



Technology transfer services impacts on open innovation capabilities of SMEs

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ARTICLE INFO

Keywords:

Technology transfer services
Intermediary organisations
Open innovation
Open innovation capabilities
Embedded case study
Small and medium enterprise

ABSTRACT

Given the limited R&D investments, small and medium enterprises (SMEs) need to orchestrate their innovation capabilities and remove technological bottlenecks properly. To enhance their possibilities and results from collaborative activities, they can refer to intermediaries that foster knowledge and technology transfer (TT) in an inter-organisational setting. This paper aims to study how the services provided by TT intermediaries can impact specific open innovation (OI) capabilities of firms acquiring these services. OI capabilities are distinguished into potential absorptive capability, realised absorptive capability, external identification and external commercialisation. We conducted an embedded case study research, with the TT services offered by AREA Science Park, the leading Italian Scientific and Technological Park, as the main unit of analysis. The analysis of OI capabilities enhanced in eight SMEs advised by AREA revealed that the types of TT services provided by AREA could be grouped into specific packages, summarised in a resulting framework of impacts of intermediary TT services. The study results contribute to the interplay between TT and OI literature and are helpful for both TT intermediaries and SME managers in designing and selecting the services according to the capabilities they would like to enhance and the type of collaborative innovation they would like to pursue.

1. Introduction

Most economies are mainly characterised by small and medium enterprises (SMEs) that are considered a driving force of modern economies and competitiveness, thanks to their innovative aptitude. Nevertheless, SMEs are more vulnerable to the complexity of new technologies and the uncertainty in technological development, with the need to properly orchestrate their capabilities to remove technological bottlenecks (Masucci et al., 2020). This could result in a scarcer ability to shape the external environment compared to medium and large enterprises, resulting in a limited market presence, demand fluctuation, and niche customer base (Santamaria et al., 2009). Given their low expenditures and suitable qualified technical staff in research and development (R&D), SMEs need to identify and properly transform knowledge inputs for new technological developments (Audretsch and Caiazza, 2016). They can consider collaboration with external sources of knowledge, in an open innovation (OI) perspective, mainly at the later stages of innovation for marketing and commercialisation purposes (Lee et al., 2010). However, they can benefit from collaborative practices

while building the overall innovation strategy (Milshina and Vishnevskiy, 2018). In this sense, SMEs represent one of the key areas of research on OI, with increasing attention to the contingencies of innovation processes (Bogers et al., 2018) and the diversity in OI adoption dynamics (Barrett et al., 2021).

Many SMEs refer to innovation intermediaries, who act as brokers in the innovation process between two or more parties, mapping and finding external knowledge, and creating a bridge between firms and knowledge to support innovation (Howells, 2006; Lichtenthaler and Ernst, 2008). These intermediaries can specialise in the provision of specific services for fostering knowledge and technology transfer (TT), intended as the transfer of specialised know-how to sustain competitive advantage or, in general, benefits of firms (Zhao and Reisman, 1992) that collaborate in an inter-organisational setting (Battistella et al., 2016) in different stages of their value chain (Landry et al., 2013). In this sense, intermediaries can play a fundamental role in activating the OI model with diverse roles, such as organising and distributing resources (Polzin et al., 2016), facilitating networking and relationships among different actors (Hakkarainen and Hysalo, 2016), and shaping

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<https://doi.org/10.1016/j.techfore.2023.122875>

Received 28 November 2022; Received in revised form 15 September 2023; Accepted 18 September 2023

Available online 22 September 2023

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collaboration patterns in the entrepreneurial ecosystem (Hernández-Chea et al., 2021).

Firms are shown to benefit from the close proximity to TT providers, as they can use knowledge spillover to enhance their innovative activities (Audretsch and Caiazza, 2016). Nevertheless, there is little research on the effect of TT from the industry side, especially from the perspective of SMEs (Bengoa et al., 2021). Moreover, the studies on the type and extent of the interactions between SMEs benefitting from TT intermediaries, and other OI actors, such as universities or public research centres, present some inconclusive results (Albahari et al., 2022). A further exploration of intermediary TT services matching SMEs' collaboration model is required, analysing how their OI capabilities developed and then institutionalised (Zynga et al., 2018). A possible level of analysis examines both the intermediary and the firms located (Phan et al., 2005), but previous studies mainly analysed the opposite perspective, i.e. the effect of the OI process on the TT and the technology value pursued by firms (Yun et al., 2018).

This study aims to study how the OI capabilities of SMEs can be enhanced by specific TT services offered by a TT intermediary, and thus how intermediaries can structure their offerings to foster specific patterns of capabilities of SMEs to orchestrate inbound and outbound OI. We build on the literature on OI capabilities and innovation intermediaries to answer the following research question: *How can intermediary TT services impact on the OI capabilities of SMEs adopting them?*

We adopt an embedded case study research methodology for theory building, with the aim to investigate the key constructs of TT services and OI capabilities and the presumed interrelationships between them within a contextualised organisational setting (Corley and Gioia, 2011; Miles and Huberman, 1994; Yin, 2018). Moreover, case study is an effective method for answering to 'how' questions (Yin, 2018) and carrying out research in the SMEs context (Chetty, 1996). The main unit of analysis is represented by the services provided by Area Science Park (AREA), the main Italian Science & Technology Park. We purposefully selected as embedded unit of analysis eight SMEs that acquired the services offered by AREA and were successfully deploying OI initiatives at the time of the study. Among TT intermediaries, the science/technology parks, together with incubators, are particularly suitable for enabling R&D through a mutual collaboration of SMEs, as they do not often own the necessary resources to develop their innovation activities internally (Wright et al., 2008). In particular, we observe how 15 types of TT services provided by a TT intermediary can be distinguished according to their ability to enhance – and thus have a major impact on – certain OI capabilities of SMEs benefitting from them.

The paper is structured as follows. The following section of the paper presents the theoretical background and defines the role of intermediaries and TT services, how they can enhance OI initiatives in advised SMEs, and the different OI capabilities from the literature. The third section synthesises the research methodology. A description of Area Science Park, its TT services and the results in terms of TT and OI capabilities of the eight SMEs are illustrated in the fourth section. These are then discussed in a framework of the impacts of intermediary TT services on the OI capabilities of SMEs. We conclude with a summary of the contributions and limitations of the study.

2. Theoretical background

2.1. TT intermediaries and services

TT can be defined as the process of transferring or spreading knowledge and technology via some channels from one individual or firm to another entity (Devine et al., 1987; Gibson and Smilor, 1991; Inkpen and Dinur, 1998). The process of transfer involves several efforts to share knowledge, skills, technologies and processes with different actors who can further develop and exploit the acquired technology in new applications, materials, products, processes or services (Cunningham et al., 2019). Usually, TT activities occur between three main

actors: universities, government and businesses (Etzkowitz, 2003). In addition, several intermediary organisations seek to bridge the gap between these actors, especially academia and entrepreneurial players and organisations, facilitating the TT activities and the successful diffusion of innovation and knowledge in cooperative relationships (Fai et al., 2018; Kant and Kanda, 2019). Such intermediaries can be identified as Technology Transfer Organisations or Offices in universities, consulting firms, agencies, science/technology parks and incubators.

Intermediaries play the role of boundary spanners that take the knowledge (tacit or explicit) from one domain or source and move it to be applied in another one, bridging the gap between them (Wright et al., 2008). They act as agents between institutions in imperfect knowledge markets, as links for firms sourcing external know-how, and as providers of access to complementary assets for technology development (Shohet and Prevezer, 1996). As brokers of the innovation system, they use their knowledge, expertise and network-based skills to integrate "their client interface (supply side of innovation) and market interface (demand side of innovation)" (Gao et al., 2021). They play an essential role in the relational context (Battistella et al., 2016) and in the organisational practices for the diffusion of technology (Siegel et al., 2003). Thus, it is pivotal for intermediaries to identify proper services and relationships with their clients, especially those with a higher orientation towards innovation, which allows technology brokers to achieve high-effectiveness performance (Roxas et al., 2011). To this aim, they consider the needs and requirements of both their intermediary role and their clients (Howells, 2006). For example, they can transfer knowledge and technology from one actor to another without taking ownership of the technology, merging the transferred knowledge with additional technology acquired in previous activities or even offering disruptive solutions to clients; they facilitate the establishment of contact between two or more parties identifying the suitable partners and enabling the terms of the transaction; they coordinate the interactions among partners without creating a direct relation among them as in the case of aligning contributions from parties involved in a common project (Aspeteg and Bergek, 2020).

In this sense, intermediaries enable the innovation processes through numerous and diverse activities, such as collecting and allocating resources and facilitating networking and partnership among the different players (Hakkariainen and Hyysalo, 2016). Previous literature presents differing views on identifying such intermediaries, e.g. distinct entities and brokers, and their activities (Kivimaa et al., 2019). This research investigates the TT services from the viewpoint of 1) the literature on TT and diffusion, as intermediaries between sources and adopters of an innovation (technology), and 2) the literature on innovation intermediaries, focusing on the type of activities the intermediaries are involved in, and thus the services they provide to firms to enhance their innovation potential (Howells, 2006; Landry et al., 2013; Roxas et al., 2011). The following Table 1 summarises and classifies the main TT services that are identified in literature among TT intermediary functions (Albats et al., 2022; Bessant and Rush, 1995; Lane, 1999; Howells, 2006; Landry et al., 2013), into a total of 15 types of services.

The most cited types of TT services include market information scanning, technology needs and opportunities assessment. Such services comprise accessing, bridging and recombining knowledge, skills and technologies, and commercialisation of technological innovation. Beyond the identification of technology commercialisation opportunities, there is a continuum of intermediary services (Lichtenthaler and Ernst, 2008). Many intermediaries have now evolved towards solving companies' problems by looking for technology worldwide rather than increasing local knowledge transfer (Wright et al., 2008).

The intermediaries support TT activities at the implementation level and in the initial phase: they assist in gathering information, identifying and analysing the opportunities and assessing the limits and benefits of technology development (Battistella et al., 2016). The intermediaries can also play as 'third-party' agents in accreditation and quality standards, by providing advice on standards and setting and verifying them

Table 1

– Typology of TT services offered by the intermediaries according to the literature.

Types of TT services	Bessant and Rush, 1995	Lane, 1999	Howells, 2006	Landry et al., 2013	Albats et al., 2022
1. Market information scanning	Building linkages with the external knowledge system	<ul style="list-style-type: none"> Product information (determining what exists in the marketplace) Local or national surveys (assessing the size and composition of markets) Market research (analysing market opportunities) 	Information scanning and technology intelligence		Scanning and information processing
2. Technology foresight and roadmapping	Knowledge (education, information and communication) about new technology		Foresight, forecasting and technology roadmapping		Foresight and diagnostics
3. Accreditation and quality standards			Accreditation and standards	Product and process safety certification	Accreditation and standards
4. Locating technology and knowledge sources	Locating key sources of new knowledge	Marketplace gateway (accessing information and resources in a field)	Scoping and filtering (Selection of collaborative partners)	Help access ideas and information related to research, technologies, production equipment, and patents	
5. Patent and IP analysis			Intellectual property (IP) rights advice		IP management
6. Technology needs and opportunities assessment	<ul style="list-style-type: none"> Articulation of specific technology needs Selection of appropriate technology options 	<ul style="list-style-type: none"> Idea/invention clearinghouse (screening devices for appropriateness) Opportunity analysis (assessing if technologies meet needs) 	<ul style="list-style-type: none"> Articulation of needs and requirements Technology assessment and evaluation 	Help specify needs related to research, technologies, production equipment, and patents	(technology) assessment and evaluation
7. Patent support			Matchmaking and brokering	Help firms prepare patent applications	
8. Accessing, bridging and recombining knowledge, skills and technologies	Identification, selection and development of skills and human resources needs		Knowledge combination of two or more partners; Generation of in-house research and technical knowledge to recombine with partner knowledge	Access to specialised equipment, facilities, and expertise to scale up manufacturing practices, processes, and technology	<ul style="list-style-type: none"> Knowledge processing, generation and combination Gatekeeping and brokering: Network building
9. Design, testing and validation of technological innovation		<ul style="list-style-type: none"> Prototype evaluation (obtaining stakeholder inputs) Research and development (improving prototypes, refining products) 	Testing, diagnostics, analysis and inspection; prototyping and pilot facilities; scale-up, validation and training		Testing, validation and training
10. Technical feasibility study	Project management, Managing external resources, Training and skill development, Organisational development	Concept reviews (securing feedback on market receptivity)		Prototype design and tests of technical feasibility (product testing)	
11. Financial support for technology development	Financial support: Investment appraisal			Access to commercial bank loans, angel investors, venture capital	
12. Commercialisation of technological innovation	Making a business case		Commercialisation: marketing, support and planning; sales network and selling; finding and organising capital funding	<ul style="list-style-type: none"> Provide assistance related to product positioning Help firms develop a business case Advertising and promotion of new products 	Commercialisation: exploiting the outcomes
13. Legal and contractual advice for technological innovation			<ul style="list-style-type: none"> Matchmaking and brokering (negotiation and deal-making) Contractual advice 	Legal issues: Negotiation and management of contractual agreements	<ul style="list-style-type: none"> Gatekeeping and brokering: Contracts Process of governance: Regulation and arbitration (Dispute resolution)
14. Development of business strategy and processes	Identification and development of business and innovation strategy			<ul style="list-style-type: none"> Help to create spin-offs design and implementation of business processes 	

(continued on next page)

Table 1 (continued)

Types of TT services	Bessant and Rush, 1995	Lane, 1999	Howells, 2006	Landry et al., 2013	Albats et al., 2022
15. Support to access marketing/distribution channels	Communication and implementation of business and innovation strategy			Access to (international) markets/distribution channels	

(Albats et al., 2022). Only a few authors consider it fundamental that TT services comprehend business-related issues as companies need to manage their products and technology effectively. In addition to these services, it is relevant to consider environmental aspects, financial support for technology development, as well as legal and contractual facets. TT services that link with other services to access capital and commercialisation lead to higher intermediary revenues and performance (Landry et al., 2013), while companies – and especially SMEs – require to enhance the production capacity and skills development, and thus competitiveness, by improving the technology development performance (Kim et al., 2010). In turn, intermediary services can result in a higher number and better quality of TT opportunities (Lichtenthaler and Ernst, 2008).

A further perspective could consider whether the TT services enhance the ability to embrace collaborative innovation initiatives for the firms that require these services, and their possible links to fully unleash the OI potential of firms.

2.2. Linking TT intermediaries and services with OI of companies

One measure of success of the intermediary function is the number of small-firm spin-offs (Rood, 1989), or the number of companies assisted and advised to compensate for the lack of capabilities and thus bridging the “managerial gap” (Bessant and Rush, 1995). Firms are highly heterogeneous and specialised in terms of internal resources, innovation capabilities, and capabilities to create value from knowledge (Landry et al., 2013), and also in TT activities. Kim et al. (2010) show that companies can strategically use intermediaries to enhance their technological capabilities better, but especially to foster the cooperative relationships needed to strengthen them effectively. Despite this, firms often cannot fully exploit the resources provided by intermediaries because they fail to align the supplied services with their internal activities (Lichtenthaler and Ernst, 2008).

On the one side, TT intermediaries should meet client firms’ needs and increase value for them by augmenting the degree of customisation of the solutions offered (Landry et al., 2013). TT services appear to be more successful when they are modelled considering the types of innovation to be generated in SMEs benefitting them (Cattapan et al., 2012). To this aim, a more detailed analysis of potential interactions between firms’ internal resources and intermediaries allows for a deepened understanding of interdependencies between the supplied activities (Lichtenthaler and Ernst, 2008).

On the other side, firms rely on services provided by intermediaries as a complement rather than as a substitute for their internal resources (Lichtenthaler and Ernst, 2008). TT intermediaries provide the social environment, the technological and organisational resources, and the managerial expertise missing in the firm to develop technological innovation (Phan et al., 2005). Firms, especially SMEs, aim to develop innovations for their market but also scale their venture by building internal capabilities to nurture future innovation potential (Barrett et al., 2021).

Bengoa et al. (2021) argue that there is a key relationship between TT and OI: firms lacking internal capacities search for different ways to engage in the OI process. For example, TT services offered by the intermediaries may help to increase the member firms absorptive capabilities. Firms rely on the roles of the TT intermediaries as technology advisories and knowledge agents (Spithoven et al., 2010). Firms can also

complement and extend their desorptive capacities of external patent exploitation by cooperating with intermediaries (Ziegler et al., 2013). Moreover, it is demonstrated that intermediaries are effective in facilitating SMEs’ OI strategy (Lee et al., 2010), but further exploration of TT intermediaries’ services matching SMEs’ collaboration model is required. This should encompass both the absorptive and desorptive capacity, while previous empirical research has focused mainly on either the first or the second one (Aliasghar and Haar, 2021), and how these OI capabilities are developed and then institutionalised (Zynga et al., 2018).

2.3. OI capabilities

Nowadays, firms’ boundaries have become increasingly permeable, and firms are progressively adopting open and collaborative models to implement their innovation strategies (Chesbrough, 2019; Shaikh and Levina, 2019). Chesbrough (2006) defines OI as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively”. According to that, firms can mainly pursue two different innovation strategies: the acquisition of external technology in outside-in processes (inbound innovation), and the outward transfer of technology in inside-out processes (outbound innovation) (Chesbrough, 2006; Gassmann et al., 2010; Huizingh, 2011).

OI enables firms to leverage inflows and outflows of knowledge to be more innovative (Bogers et al., 2018). To this aim, companies should be able to develop a set of capabilities to absorb and assimilate external knowledge from different sources, or disseminate and commercialise technologies developed by internal R&D to the external environment, in an efficient and effective manner (Adamides and Karacapilidis, 2020).

This paper conceptualises OI capabilities as the organisational capabilities of firms to pursue and manage the inbound and outbound innovation initiatives, and thus to organise the knowledge inflows and outflows for an OI strategy, distinguishing them into the multidimensional constructs of *absorptive* and *desorptive* capability as in Aliasghar and Haar (2021).

On the one hand, to obtain the greatest benefits from the adoption of an inbound innovation strategy, firms should improve their *absorptive* capability since this attitude allows them to generate more significant competitive advantages deriving from the acquired external knowledge (Lichtenthaler and Lichtenthaler, 2009). The absorptive capacity indicates the ability of a firm to identify, integrate, exploit and apply new knowledge from external sources (Cohen and Levinthal, 1990) to produce a dynamic organisational capability (Zahra and George, 2002). Indeed, it is positively related to a range of different organisational outcomes involving organisational learning (Lane et al., 2001), detection of opportunities (Saemundsson and Candi, 2017), acquisition of technology (Haro-Domínguez et al., 2007), and firm performance (Ferrerías-Méndez et al., 2016; Kostopoulos et al., 2011; Lane et al., 2001). To these aims, firms ability is using knowledge from outside their boundaries (Bedford et al., 2022; Bouguerra et al., 2020) while strengthening, matching or relocating their own knowledge (Lane et al., 2006). Moreover, the absorptive capability is considered not only a knowledge-creation tool in technology-related sectors, but also a “business knowledge referring to customers, suppliers, competitors, partners, and general industry information” (Ben-Oz and Greve, 2015, p. 1831). This capability is crucial to understanding the various innovation

forms as a successful OI (Cordero and Ferreira, 2019; Zobel, 2017).

The absorptive capability includes two dimensions: potential absorptive capability and realised absorptive capability (Zahra and George, 2002).

The *potential absorptive capability* involves identifying and understanding the valued knowledge produced in the external environment in relation to a technology acquisition (Aliasghar and Haar, 2021; Zahra and George, 2002). It entails a renewal of the technology base with an acquisition, thanks to 'active listening' and the receptiveness of the firm to external knowledge (Liao et al., 2003; Jiménez-Barrionuevo et al., 2011). For example, firms are able to thoroughly observe the new technological trends, and to quickly analyse and interpret them for new knowledge assimilation (Aliasghar and Haar, 2021; Jansen et al., 2005). A firm must be aware of the internal technology correlated with the knowledge it intends to acquire because this is the only way to make a successful acquisition from the outside (Cohen and Levinthal, 1990; Zahra and George, 2002). Therefore, a high potential absorption capacity allows renewal of the firm's internal technology, enhancing its strategic flexibility and improving the innovation performance (Zahra and George, 2002).

The *realised absorptive capability* entails transforming and exploiting the external knowledge acquired (Zahra and George, 2002). It means the capability to leverage, transform and deploy absorbed knowledge for commercial ends (Jansen et al., 2005; Matusik and Heeley, 2005). For example, it defines the attitude to grasp the opportunities and applying newly acquired technologies in new products (Aliasghar and Haar, 2021). A high level of realised absorptive capability permits the firm to maintain a competitive advantage by exploiting the technology acquired in the internal innovation processes.

On the other hand, the *descriptive capability* means the ability of the firm to identify and transfer knowledge for external exploitation. A firm can identify TT opportunities through the outbound innovation strategy and simplify and assist the application of the technology to the recipient (Lichtenthaler and Lichtenthaler, 2010), while implementing efficient intellectual property protection to avoid potential risks deriving from the outward transfer of technology (Bigliardi et al., 2020). The concept of descriptive capacity was first mentioned by Lichtenthaler and Lichtenthaler (2010, p. 158) in technology management studies, defining it as "an organisation's ability to identify TT opportunities based on a firm's outward TT strategy and to facilitate the technology's application at the recipient." By leveraging this capability, firms that orchestrate outbound OI strategically can accelerate technological progress and thus remove technological bottlenecks in the firms they collaborate with (Masucci et al., 2020). The descriptive capability includes two different constructs: external identification and external commercialisation (Aliasghar and Haar, 2021).

The *external identification* is the capability of a firm to recognise external TT opportunities. A firm with relevant knowledge should be able to identify its advantageous applications and the possible buyers. It is essential to comprehend the requirements of the potential customers to propose relevant applications and extract value from the license agreements (Davis and Harrison, 2002). External identification indicates the firm's capability to identify external TT opportunities. While external recognition is crucial for successful external technology exploitation, it is often undervalued (Lichtenthaler and Lichtenthaler, 2010). Firms are often unable to recognise potential applications and buyers to purposefully licensing their technology to third parties: "they need to understand customer needs to target applications, identify, assess, and select licensees" (Danneels, 2007, p. 531). Thus, *external identification* capability could entail actively trying to identify external opportunities for out-licensing, and employ additional resources to this aim (Aliasghar and Haar, 2021).

The *external commercialisation* concerns the firm ability to transfer its internal technology outside its boundaries and assist its application and use from the external partner (Lichtenthaler and Lichtenthaler, 2010). In this case, a firm should be able to commercialise its know-how or co-

develop it with an external partner (Chesbrough and Garman, 2009). In some cases, the lack of complementary resources to commercialise new technologies could force the firm to license unused assets and market its technologies externally. Furthermore, firms may invest in technology licenses to obtain new financial and strategic opportunities (Lichtenthaler, 2009), since they mainly focus on the time to market and financial gain (Siegel et al., 2003). In this sense, an example of *external commercialisation* capability entails being able to organised in an adequate and effective manner the transfer of the technology to the external parties (Aliasghar and Haar, 2021).

Table 2 reports the OI capabilities, related definitions and examples from literature.

The four OI capabilities, i.e. potential absorptive capability, realised absorptive capability, external identification, external commercialisation, are further investigated in the context of SMEs. These firms often lack the assets to effectively develop and exploit the complementary capabilities (Aliasghar and Haar, 2021; Cassiman and Valentini, 2016), thus it is interesting to further explore how TT services provided by an intermediary could impact the single capabilities or even their complementarity in SMEs acquiring them.

3. Research methodology

The links between TT services and OI capabilities are investigated in a single embedded case study in AREA Science Park, which is the leading multisectoral Science and Technology Park in Italy. We purposefully selected AREA as peculiar and important innovation intermediary in the European context, and indeed it comprehends all TT services presented in Table 1. As embedded unit of analysis, we then selected eight paradigmatic cases of SMEs experimenting with some of the TT services offered by AREA and successfully developing their OI capabilities.

AREA offers firms many important and high-quality services and promotes SMEs growth through technology development and innovation. The TT is one of the principal services offered by AREA. This service supports and encourages the innovation abilities of regional and also neighbouring (Slovenian and Austrian) enterprises, mainly targeting SMEs, through a vast network of relations of collaboration with regional and national research centres. The TT services of AREA are provided by intermediaries and facilitators of the know-how and technology flows of research centres and universities.

We selected the sub-units on the basic principles of theoretical sampling (Eisenhardt, 1989). Considered the focus of the study, we searched for SMEs that: 1) have acquired at least one TT service by AREA after 2015 (date of the most recent and important project of TT in AREA); 2) have adopted an OI inbound or outbound strategy or OI initiatives not >5 years after. First, we considered heterogeneous cases in terms of industry (both high-tech and more traditional industries as mechanical equipment) and mix of services acquired from AREA as from Table 1. Moreover, we selected the cases because of data access (Yin, 2018), i.e. those companies that answered a questionnaire post-service of AREA in a coherent and complete manner. We counted the companies that provided feedback on the impacts on their collaborative innovation attitude after implementing one or more services with AREA. Supported by AREA staff, we contacted these companies asking their availability to provide information on the effective deployment of OI capabilities before and after the use of TT services acquired. Third, the selection of the cases relied on the combination of ongoing TT activities and potential interest in the study aims (Siggelkow, 2007). All the cases are located in the same region and have a high level of R&D and innovation, as they were assessed and located in the technological park. Only Firm 1 is at the second request of services, while all the others are at their first experience. The main features of the eight cases that constitute the sub-units of our research are summarised in Table 3.

In developing the cases we drew on multiple sources of information to ameliorate the trustworthiness of the data (Lincoln and Denzin, 1994), the comprehension of the sampling choice (Cook et al., 1992),

Table 2
– OI capabilities.

OI capabilities	Definition	Examples	References
Absorptive capability	Potential absorptive capability It involves the identification and understanding of the valued knowledge produced in the external environment in relation to a technology acquisition	<ul style="list-style-type: none"> Ability in thoroughly observing the new technological trends Ability to quickly analyse and interpret trends for new knowledge assimilation Ability to grasp the opportunities from external knowledge acquired Ability to apply the newly acquired technologies in new products Ability to scan the environment for commercialisation opportunities, e.g., out-licensing 	<p>Aliasghar and Haar, 2021; Cohen and Levinthal, 1990; Liao et al., 2003; Jansen et al., 2005; Jiménez-Barrionuevo et al., 2011; Zahra and George, 2002</p> <p>Aliasghar and Haar, 2021; Jansen et al., 2005; Matusik and Heeley, 2005; Zahra and George, 2002</p>
	Realised absorptive capability It entails the transformation and the exploitation of the external knowledge acquired for technology application or commercial ends		
Descriptive capability	External identification It indicates the firm capability to identify external technology transfer opportunities	<ul style="list-style-type: none"> Employing additional resources to identify external technology transfer opportunities Ability to organise in an adequate and effective manner the transfer of the technology to the external parties Coordination of persons involved in selling the intellectual property 	<p>Aliasghar and Haar, 2021; Danneels, 2007; Davis and Harrison, 2002; Lichtenthaler and Lichtenthaler, 2010</p> <p>Aliasghar and Haar, 2021; Chesbrough and Garman, 2009; Lichtenthaler, 2009; Lichtenthaler and Lichtenthaler, 2010; Siegel et al., 2003</p>
	External commercialisation It concerns the firm ability to transfer its internal technology outside its boundaries and assist the application and use from the external partner		

Table 3
– Overview of case studies.

FIRMS	Industry	Sales	Employees	Products	Interviewees
1	Food	2 m	<25	Decaffeinated coffee	CEO, Product manager
2	Manufacturing	1 m	<25	Mechanical equipment for the food industry	Process engineer, Service manager
3	Manufacturing	2 m	<25	Anticorrosive coating	Technical developer, Process engineer
4	Food	10 m	50–100	Spirits	CEO, Marketing manager, Production planner
5	Manufacturing	1 m	<25	Boats construction and maintenance	Service manager, Senior technician
6	Manufacturing	3 m	<25	Electric motors	CEO, Senior technician
7	IT	0,5 m	<25	Knowledge sharing software	CTO, Project manager
8	Manufacturing	0,5 m	50–100	Paper	CEO, Production manager

and the triangulation of data types (Creswell, 1998). More specifically, we collected data available from companies websites, press releases, reports, and newspaper articles. We performed 5 interviews with AREA and at least 2 interviews for every company. The role of interviewees per each company are highlighted in Table 2. All the interviewed SMEs have received the services and training from AREA in the five years preceding our interviews (performed in 2020), and during our interview we asked also comparative questions about the situation before the service and after the service offered by AREA.

The semi-structured interviews followed the interview protocol (as in Appendix A) along three main topics: 1) the type of TT services received; 2) the OI approaches realised by the firm and the OI capabilities developed before and after the use of TT services by AREA; 3) the outcomes obtained and the nature of the impact of TT services on OI approaches. During interviews, the authors did not explicitly mention the list of OI capabilities, because they were conscious that

entrepreneurs hardly know the OI paradigm in-depth and that it was even more challenging to assess their capability in doing it. The authors asked some questions which have conducted the interviewees to define their OI approaches and initiatives, thus enhancing OI capabilities.

We followed Eisenhardt (1989) to examine themes, similarities, and differences across cases as well as to dissect a trend that characterises each impact of TT services. The three authors have separately scrutinised the data collected per each case by using the definitions of prior studies on TT services and OI capabilities and formed an independent view of each case. We then began a cross-case analysis to explore the existence of any consistent patterns of relationships across the cases (Eisenhardt, 1989). Per each case, we evaluated if the TT services impacted the OI capabilities, and which specific OI capability. During the cross-case analysis, we iteratively examined the qualitative data by moving back and forth between the theory, data, and literature to adjust for emerging theoretical relationships.

4. Case study results

4.1. AREA TT model and TT services in the analysed SMEs

Area Science Park is a National Public Research Centre that also manages one of the most important multi-sector Science and Technology Park in Italy. Located in the north-east of Italy, the main objective of AREA is to connect the business community and the international scientific institutions in the region. It mainly supports SMEs located in the region, also considering that some of the services provided are supported by regional funds. AREA provides different business development services along with support including: legal, fiscal and accounting consultancy, engineering and plant technology, occupational health and safety, marketing and promotion, information and assistance on EU programmes. It promotes the development of innovation processes and it can be considered a key facilitator of the collaboration between research and business, between the public and the private sectors, with initiatives also at the international level. AREA offers specialised skills for business innovation services, creation and development of innovative start-ups, human resources training in R&D fields, world-class technology facilities, infrastructures for industrial research, the attraction of new industrial investment and creation of innovative enterprises. It mainly provides paid support services for TT and innovation activities.

Specifically, the TT services can be requested directly by the firms to face a particular need, however AREA staff carries out an initial assessment of the company which allows to identify the organisation assets, evaluate the strengths and weaknesses and determine whether

the firm is able to act more effectively or efficiently than its competitors. As explained by an interviewee, “we also opt to identify the sectors that can potentially receive the TT services provided. Furthermore, we consider the geographical area in which the largest number of companies in that sector is present”. The services are paid, but vouchers are also provided for companies in order to facilitate payment. In some cases, the services provided are supported at a regional level or with European Union funds. Even partial payment of the services requires a greater commitment in their implementation by the beneficiary companies. Nevertheless, since these are SMEs with rather limited financial resources, this justifies the vouchers and some free services.

In addition, companies often require more than one service to achieve the intended purpose. These are agreed with the AREA staff in order to obtain the best result through the specific mix of services. As explained by an interviewee, “this helps to determine the best possible path for the company towards innovation [...] we propose some services which are shared and discussed with the company to evaluate the actual need and the path that the firm intends to follow in order to achieve the set goals”. Following the decision, AREA staff develops an intervention program that describes the TT activities the selected companies could carry out. A general agreement between AREA and the identified company is required to define the program’s implementation. The companies that receive the services can either be incubated or not within the park. Incubated firms are mostly technological companies active in the ICT, life science, circular economy sectors. Non-incubated companies can also operate in more traditional sectors. In particular, some companies in the sample observed carry out traditional activities but always with a certain innovative content which justifies the request for TT services.

Below we describe the TT services provided by AREA. These are analysed following the typology of [Table 1](#).

The TT1 *Market information scanning* means understanding the sectors environment. This service is a way for management to obtain important information about events that may occur outside the boundaries of the firm to guide the future activities. Indeed, it is important to analyse and monitor information about the size and growth rate of markets, consumer purchasing characteristics, competitors’ products and prices, and general economic trends. Through TT2 *Technology foresight and roadmapping*, research and development requirements are better defined, and existing innovative solutions identified. AREA staff develops an intervention program that describes a technological roadmap to foster innovation and assist management in planning and defining innovation strategies, especially in high-tech sectors where there are considerable uncertainties in technical progress, priorities, acceptability and social concerns. This roadmapping can guide the future development of a particular technological innovation by enabling management to identify key areas where maintaining competitiveness is critical. TT3 *Accreditation and quality standards* includes providing advice on quality standards, defining and verifying standards, and specifically covers the requirements based on criteria inspired by the ISO 9001 standard, the accreditation and certification required for specific activities. TT4 *Locating technology and knowledge sources* supports the firms to identify the necessary skills and competences that could drive innovation, also focusing on sources of technology and knowledge relating to specific sectors. This allows companies using this service to have easier access to the resources they need to carry out their business. TT5 *Patent and IP analysis* is a basic service to raise awareness of SMEs on the issue of intellectual property rights, highlighting the possible risks arising from emerging intellectual property. Typically, by searching in various patent databases, it benchmarks a technology’s patent portfolio and monitors competitors’ technology development efforts, highlighting similarities and differences with existing patents. The aim of this TT service is mainly raising awareness of SMEs on the issue of intellectual property rights, while the TT7 *Patent support* provides assistance for the patent procedure and therefore requires that the firm has an innovation to be patented. AREA supports companies in preparing and submitting patent applications, better tailored to the real needs of the company. In

some cases, a patent attorney provides free initial consulting to firms. TT6 *Technology needs and opportunities assessment* entails an analysis of the company’s technological needs in terms of resources, personnel, processes – also giving the firm certain advantages and disadvantages in meeting the needs of its target market – and an assessment of the opportunities (and threats) existing in the company environment. Conversely, TT8 *Accessing, bridging and recombining knowledge, skills and technologies* allows the firm to have a greater awareness of access to knowledge such as the ability to create, distribute and acquire information and experiences, thus to synthesizes and use them. AREA supports firms to detect a possible combination of knowledge between two or more partners or fields of knowledge, and to recombine internal research and technical know-how with the knowledge of other partners for a two-way exchange of understanding and mutual learning.

Concerning specific technological innovations, TT9 *Design, testing and validation of technological innovation* specifically covers the design, prototype evaluation and testing activities related to a new product, service or process and the validation of the technology and process conceived by SMEs. Through process validation, it is possible to collect and evaluate data from the process design stage during production that a given process can consistently deliver quality products. The TT10 *Technical feasibility study* is an in-depth research and financial analysis that advises whether to implement a new business idea or an original product. A technology audit is performed including also estimates of items such as revenue, costs, but also a forecast of possible obstacles and technical challenges. Usually, companies request feasibility studies to determine whether their innovative idea or new product is worth pursuing. The TT11 *Financial support to technology development* is then specifically aimed at providing assistance to companies in accessing funds, starting from venture capital investors. This intermediary activity has a significant influence on the product and process innovation of SMEs which often suffer from financial problems. Technological innovation are also supported by services such as the TT12 *Commercialisation of technological innovation*, which concerns the process of transforming an innovative technology into a commercial product or service or improving an existing product/service by incorporating the innovative technology into it for commercial profit. In addition, TT13 *Legal and contractual advice for technological innovation* is also provided in the case of TT matchmaking and brokering activities, negotiation and deal-making. Contractual obligations in the event of signing technology transfer agreements such as licensing agreements or legal protection are also considered, in the event of any disputes between the parties involved.

Finally, AREA assists in identifying and developing a business strategy aimed at innovation. After evaluating the resources and capabilities of SMEs and their ability to maintain a competitive advantage on the market, TT14 *Development of business strategy and processes* provides for the formulation of a business strategy aimed at determining the most suitable organisational structure to make the most of external opportunities. The business strategy also allows to identify the firm’s strategic positioning with respect to its competitors and the resource gaps that need to be filled by increasing and enhancing the organisation’s resources. As highlighted by an interviewee from AREA, “we also take care of making them aware about the development of a sustainable competitive advantage, thus they have to include distinctive skills or assets, they have to develop of appropriate processes and also create synergies [...] it is not only about the technological innovation per se”. In addition, through the TT15 *Support to access marketing/distribution channels*, it is ensured that a new technology gains rapid and sustained entrance to the market. Regarding distribution channels, AREA staff advice on related to product positioning, helps firms develop a business case and assists in advertising, promotion and distribution of the new technology or product for the SME’s customers.

The TT services adopted by the eight SMEs of the study are reported in [Table 4](#) and described below.

The service related to accessing, bridging and recombining

Table 4

- Types of TT services provided by AREA and implemented by case study firms.

Types of TT services	Firms							
	1	2	3	4	5	6	7	8
1. Market information scanning	x	x						
2. Technology foresight and roadmapping								
3. Accreditation and quality standards								
4. Locating technology and knowledge sources			x					
5. Patent and IP analysis	x	x						
6. Technology needs and opportunities assessment	x	x						
7. Patent support								
8. Accessing, bridging and recombining knowledge, skills and technologies		x	x	x	x	x		x
9. Design, testing and validation of technological innovation	x		x				x	
10. Technical feasibility study	x	x						
11. Financial support for technology development							x	
12. Commercialisation of technological innovation							x	
13. Legal and contractual advice for technological innovation							x	
14. Development of business strategy and processes							x	
15. Support to access marketing/distribution channels							x	

knowledge, skills and technologies is the more demanded TT service supplied by AREA. This service aims more than others to map and find the distributed knowledge internalised and rearranged within the firm to realise innovation. Six of the eight companies observed found this service particularly suited to their needs, as it makes it possible to identify the crucial competences that lead to innovation.

Three firms have benefited from the most significant number of TT services. Firms 1 and 2 requested various TT services such as market information scanning, intellectual property analysis, an overview of the technological needs and opportunities present in the market, and a technical feasibility study. This suggests a strong interest in an outward TT activity. However, only Firm 7 has requested financial support services for technology development and TT service aimed at business creation, such as development of business strategy and processes and support to access marketing and/or distribution channels.

The development of a business strategy that includes consulting services for enterprise creation as well as support for access to marketing and/or distribution channels are the least requested TT services as they involve an advanced stage of technological development within a company. Indeed, as highlighted by AREA staff, “creating a company from an innovative idea or a research project is complex, and then it is clear that this service is requested less frequently than others”.

4.2. Linking AREA TT services and OI capabilities in the analysed SMEs

The eight SMEs were purposefully selected for having acquired at least one TT service by AREA and adopting an OI strategy or initiatives. Firstly, as shown in Table 4, SMEs adopted different mixes that included all AREA services, except for TT2 Technology foresight and roadmapping, TT3 Accreditation and quality standards, and TT5 Patent support. Secondly, different innovation patterns emerged during the study, also in the cases adopting similar services. For examples, Case 2 and 3 declared to be very interested in implementing OI activities especially after their experience with AREA. For example, Case 2 initially received TT1 to gain more insights into the market of machinery for personnel and food-plant hygiene, then also asked TT6 for an analysis of the company’s technological needs in terms of resources, personnel, processes and an assessment of the opportunities offered by the market, and TT8 to acquire the ability to create, distribute and

obtain knowledge and experiences with new partners. The service manager states that “these services have helped the company to access new markets and to establish collaboration agreements with new partners”. Firms such as Case 4, 5 and 7 already carried out some research and development activities, but only recently has the entrepreneur promoted them within a better-structured OI strategy that exploited knowledge exchanges into new ideas or commercialisation opportunities. The CEO of Case 5 argued that the main OI projects are aimed at developing innovative solutions by “leveraging the specialised competences and especially the collaborative attitude of some of our supply chain companies [...] in the maritime industry with several competitors of different sizes is something that can make the different”.

The analysis on the specific OI capabilities revealed that most SMEs confirmed their interest and investments in activities aimed at scanning and exchanging ideas with networks of people and companies, thus enabling a *potential absorptive capability*. Main efforts were addressed through interactions with different kinds of organisations and the general public to bring new knowledge, development methods and experiences into the firm. Thanks to AREA’s dedicated information services, they started to actively participate in virtual communities, to share interests and gather ideas from experts and groups of interest on the same kind of technology. With TT10 Technology needs and opportunities assessment offered by AREA, Case 1 has been able to improve its potential absorptive capacity by thoroughly observing the new technological trends in the coffee segment, as reported by the CEO: “the service of AREA permitted us to identify younger customers as future possible market segment, following a sociological trend of earlier use of coffee but healthy”. Case 2, dealing with construction of stainless steel equipment for the food industry, asked TT4 to identify sources of technology related to the company’s business to detect new technologies to broaden the range of products and TT5 to consider the possibility of protecting in the future the innovative ideas.

Indeed, Case 2 has also in place several research collaborations with public and private research structures (universities, but also fab labs or technology developers), to serve as use cases for developing their technologies. As the majority of the interviewed firms, they improved their ability to effectively combine external knowledge insights, with existing ones, to be exploited into new technologies or even value offers, demonstrating a *realised absorptive capability*. TT8 Accessing, bridging and recombining knowledge, skills and technologies was fundamental for Case 4 to exploit the knowledge acquired on the best practices of the consumer goods best player to be combined with the local heritage of production of spirits. Some firms mention the improved attitude in scanning customers’ innovative ideas, especially the historical ones showing a more collaborative attitude. The technical developer of Case 3 stated that with TT9, the company received information relating to the design, testing and prototyping activities relating to new coatings and paints specifically designed for use in marine environments and “now we are able to apply the new technologies acquired in eco-friendly coatings and to specialise in customised solutions based on customer needs while also taking into account environmental sustainability”. Also Case 7 was able to better apply the newly acquired technologies from the collaboration with research centres in new products, i.e. software. Other cases leveraged these opportunities mainly to update their competences and exploit the latest developments carried out more systematically in other kinds of organisations. For example, TT10 Technical feasibility study was fundamental for Firm 2 to “design the optimal solution on clients layouts in compliance with health and hygiene regulations and to produce a new line of machinery for personnel and plant hygiene”, as argued by the process engineer.

Interestingly, the interviewed firms also leveraged the TT services to enhance their outbound innovation strategy better. Some interviewees argued that they acquired some essential abilities and proactivity in identifying and selecting opportunities for commercialising some of their innovative ideas, thus enabling a *potential desorptive capability* or *external identification*. The TT service of TT6 Technology needs and

opportunities assessment and TT9 Design, testing and validation of technological innovation permitted to have a review about market receptivity and trying to scaling-up the business in decaffeinated coffee of Case 1, as highlighted by the product manager “by reinforcing the product lines of specialty drinks and artisan coffee that are on the rise”. With the adoption of TT8, the CEO of Case 6 argued to be able to “identify the opportunities offered by the market in terms of new technologies that could be combined with internal knowledge and understand if there were real possibilities of being able to license some proprietary technologies already covered by patent”. In these firms, the role of the entrepreneur emerged to be very important as the main broker of knowledge and technology.

Only few firms invested in an effective transfer of their knowledge or even technology, by reaching an effective external commercialisation capability. Case 5 activated temporary contract agreements with some suppliers of main components to let them apply their competences in the construction and maintenance of boats, but also with some competitors, considering the potential wider opportunities to be reached in terms of competitiveness and innovation frontier in the maritime industries. Case 7 invested in a technology license to strategically extend the target markets, and adopted a rich mix of service to support the technology development from multiple viewpoints, from the evolution of regulation and quality certification for legal purposes (TT13) to the support to access marketing/distribution channels (TT15), considering that these were not a core competence for the SME. As highlighted by the project manager “our company is producing customized software, then our customers are the real driver of innovation. That is why a support related to marketing proposed by AREA was important for us to acquire new knowledge on customers and organize to transfer the new products to them”.

To sum up, results show that different services can foster different kinds of OI capabilities. The following Table 5 reports the linkages between TT services of AREA and OI capabilities of SMEs adopting them, by ordering the TT services according to the major impact they have on certain OI capabilities.

As highlighted in the Table, the analysis reveals that TT services can be grouped in packages to be designed by the TT intermediary to enhance both absorptive and desorptive capabilities of SMEs acquiring the services. Group III and IV of TT services emerged to mainly foster respectively *desorptive* and *absorptive capability*. On the one hand, the services that are part of the III group are more oriented towards the

external identification, i.e. the capability of a firm to recognise external technology transfer opportunity, and external commercialisation, i.e. the firm ability to transfer its internal technology outside their boundaries and assist its application and use from external partner. Indeed, *Financial support for technological innovation* is a service that assists companies in accessing funds, *Commercialisation of technological innovation service* concerns the process of transforming an innovative technology into a commercial product or service, *Legal and contractual advice for technological innovation* regards contractual obligations in the event of signing technology transfer agreements, *Development of business strategy and processes* service provides the formulation of a business strategy aimed at determining the most suitable organisational structure to make the most of external opportunities, and *Support to access marketing/distribution channels* service ensures that a new technology gains rapid and sustained entrance to the market. On the other hand, the service that is part of the IV group is more oriented to potential absorptive, which involves the identification and understanding of the valued knowledge produced in the external environment, and realised absorptive, that entails the transformation and the exploitation of the external knowledge acquired. In fact, *Locating technology and knowledge sources* service makes it possible to identify sources of technology and knowledge relating to specific sectors, allowing companies to have easier access to the resources they need.

5. Discussion

The findings of the study show that SMEs benefitted from TT services of AREA in different ways, unleashing the potential OI opportunities into specific capabilities. The TT intermediary was shown to enhance purposeful inbound and outbound knowledge flows of its member companies, with commonalities and differences between the multiple cases of SMEs acquiring Area Science Park services. While each SME has unique characteristics in terms of business and types of OI approaches activated, their study allowed us to identify groups of TT services that can be ascribed as encouraging specific attitudes, investments and learning of SMEs for opening up their innovation efforts.

All TT services were selected by at least one SME, except for Technology foresight and roadmapping, Accreditation and quality standards, and Patent support. This could be motivated by the resource-constrained

Table 5
– The impacts of intermediary TT services on the OI capabilities of SMEs.

Intermediary TT services		OI capabilities in SMEs			
Types of TT services	Identified packages	Potential absorptive	Realised absorptive	External identification	External commercialisation
1. Market information scanning	I	Case 1,2	Case 2	Case 1	
5. Patent and IP analysis		Case 1,2	Case 2	Case 1	
6. Technology needs and opportunities assessment		Case 1,2	Case 2	Case 1	
10. Technical feasibility study		Case 1,2	Case 2	Case 1	
8. Accessing, bridging and recombining knowledge, skills and technologies	II	Case 2,3	Case 2,3,4,5,8	Case 6,8	Case 4,5
9. Design, testing and validation of technological innovation		Case 1,3	Case 3	Case 1,7	Case 7
11. Financial support for technology development	III			Case 7	Case 7
12. Commercialisation of technological innovation				Case 7	Case 7
13. Legal and contractual advice for technological innovation				Case 7	Case 7
14. Development of business strategy and processes				Case 7	Case 7
15. Support to access marketing/distribution channels				Case 7	Case 7
4. Locating technology and knowledge sources	IV	Case 2	Case 2		

setting of SMEs to effectively use tools such as foresight studies and accreditation, with a scope and time horizon requiring relying on a business ecosystem of different stakeholders (Milshina and Vishnevskiy, 2018) that goes beyond the innovation capabilities of a single company. Moreover, the services supporting the potential for developing patents from entrepreneurial ideas seem to be less relevant to SMEs in more traditional industries (as mechanical equipment), as they are mainly linked to invention and significant innovation (Cattapan et al., 2012), or they are carried out with entities such as universities and not requiring the intermediary TT services.

Results show that only part of the TT services provided by AREA resulted in the building of all OI capabilities (potential absorptive capability, realised absorptive capability, external identification, external commercialisation) for interviewed SMEs. Conversely, all OI capabilities can be distinctively activated by more than one TT service.

Moreover, we observed that the mix among the services provided by AREA produces different effects in terms of capabilities. The analysis of the patterns of OI capabilities enhanced in SMEs allowed thus to identify three sets of TT services provided by the intermediary that could be grouped into specific packages.

The TT services that resulted in absorptive capabilities (both potential and realised) and potential desorptive capability (external identification) of SMEs can be grouped in a first package defined as *Internal / external analysis and assessment of knowledge sources and technologies for innovation*. Indeed, the innovative solutions could result from a purposeful inflow or outflow of knowledge from the SMEs according to their strategic aims. Services of market information scanning, patent and IP analysis, technology needs and technical feasibility study were exploited in their function of gaining knowledge on both the market expectations and the technical features of the innovative solutions. These services supported an effective transformation of external knowledge into an innovation only for some SMEs. Indeed, the intermediary can facilitate access to external knowledge and assess internal needs together with external opportunities. However, the benefits of the newly accessed knowledge require appropriate internal skills and developer roles (Tang et al., 2020) to be transformed into realised absorptive capability. In this sense, this TT service package should address SMEs that aim to benefit the participation of communities or research collaborations to analyse knowledge sources for inbound or outbound flows. Consequently, SMEs' internal resources need to be properly dedicated to transforming the results of the analyses and assessments performed by AREA if they aim to assimilate and transform external knowledge into the realisation of innovative solutions.

The TT services that resulted in all OI capabilities are fewer but can be grouped in a second package as *Services for knowledge recombination and integration into innovation*. The SMEs that used these services established effective partnerships with suppliers, customers and even competitors thanks to their ability to recombine the knowledge on technological innovation into effective solutions, properly tested and validated. These services thus lead to a complementary development of absorptive and desorptive capabilities (and accordingly OI inbound and outbound initiatives), expanding the opportunities of SMEs to concentrate not only on the ability of acquiring external knowledge but also on the ability of transferring their technological innovations (Aliasghar and Haar, 2021; Cassiman and Valentini, 2016). External sources of knowledge can indeed contribute to the way the learning and absorptive capability of companies effectively result in a product innovation capability (Najafi-Tavani et al., 2018) and contribute to their innovation strategy (Malik and Wei, 2011). This package of TT services could be mainly proposed to SMEs that aim to properly access and combine external knowledge sources already identified, with an innovation that is already developed but needs the support of partners to be properly exploited, once tested and validated. In this case, unlike the results by Dhewanto and Sohal (2015), the orientation to collaboration with competitors also positively impacts technology commercialisation capability.

The third package groups the intermediary TT services that impact on potential desorptive capability (or external identification) and realised desorptive capability (or external commercialisation) of SMEs adopting them. These can be identified as *Services for assisting entrepreneurial innovation*. Indeed, this set encompasses services for business plan drafting, legal and contractual advice, managerial education and research of customers and proper marketing/distribution channels for developing the technological knowledge into innovative solutions to be commercialised and out-licensed. These should include activities that potentially generate capital returns (Krätzig and Sick, 2021) that go beyond single collaboration projects. The ability of an SME to identify opportunities or even transfer its internal technology outside its boundaries should thus be fostered by the proper exploitation of a wider package of services. Thus, this package should include multifaceted aspects – technological, legal, and commercial – to enhance SMEs' innovation outcomes to be further enlarged into an effective long-term strategy for commercialising innovation products (Vishnevskiy et al., 2015).

Finally, the TT services of Locating technology and knowledge sources mainly impact the absorptive capability. Specifically, SMEs seem to be motivated to activate an attitude to targeting and exchanging ideas with networks of people and companies, once AREA properly identifies these. While this service seems not to represent a package per se, it could be integrated alternatively to the first package identified (Internal / external analysis and assessment of knowledge sources and technologies for innovation), or the second one (Services for knowledge recombination and integration into innovation), to further strengthen OI capabilities towards specific technologies and/or knowledge sources.

The following Fig. 1 summarises the different ways the intermediary TT services can impact on the OI capabilities of SMEs adopting them, and the packages resulting from the analysis.

6. Conclusions

The paper analyses how the OI capabilities of SMEs – potential absorptive capability, realised absorptive capability, external identification and external commercialisation – can be impacted by specific sets of TT services offered by a TT intermediary. In turn, TT intermediaries can shape their service offerings to enhance specific SMEs capabilities and thus foster inbound and outbound OI activities.

We examined a single case study represented by the AREA, a Science and Technology Park known at the European level, which delivers all TT services considered in the research to SMEs. We also analysed in detail eight cases of SMEs that acquired some of the services offered by AREA and have successfully developed their OI capabilities.

The paper offers theoretical and practical implications for researchers and actors involved in the TT process.

From a theoretical viewpoint, the results contribute to the interplay between TT and OI literature. The TT services provided by intermediaries are classified and further valued, considering their impacts on collaborative interactions of firms with other OI actors (Albahari et al., 2022). We focus on the effect of TT from the SMEs' perspective and their engagement in the OI process (Bengoa et al., 2021). We confirm that intermediaries are effective in facilitating SMEs' OI strategy (Lee et al., 2010), and we extend previous research by showing that they can foster single or complementary OI capabilities also in SMEs that thus can pursue a balance development of abilities for inbound and outbound OI initiatives towards better R&D productivity and financial performance (Aliasghar and Haar, 2021; Cassiman and Valentini, 2016).

Regarding the practical implications, the paper provides insights to TT intermediaries who can gain a broader view of the services they offer and how these increase the innovative capabilities of SMEs that request them. Therefore, intermediaries can define ad hoc service offers to enhance some specific SMEs' capabilities to organise a full range of OI activities. SME managers can become more aware of the choice of services to be requested by intermediaries based on the impacts that they

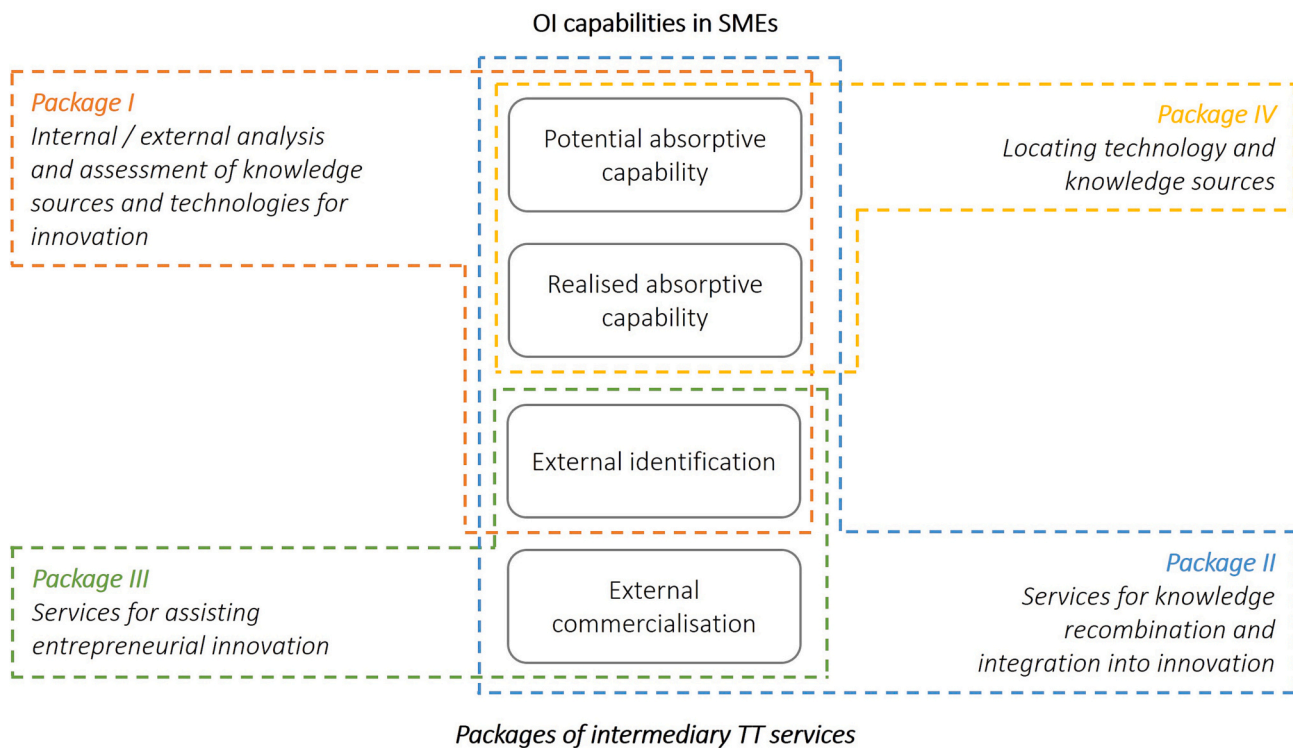


Fig. 1. – Packages of intermediary TT services enhancing OI capabilities of SMEs adopting them.

intend to achieve and the kind of collaborative innovation they pursue.

Future research should consider a larger sample of SMEs to have a broader understanding of the impacts of TT services on OI capabilities and to observe other economic sectors to compare the obtained results.

CRedit authorship contribution statement

All Authors equally contributed to Conceptualization; Methodology; Investigation; Formal analysis; Writing - Original Draft; Writing - Review & Editing.

Declaration of competing interest

None.

Data availability

The data that support the findings of this study are not publicly available.

Appendix A. Interview protocol

A.1. Interview protocol

- General information about the company
- TT services
 - o Which type of the following TT services offered by AREA have you chosen? (*list*)
 - o Why did you chose them and not others?
 - o When, how and why how did you use them? (*for each service*)
 - o Can you describe in detail the specific TT service? (*for each service*)
- OI approaches realised by the firm
 - o Can you describe your approach to innovation (and especially collaborative innovation) before and after your experience in AREA?

- o In particular, after the using the TT service by AREA (*for each service mentioned*):

- How did you identify and value the knowledge produced in the external environment for a technology acquisition? Can you give us concrete examples?
- How did you exploit the external knowledge acquired, i.e. for technology application or commercial ends? Can you give us concrete examples?
- How did you identify external technology transfer opportunities? Can you give us concrete examples?
- How did you effectively transfer your internal technology outside your boundaries and assist the application and use from the external partner? Can you give us concrete examples?

- o Can you describe in your opinion the outcomes obtained and the nature of the impact of TT services on your innovation activities, and in particular with those of open innovation? Can you give us concrete examples?

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