensing capabilities are typically the first to emerge, followed by the sharpening of problem-solving and communication skills, and culminating in the improvement of reconfiguring abilities. These mechanisms, which we consider to be microfoundations, emerge progressively and, over time, underpin the construction of the three dynamic capabilities.

On this point, Salvato and Vassolo (2018) emphasize the role of human actions in enhancing managers' dynamic capabilities. Human actions generally encompass three elements: learned behavior, emotion, and cognition (Cohen, 2007; Hodgkinson & Healey, 2011). Each element can trigger specific actions. For example, logical deliberation drives ad-hoc problem-solving (Winter, 2003), inferential learning (Miner & Mezias, 1996), and search (Levitt & March, 1988); habit leads to routinized responses to external stimuli (Bargh & Chartrand, 1999); and emotions provoke automatic physical and cognitive reactions (Hodgkinson & Healey, 2011). Our findings highlight the importance of managers integrating these three elements—habit, cognition, and emotion—into a cohesive experience.

Through their participation in the Consortium, middle managers share ideas with peers in formal and informal settings, absorb new theoretical tools from scholars, and learn from others' experiences, thereby strengthening these three elements. First, habit is reinforced by attending regular meetings, which remove managers from their day-to-day environment and focus their attention on consortium activities. Second, cognition is enhanced through consistent participation in poster discussions, workshops, and research seminars conducted by other managers who share their experiences. Finally, emotion is triggered by exposure to a stimulating and dynamic environment that fosters innovative thinking.

Managers who are open to emotional influences are more likely to recognize external opportunities and suggest innovative courses of action. Based on our observations, capabilities related to sensing are the first to develop. In line with studies on middle managers' knowledge (e.g., Nonaka et al., 2016), acquiring basic information enhances managers' perception and attention, equipping them with the cognitive tools necessary to begin scanning the external environment. Next, managers improve their seizing capabilities by refining their reasoning and problem-solving skills through empathy, peer interaction, and participation in seminars and workshops. Finally, reconfiguring capabilities improve as managers engage in an iterative knowledge acquisition process, synthesizing and applying tacit knowledge effectively (Polanyi, 2009).

Additionally, we contribute to the literature on knowledge transfer by elucidating the lesser-researched impact of university–industry relationships focused on capability transfer. These collaborations play a significant role in bridging the gap between theoretical knowledge and practical application, enhancing the flow of capabilities from research to business environments. By participating in these partnerships, firms gain access to cutting-edge research and expertise, strengthening their own dynamic capabilities. This interaction not only fosters innovation but also broadens the understanding of how external knowledge sources, such as universities, influence capability development in corporate settings. Through this process, the synthesis of tacit and explicit knowledge becomes more robust, facilitating more effective capability transfer and application.

Our fourth contribution focuses on the process of capabilities renewal. OI enables middle managers to expand their knowledge base through diversified interactions, offering greater opportunities to acquire new external information. In this sense, our findings address the gap in the literature regarding the transfer of tacit knowledge between individuals and organizations. Prior work Zollo et al. (2002), Haleblian and Finkelstein (1999) emphasized learning from internal experience to improve performance but did not fully recognize the role of external experience. While previous research acknowledges the importance of trust and relational capital in knowledge transfer, it does not provide empirical evidence on how external acquisition and development of competencies are achieved (Teece et al., 1997; Ambrosini et al., 2009). Ambrosini et al. (2009) noted that individuals, such as a new CEO, could trigger capability renewal, but the literature has not sufficiently explored how such processes are developed and maintained at the individual level (Ma et al., 2023). Our findings demonstrate that companies can develop multiple dynamic capabilities simultaneously through concurrent learning (Bingham et al., 2015), showing how middle managers transfer knowledge across different processes. However, our research also identifies additional mechanisms beyond experience and codification (Bingham et al., 2015), which are crucial for the development of dynamic capabilities. Moreover, while Ambrosini et al. (2009) and D'Aveni (1995) emphasized turbulent environments as drivers of dynamic capability development, our findings reveal that exposure to the routines of others and credible external examples also incentivizes renewal and regeneration of dynamic capabilities.

The final contribution relates to the microfoundations that drive dynamic capabilities' progression (Zahra et al., 2006). Regarding sensing microfoundations, engagement in research-oriented projects enhances managers' theoretical background, enabling them to acquire technology and innovation management competencies while reducing the fear of novelty. These skills subsequently contribute to seizing microfoundations, particularly in reasoning and problem-solving. Continuous interaction with scholars and an expanded network allows managers to accumulate specialized knowledge, compare experiences, and refine their cognitive and practical skills. Lastly, engagement with scholars enhances managers' reconfiguring capabilities by improving personal and technical skills, particularly in communication and decision-making. This enables managers to confidently communicate and promote external knowledge internally.

Whilst previous studies noted that differences in objectives and cognitive frameworks often lead to ambiguity and misunderstandings, little was known about the interventions that bridge these gaps (O'Dwyer et al., 2023). Our study finds that the credibility and reputation of the STIM consortium helped managers overcome cognitive resistance within their organizations, allowing them to reconfigure internal practices to better integrate external knowledge. The ability of managers to leverage institutional credibility for internal acceptance and knowledge transfer bridges the cognitive and cultural divide, providing a concrete mechanism for overcoming these barriers.

5.2 Implications for managers

Our findings offer several key implications for managers and organizations. First, rather than investing resources in isolated initiatives to enhance DC at the individual level, companies should consider increasing their participation in OI environments and structured shared learning experiences that are specifically tailored for middle managers. These environments

promote interpersonal experiences that help managers develop their sensing, seizing, and reconfiguring capabilities. Companies should actively support managers in building relationships with peers from other companies, universities, research institutions, and government bodies, as these ties facilitate knowledge acquisition and application.

The engagement in skills-based communities of practice—such as the STIM Consortium—can serve as a valuable learning platform for managers, enabling them to acquire skills that are often not covered in traditional training programs. As highlighted by Mortara et al. (2022, p. 161), reflecting on lessons from the pandemic, "encouraging an innovation management education should be paramount. […] so that physicists, biologists, doctors, and all the specialists, who might play a potential role in innovation, will not have to learn from their own experience in real-time when fighting a crisis but instead have theoretical grounding to inform their innovation decisions." This principle applies to middle managers, who benefit from structured learning ecosystems that help them develop critical innovation management skills proactively, rather than in reaction to emerging challenges.

Second, organizations should focus on improving internal knowledge-sharing systems to ensure that insights gained from external OI experiences are effectively disseminated within organizational boundaries. Creating formalized mechanisms for knowledge transfer, such as internal workshops, innovation task forces, or cross-functional knowledge-sharing sessions, can help translate externally acquired knowledge into tangible organizational improvements.

Promoting open dialogue among colleagues within the company can replicate the positive learning patterns observed in OI environments, reinforcing internal collaboration and strengthening intra-organizational ties. This, in turn, helps reduce resistance to change, mitigate conflicts, and facilitate the implementation of innovation-driven strategies.

Third, organizations must recognize that while OI provides valuable opportunities for capability development, managers may face challenges in organizing, prioritizing, and applying external knowledge. Companies can mitigate these barriers by ensuring strategic alignment between OI engagements and business objectives, encouraging trust-based collaborations, and providing incentives for active participation in external innovation ecosystems. By implementing these strategies, firms can maximize the return on investment from their managers' involvement in OI and enhance their overall innovation performance.

5.3 Limitations and future research directions

Like other studies, this shows limitations that also provide opportunities for future research. First, this study focuses on a specific single case study. Also, it is grounded on a particular research-based university–industry consortium. Thus, it should be read as such, and its results should be expanded to other settings carefully. Furthermore, the paper's qualitative nature and the sample's bias affect the study's generalizability of the findings.

However, considering the limitations, the study might generate new avenues for further exploration. For example, a possible field of study might focus on the role of middle-level managers' traits, such as skills or professional backgrounds, in improving dynamic capabilities. Also, replicating the study in a different type of consortia or engagement experience might offer new insights. Further, implementing different methodologies (e.g., quantitative or mixed) could offer a more general view. Furthermore, what is needed to reach a deeper understanding of the real impact of such improvement in managers' capabilities is the obser-

vation in the long term of the output obtained within and by the companies. Future research questions might delve into, first exploring the competitive advantage gained by companies involved in different types of collaborations compared to their competitors, and second, observing the results obtained by managers in the long term (such as new product development, optimization of internal processes, and career improvements) and the type of relationships built with top managers.

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Author contributions A.C. and L.M. jointly conceived the study and conducted the literature review and developed the theoretical framework, while A.C. managed the data collection and analysis. L.M. contributed to the validation of data and results. Both authors contributed equally to the interpretation of results and discussion. A.C. and L.M. co-wrote the main manuscript text, and both reviewed and approved the final version of the manuscript.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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