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The organization of innovation services in Science and Technology Parks: Evidence from a multi-case study analysis in Europe

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ABSTRACT

Science and Technology Parks (STPs) are key elements of the infrastructure supporting the growth of today's global knowledge economy. STPs create environments that foster collaboration, innovation, and entrepreneurship, and provide innovation services to support new technology-based firms in their activities. However, despite the extensive research on STPs, limited evidence has been provided regarding their organization of a portfolio of innovation services. In this work, we deepen the organizational challenges in developing a portfolio of innovation services through the analysis of the literature and ethnographic research on six case studies of European STPs in Italy, Spain, and Switzerland. In conclusion, based on the literature and the case studies, we highlight i) the four main alternatives to include an innovation service in an STP's portfolio; ii) the fundamental six drivers influencing the choice between these different alternatives.

Keywords: Science and Technology Parks, Science Parks, Technology Parks, Innovation Services, Innovation portfolio

1. INTRODUCTION

In recent years, several studies have analyzed Science and Technology Parks (STPs) in various countries using different methodologies (e.g., Tan, 2006; Filatotchev et al., 2011; Díez-Vial and Montoro-Sánchez, 2016; Albahari et al., 2018; Ng et al., 2021). These studies have shown that STPs may have an important role in creating and developing local entrepreneurial ecosystems (Theeranattapong et al., 2021). For instance, Siegel et al. (2003) pointed out that new technology-based firms located in an STP have greater research productivity than equivalent firms not-located in an STP.

According to the literature (e.g., Squicciarini, 2009; Xie et al., 2018; Albahari et al., 2019), STPs are purpose-built clusters of office spaces and labs designed to foster innovation and support new technology-based firms through a portfolio of innovation services. One of the oldest and largest STPs in the world is the Cummings Research Park (in Alabama, United States), which defines itself as a collaborative and connected ecosystem. Similarly, the Amsterdam Science Park (Netherlands) describes its entity as a vibrant hub where business, science and innovation meet in an inspiring cross-disciplinary mix. According to the International Association of Science Parks (IASP), the acronym STP is used to refer both to "technology park", "technopole", "research park", and "science park". STPs may act as incubators or accelerators by offering additional incubation or acceleration programs (Phan et al., 2005; McAdam and McAdam, 2008; Mian et al., 2016). However, unlike incubators and accelerators, STPs usually have a tech-lab, and their tenants may include SMEs and corporations in

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addition to startups. On the other hand, incubators and accelerators have a tech-lab only in some cases, and their tenants are usually only startups.

Nowadays, there are more than 800 STPs worldwide (Mian et al., 2016), and new STPs are being created in different countries (Arauzo-Carod et al., 2018). For instance, in 2018 the Ukraine Science Park Synergy was created. In the same year, the Italian STEP Tech Park was established. The Space Park Leicester in the United Kingdom is one of the STPs currently under construction. This trend may derive from the fact that, in many countries, substantial public investments have been allocated in the establishment and development of STPs (Link and Scott, 2007; Albahari et al., 2013; Link and Yeong Yang 2017; Chen and Link 2017; Lecluyse et al., 2019).

Despite the extensive research on this topic, only a few studies (Albahari et al., 2018; Cadorin et al., 2020) have analyzed STPs' organization of a portfolio of innovation services. Innovation services concern all the services provided to create and develop new technology-based firms and foster innovation. Lecluyse et al. (2019) have recently explained that the packages of innovation services of STPs change considerably in type and range and further studies are needed. Therefore, many questions regarding the organization of a portfolio of innovation services remain unanswered. For example, what are the main alternatives to include an innovation service in an STP's portfolio? And what are the fundamental drivers influencing the choice between different alternatives? In addition to this, as observed by Hobbs et al. (2017), only a few studies analyzed STPs in more than a country.

To answer these questions, we focused our work on two objectives regarding European STPs a) to highlight the main alternatives of inclusion of innovation services in an STP portfolio and b) to identify the fundamental drivers influencing the choice between the different alternatives. To achieve these objectives, we first analyzed the literature in order to develop an innovation service list. We also analyzed the literature to understand the drivers influencing the selection of innovation services for a portfolio. Then, we applied an ethnographic case study to several interviews realized with six European STPs.

In conclusion, the findings provide evidence of five core options to implement a portfolio of innovation services in an STP. These options are: not providing the service; directly providing the service without the involvement of other organizations; providing the service with a framework agreement as an intermediation mechanism; providing the service with a supply contract as an intermediation mechanism; providing the service with a partnership as an intermediation mechanism. Moreover, the results suggested that six major drivers affect the preference between the different options to implement a portfolio of innovation services in an STP. These six drivers are: organizational and institutional context; specificity; intensity of competition; replacement rate; experience; capital and cost intensiveness.

2. LITERATURE REVIEW

STPs began to spread at the beginning of the second half of the last century. One of the first in the world was the Stanford Research Park, which was created in the early 1950s as a cooperative venture between Stanford University and the City of Palo Alto, in the United States.

STPs are public, private, or public-private organizations that aim at improving innovation and entrepreneurial activities through the collaboration of different entities such as governments, universities, and private companies (Appold, 2004; Guadix et al., 2016). According to Guadix et al. (2016), the main goal of STPs is not solely financial but also cultural and social. In addition, according to Silva et al. (2020), STPs' collaborative and connected ecosystems enable open innovation.

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Several studies (e.g., Lindelöf and Löfsten, 2003; Dettwiler et al., 2006; Fukugawa, 2006; Corrocher et al., 2019) reported a positive impact of STPs on the development of new technology-based firms. The benefits for firms located within STPs range from enhanced R&D activity (Colombo and Delmastro 2002) to easier access to new financial resources (Kihlgren, 2003). For instance, some authors pointed out that new technology-based firms situated inside STPs present a higher R&D productivity (Siegel et al., 2003; Yang et al., 2009) and efficiency (Yang et al., 2009) than their counterparts situated outside of the STPs. Similarly, other authors discovered a positive impact of STPs on tenants' innovation output (e.g., Huang et al., 2012). In particular, firms located in STPs produce more product innovation (Vásquez-Urriago et al., 2014) and adopt more frequently advanced technologies (Colombo and Delmastro, 2002). Also, Colombo and Delmastro (2002) reported that new technology-based firms within STPs outperform equivalent firms in terms of growth rates.

However, where the value of the on-park location comes from is still debated. For instance, some studies did not identify a significant positive impact of STPs on the development of new technology-based firms (e.g., Bakouros et al., 2002; Ferguson and Olofsson, 2004; Radosevic and Myrzakhmet, 2009; Albahari et al., 2018). These mixed results may derive from the fact that firms do not benefit equally from residing in STPs (see Albahari et al., 2010 for a review) because of the heterogeneity of tenants and STPs (Ferrara et al., 2016; Albahari et al., 2017; Albahari, 2019). In this regard, Diez-Vial and Fernández-Olmos (2017) pointed out that younger firms get higher benefits from STPs because they are more open to change. Furthermore, tenants' performances are also influenced by the typology of STP and the needs of the firms. Wright et al. (2008) showed that tenants with previous commercial experience benefit more from university STPs, while tenants who hold patents perform better in non-university STPs. However, the value of the on-park location also depends on factors not directly related to the specific tenant or STP, such as the stage of the industry life cycle. According to Diez-Vial and Fernández-Olmos (2017), the benefits for firms are higher in the early stages of the industry lifecycle because standards are still to be defined and firms benefit more from knowledge spillovers and shared resources. However, it is conventional wisdom that clustering plays an important role in the value added by STPs. Findings from Gwebu et al. (2019) showed that firms residing in STPs with more co-located complementary firms have better economic performances. According to Yang et al. (2009), the higher R&D productivity evidence for firms located in STPs may derive from the connections among firms and other institutions established within the STPs. As suggested by Hu (2007), the theories of Arrow (1971) and Romer (1986) explain how the geographical concentration of companies might create knowledge spillovers that develop dynamic externalities and long-term economic growth. However, Torres de Oliveira et al. (2021) showed that STPs tenants usually improve their innovation performance by deepening the relationship with external sources of knowledge rather than expanding the number of external sources. Moreover, according to Porter (1985), geographical clustering generates competition between the companies, enhancing innovation. Additionally, Mae Phillips and Wai-chung Yeung (2003) suggested that STPs may significantly impact R&D activities if integrated with the local ecosystem to create a synergistic path across cooperation and competition.

Nevertheless, STPs play an active role in generating benefits for their tenants through the services they provide. Koçak and Can (2014) showed that STPs managers contribute directly to the collaborations among tenants through networking activities. According to the literature, tenants benefit from the range of services provided by STPs (Kihlgren, 2003; Vásquez-Urriago et al., 2014) and, specifically, from the effective coordination of those services (Colombo and Delmastro 2002). Despite that, limited evidence has been provided regarding the organization of a portfolio of innovation services. Only a few papers (Albahari et al., 2018; Cadorin et al., 2020) have analyzed STPs' organization of a portfolio of innovation services.

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Our paper contributes to this topic in two ways. First, it analyzes the main alternatives to include an innovation service in an STP portfolio. Second, it explains the fundamental drivers influencing the choice between these different alternatives.

In the following subsections, we focus our literature review on the two themes directly related to the aims of our research: i) the studies regarding different portfolios of innovation services and ii) the literature regarding the drivers influencing the choice between different alternatives. Given the limited number of contributions specifically related to STPs on this topic and because STPs have similar aims to incubators and accelerators (Mian et al., 2016), we extend the analysis to all business support initiatives (e.g., STPs, incubators, accelerators, startup studios, etc.).

2.1 PORTFOLIOS OF INNOVATION SERVICES

In literature, a few authors (Albahari et al., 2018; Cadorin et al., 2020) referred explicitly to portfolios of innovation services; however, many authors discussed the services provided by business support initiatives.

The IASP divided the STPs' innovation services into four categories: product and process innovation, finance, market, and human resources (IASP, 2017). Lecluyse et al. (2019) reported that several STPs' innovation service studies categorized the services provided within three main groups: property-related services, which include logistics services; business and innovation support, which involves fund raising and administration & finance services; and networking services, which include networking and internationalization services. However, these innovation services may change significantly in type and range based on the STP.

By analyzing STPs in Greece, Sofouli and Vonortas (2007) suggested that STPs are business support organizations specialized in support services related to product and process innovation, finance and market. Bruneel et al. (2012) and Vanderstraeten and Matthyssens (2012) explained that logistics, finance, management consulting, and training are common services offered by business support initiatives. Furthermore, Lecluyse et al. (2019) showed that intellectual property protection and licensing services are relevant. In addition, Bergek and Norrman (2008) pointed out that management consulting and training are important services for business support initiatives. By investigating STPs in China, Ng et al. (2021) found that tenants perceive the STP management's activities as important to develop connections with other firms. Also, by analyzing an STP in Brazil, Balle et al. (2019) suggested that technical consultancy, product and process innovation, and human resources training are essential services for tenants. According to Balle and colleagues (2019), these services may develop knowledge-sharing mechanisms. Similarly, the report from Global Accelerator Network - GAN (2019) reported that the services linked to product and process innovation, finance and human resources are essential for the startup studios. Cadorin et al. (2020) pointed out that STPs' HR talent-attraction services are relevant but need to be adapted to the actual needs of the tenants. Moreover, McAdam and McAdam (2008) analyzed the role of business support initiatives and their services during the lifecycle of enterprises. They discovered that the most important services are the logistic ones because they allow entrepreneurs to focus more on their business and networking activities. In addition to that, Salvador (2011) suggested that the most appreciated services of STPs are those related to product and process innovation, such as technical consultancy. Xiao and North (2018) pointed out that technical and financial services provided by business support initiatives had a positive impact on all the phases of innovation activities of their tenants. By analyzing STPs in Italy, Corrocher et al. (2019) pointed out that STPs' services, such as consultancy and legal support, contribute to tenants' superior innovative performances compared to off-park businesses.

In addition to this, Scillitoe and Chakrabarti (2010) reported that business support organizations can provide a service with the involvement of external players. Similarly, Aaboen (2009) explained that a

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business support organization offers part of the services in its portfolio through the involvement of external actors. Moreover, Albahari et al. (2018) suggested that, in some cases, the best provider for some services might not be the STP. Also, Bruneel et al. (2012) explained that the new generation of business support organizations is more focused on providing access to external resources and knowledge than the previous generations.

Given the increasing importance of innovation services for STPs, the evolving context (e.g., the shift towards external services), and the fragmented evidence in the literature, the first aim of our research has been to highlight the main alternatives of inclusion of innovation services in an STP's portfolio. We focused in particular on the different intermediation alternatives.

2.2. Drivers influencing the selection of innovation services for a portfolio

Within the literature on business support initiatives, several contributions have been written on the drivers influencing the inclusion of services in a portfolio. For instance, Boyt and Harvey (1997) introduced a set of drivers (e.g., Complexity and Replacement Rate) to recognize intricate services and elementary services. Mas-Verdú (2007) added new elements like the distinction between capital intensive services, specific services, standardized services, and operative services. Moreover, Albahari et al. (2019) explained that it is crucial to consider the organizational and institutional context for shaping the STP's innovation services.

To summarize this literature, we grouped the most cited and acknowledged drivers in Table 1. For each driver, we provided at least one reference to the related literature. Each driver in the list collects and merges different aspects which influence the selection of innovation services. In most cases, if the value of a driver increases or decreases, it pushes the decision-makers to outsource the service or to provide it internally. By analyzing the literature, we grouped the drivers into 14 macro drivers to simplify the following analysis and avoid redundancies. Table 1 presents the macro drivers in alphabetical order.

Macro driver	*Driver*	*Main reference*
Appropriability	Proprietary risk	Sanders et al. (2007)
	Appropriability	Veugelers and Cassiman (1999); Steensma and Corley (2000); Gooroochurn and Hanley (2007)
Capital intensiveness	Credence property	Boyt and Harvey (1997)
	Capital intensive	Mas-Verdú (2007)
	Contention Risk	Sanders et al. (2007)
	Capital investment reduction	Razzaque and Sheng (1998)
	Reducing risk and maintaining quality	Woodall et al. (2009)
Complexity	Complexity	Boyt and Harvey (1997)
	Standardization	Mas-Verdú (2007)
	Operativity	Mas-Verdú (2007)
	Cost variability	Spina et al. (2002)

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Cost (margin) intensiveness	Profit Margin	Calantone and Stanko (2007)
	Employee sales efficiency	Calantone and Stanko (2007)
	Inventory turnover	Calantone and Stanko (2007)
	Cost saving and reduction	Embleton and Wright (1998); Veugelers and Cassiman (1999); Gonzalez et al. (2005); Calantone and Stanko (2007); Woodall et al. (2009)
Easiness to monitor	Monitoring and control	Manning et al. (2011); van der Valk and van Iwaarden (2011)
Experience	Internal expertise	Spina et al. (2002)
	Impact on critical capabilities	Sanders et al. (2007)
	Learning Effects' Importance	Calantone and Stanko (2007)
	Exploratory research performer	Calantone and Stanko (2007)
	Focus on core competence	Weerakkody et al. (2003); Calantone and Stanko (2007)
	Management experience	Kent (2011)
	HR experiences and competences	Woodall et al. (2009); Cadorin et al., (2020)
Intensity of competition	Intensity of competition	Sanders et al. (2007); Neirotti and Pesce (2019)
	Capability of supplier	Jennings (2002)
Level of internationalization	Globalization	Clott (2004)
	International strategy	Martínez-Noya and Garcia-Canal (2011); Albahari et al., (2018); Cavallo et al, (2019)
Market demand	Volume of transactions	Kent (2011)
	Firm size	Veugelers and Cassiman (1999)
Organizational and institutional context	Organizational context	Steensma and Corley (2001); Albahari et al., (2019)
	Institutional context	Grimshaw and Miozzo (2009); Martínez-Noya and Garcia-Canal (2011); Albahari et al., (2019)
	Economic context	Grimshaw and Miozzo (2009)
	Political context	Miranda and Kim (2006)
Relevance	Essentiality	Boyt and Harvey (1997)
	Ability to develop competitive advantage	Steensma and Corley (2001); Bardhan et al. (2006)
Replacement rate	Replacement Rate	Boyt and Harvey (1997)

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	Transaction frequency	Aubert et al. (1996); Everaert et al. (2010)
Specificity	Asset and relation specificity	Cesaroni (2004); Gooroochurn and Hanley (2007); Mas-Verdú (2007); Manning et al. (2011)
	Knowledge intensity of services	Manning et al. (2011)
Uncertainty	Market uncertainty	Love and Roper (2005)
	Environmental uncertainty	Kent (2011)
	Technological uncertainty	Calantone and Stanko (2007)
	Behavioral uncertainty	Steensma and Corley (2001)

Table 1. Drivers influencing the selection of innovation services for a portfolio

All these 14 macro drivers identified may play a role in determining the service innovation portfolio. However, given that they are derived from a broad literature review, there could be more relevant drivers than others. Therefore, the second aim of our research has been to identify among this list of 14 variables the fundamental drivers influencing the selection of innovation services in STPs portfolios.

3. RESEARCH METHODOLOGY

The following research process has been based on two phases: i) development of a taxonomy of innovation services; ii) case studies development.

3.1 DEVELOPMENT OF A TAXONOMY OF INNOVATION SERVICES

The first phase had the aim of identifying a comprehensive set of innovation services that STPs may offer.

A taxonomy of possible innovation services was created to develop the case studies and analyze innovation services portfolios. The list was pivotal in the case study protocol, as explained in the following section. We identified the most important innovation services through a desk analysis of the STPs belonging to the IASP and the analysis of the literature (e.g., Sofouli and Vonortas, 2007; Lecluyse et al., 2019). Moreover, the obtained list was validated with a team of international experts on STPs, startups, and SMEs. We divided the innovation services into four broad categories considering their outputs: product and process innovation, finance, market, and human resources. Each category has then been divided into macro-activities. Each macro-activity has then been divided into specific activities, as illustrated in Annex 1. In more detail, Table 2 presents the most important innovation services divided into four categories and 15 macro-activities.

Category	*Macro-activity*
Product and process innovation	Technical consultancy (process)
	Technology forecasting
	Protection of intellectual property and licensing
	Logistics

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	Product and process innovation
	Sourcing
	Scouting
Finance	Fund raising
	Participation in calls for projects
	Administration & finance
Market	Internationalization
	Marketing
	Management consulting
Human resources	Training
	Organization

Table 2. List of categories and macro-activities for the innovation services of an STP

We checked this list of services with the managers of the STPs involved in the case studies described below. Even if this was not the main aim of our research, we obtained a confirmation of the validity of the selection from the STPs managers.

Moreover, we interviewed the six STPs to understand the main alternatives to include an innovation service in an STP's portfolio and to understand the fundamental drivers influencing the choice between these different alternatives.

3.2 Case studies development

Finally, we performed an ethnographic case study of the six STPs described in Table 3. According to Yin (2009), a case study design should be considered when the focus of the study is to answer "how" and "why" questions, and the behavior of those involved in the study cannot be manipulated. Ethnographic case studies are defined as "the application of the ontological, epistemological and methodological features of ethnography to a theoretically selected set of business cases" (Visconti, 2010, p. 29). This type of research is suitable to analyze actions that cannot be measured by quantitative analyses (Visconti, 2010; Robinson and Shumar, 2014). Moreover, this method includes unstructured and flexible activities suitable for unstructured research fields (Robinson and Shumar, 2014). Thus, an ethnographic case study is a designed mixture of a case study and ethnographic methods (Visconti, 2010). The flexibility structures of an ethnography case study method make it a suitable instrument for our research. In fact, an ethnographic case study may explain perceptions that cannot be analyzed by quantitative data but which involve different descriptions and qualitative methods (Robinson and Shumar, 2014).

Concerning the number of cases to study, as also mentioned by Eisenhardt (1991), the appropriate number depends on what is known and how much an additional case may contribute. Furthermore, Harrison and Easton (2004) argued that there are two kinds of multiple cases, independent and embedded. These arguments were the main reason for choosing to develop six independent case studies and to interview STPs that were located in different geographical areas. The cases were selected one after the other, considering the ongoing results of the research. These six selected cases represent a convenient sample (Bell and Bryman, 2007) of STPs located in different geographical areas. None of the selected case studies was an STP owned by one or more universities. The cases have been studied with an explorative mindset and mainly through qualitative data. According to Hill and McGowan (1999), this leads to an increased understanding, compared to a more quantitative approach, when it comes to exploring the different set of factors and processes in organizations.

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We interviewed the managers of six selected STPs from Italy, Spain, and Switzerland. As it is possible to see from Table 3, four STPs are in Italy, one in Spain, and one in Switzerland. As reported by the literature (e.g., Mian et al., 2016), several STPs in the sample also offer incubator or accelerator activities. The first interviews started in 2013, and we continued to interact with the STPs and refine the model in the following years. Also, by interacting with STPs, we had the opportunity to talk with other important actors in their local entrepreneurial ecosystem, such as Business Angels, Venture Capitalists, Student-Led Entrepreneurial Organizations, etc.

STP	Country	Sector of interested	Age	Revenues (Million euros)	Employees	Tenants (number)	Incubation/ acceleration activities	Square meters
STP1	Italy	Energy, ICT, Life Sciences, Manufacturing	12	n.a.	n.a.	54	Yes	15 000
STP2	Italy	Biotechnology, Foodtech	33	1.20	55	22	Yes	400 000
STP3	Italy	Chemistry, Energy, ICT, Materials, Mechatronics, Physics	11	1.00	5	37	No	400 000
STP4	Spain	ICT, Manufacturing	28	2.50	23	410	Yes	n.a.
STP5	Switzerland	Energy, ICT, Materials, Meditech	29	2.87	10	500	Yes	42 000
STP6	Italy	Digital	15	1.50	15	30	Yes	n.a.

Table 3. Main characteristics of the six STPs analyzed

The data collection process comprised three steps. The first step consisted in collecting information and data from secondary resources, such as company websites, newspaper articles, company reports, social media (Facebook, LinkedIn, Twitter, and Instagram), etc. This first step allowed us to obtain some preliminary insight into the STPs. Then, we contacted an STP's key person. We asked to fill in the list of the offered innovation services (presented in Annex 1) and to provide basic information about the services and the other organizations involved. This second step allowed us to understand the innovation services offered by the STPs. The third step consisted in carrying out interviews with the key people involved in the administration of the innovation services in the STPs. At least one key person was questioned for each of the participating STPs. This last step allowed us to collect the information regarding the main alternatives of inclusion of an innovation service and the fundamental drivers influencing the choice between the different alternatives.

A case study protocol was specifically developed to carry out the interviews. The protocol was also validated with an advisory board from the STPs. The case study protocol comprised a set of questions on the portfolio choices and drivers. These questions were not necessarily followed strictly, as long as all headlines were covered during the conversation. With a semi-structured interview to guide the interviewees, we were able to formulate the key people's views on their environment through dialogue rather than simply by having questions answered. During the interviews, we asked the managers to explain their choices regarding their STPs portfolio of innovation services. In particular, for each innovation service contained in Annex 1, we asked questions about: the drivers leading to the inclusion of the service in the portfolio; the management of the service and the reasons behind this choice; the involvement of other organizations in the management of the service and the reasons behind this choice;

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the strategic relevance of the service in the portfolio and the probable future developments of the service. Later, we performed ex-post content analyses of these interviews to define the fundamental drivers influencing the managers' choices. The duration of the interviews varied depending on how the dialogue developed, but they never lasted less than 1 hour. The Italian-speaking interviewees were interviewed in their mother tongue, and their quotes were translated into English in the present work. The other interviews were performed in English.

4. RESULTS

In this section, the results of the case study analysis are presented. Coherently with the two objectives of our research, the results are presented in two paragraphs. The first paragraph illustrates the different alternatives that emerged regarding the inclusion of an innovation service in the portfolio. In the second paragraph, the fundamental drivers influencing the choice between the different alternatives are discussed.

4.1. MAIN ALTERNATIVES OF INCLUSION OF AN INNOVATION SERVICE IN AN STP PORTFOLIO

Based on our interviews, we found five main alternatives when evaluating the inclusion of an innovation service in a portfolio. In particular, a service could be not included, offered directly without the involvement of other organizations, or offered indirectly with three different forms of intermediation (i.e., involvement of other organizations). These three different forms of intermediation may be defined as framework contract, supply contract, and partnership. Intermediation mechanisms contribute to filling in a continuum of solutions from not offering the service to providing it without the help of other organizations. The costs of offering these services and managing the relationships with external organizations increase with the intensity of collaboration.

Therefore, the five main alternatives available when evaluating an innovation service are: not providing the service; directly providing the service without the involvement of other organizations; providing the service with a framework contract as an intermediation mechanism; providing the service with a supply contract as an intermediation mechanism; providing the service with a partnership as an intermediation mechanism. In Figure 1, these main alternatives of inclusion of an innovation service in an STP's portfolio are illustrated, highlighting the possibility to offer the services to tenant and external firms. As emerged from our interviews, some services may be provided only to companies inside the STP because of a strategic approach aimed at concentrating the resources of public institutions financing the STPs on a selected number of companies with specific characteristics. In the past, it was common for STPs to have almost only services exclusive for their tenant companies and a few or no services for external companies. However, we had confirmation that many STPs are offering their services also to external firms nowadays.

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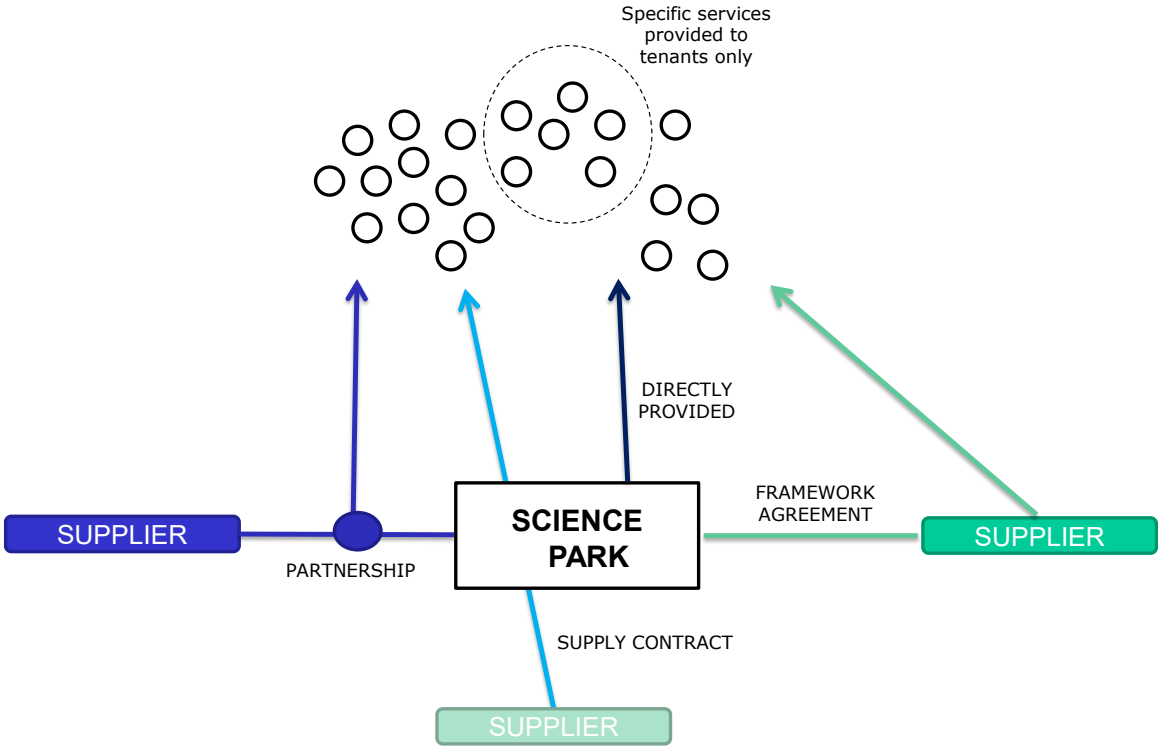

Figure 1. Main alternatives of inclusion of an innovation service in an STP portfolio

Based on our interviews, in the following sections, we delve further into the implications for STPs when offering the services directly without the involvement of other organizations or indirectly with the three different forms of intermediation.

4.1.1. Providing the service directly

When an STP directly provides a service to its tenants, it sustains all the costs and planning. The STP manages the relationship with the firm interested in the service from the prospecting to the supporting phase, and it handles all the commercial and administrative issues related to the service. STPs are the only ones responsible for the quality of the service provided, and they monitor quality and improve their offering by implementing the best market practices.

When implementing a new service, STPs do not limit themselves to their past experiences but try to evolve their capabilities in order to adapt their offering to the tenants' requests. As the manager of STP6 said, *"Whether implementing an internal service is a choice made in the making. Our initial focus was on logistics, administration, and finance, but gradually we introduced new services on the basis of the market's requests."*

4.1.2. Involvement of other organizations

In the following paragraphs, we describe in more detail the three main alternatives of inclusion of an innovation service in an STP portfolio with the involvement of other organizations.

Framework contract

Involving other organizations to provide the service through a framework contract is the easiest and most simple form of intermediation. Compared to the other forms of intermediation, the contribution of the STP is limited to providing visibility to the service offered by the external organization (e.g., on its website). All the related activities, including the customer relationship and payments, are

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completely managed by the external organization. In many cases, as a result of a formal contract setting out the terms of the agreement, in exchange for the promotional service provided to the external organization, the STP obtains benefits (e.g., lower rates) for its tenants and generally for the organizations accessing the service through them. In some cases, the service providers may be or may become tenants of the STP. For example, STP3 promotes the external organization by showing its logo on its own website. Also, when firms need the service provided by the external organization, STP3 sends them to that service provider and obtains favorable economic conditions for its longtime tenants. Similarly, STP4 provides support for the participation of tenants and external firms to calls for projects through a framework agreement with an external organization and at a special price. In more detail, the manager of STP4 said, "*A really nice local marketing agency is helping us with the creation of several calls for projects. In exchange for their help, we are putting their logo in our website and in all these calls for projects. Moreover, we suggested our tenants and external firms to work with them if they needed something related to online marketing.*" The main advantage of the framework contract is that the STP can add another service to its portfolio with limited costs and limited responsibilities (it only points out the service provider). On the other hand, the STP misses the opportunity to build stronger internal capabilities to assist its tenants on that subject in the future.

Supply contract

With the involvement of other organizations through a supply contract, the service is included in the list of services provided by the STP, but it is almost completely outsourced to an external organization. Compared to the framework contract, the STP holds a direct relationship with the customer (e.g., for the payments and for the administration and provision of other related services). Furthermore, through a formal contract with the provider, the STP is able to define prices and quality levels of service provision. The service is delivered by the supplier but with managerial, commercial, and supporting activities done by the STP. The service may take place inside or outside the STP. Usually, clients ask the STP for a set of services. Sometimes, STP is not able to provide all the required services by itself. By leveraging its networks, the STP can establish supply contracts to provide those services. The main benefit is that the supply contract allows the STP to provide the service also when it does not have the internal capabilities to do it. Furthermore, the STP keeps a relationship of trust with the supported firms by managing the relationship with them directly. In this way, it is easier for the supported firms to interface with only one institution. Also, for customers, it could be cost effective to access the service through the STP. On the other hand, the STP is directly responsible for the quality of the services delivered by its suppliers. Consequently, the STP has to develop and implement an appropriate quality and customer management strategy. For example, STP6 directly provides a set of services to the incubated startups; but legal, administrative, and licensing services are supplied as a result of a supply contract with a law firm. Since STP6 offers this service to several tenants, it is a convenient agreement for all the parties. In fact, as explained by one of the managers of STP6, "*We know that legal services are important […], several of our tenants are asking us support for establishing an innovative startup. We are offering this service with a law firm that is an expert on the Italian laws on startups […]; not all the law firms are working with startups. Usually, they work with big corporations, and they do not know the Italian legislation on startups very well since it is recent.*" STP6 also has a supply contract with a very well-known Italian firm on licensing and patents. As a result, the law firm increases its revenues by helping the tenants of the STP6. The tenants pay a fixed price to the STP6 for all the services, both those provided directly by STP6 and those provided by external actors. This model of intermediation is the same used by STP1, which outsources catering services, event management services, and both online and offline promotion to specialized firms.

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Partnership

When the STP provides the service through a partnership with an external organization, the links between the STP and the external organization are stronger than in all the other intermediation forms. In some cases, to facilitate the collaboration in providing the service, the STP hosts a subsidiary or an organizational unit of the partner in its own buildings. Compared to the supply contract, the STP is directly involved in providing the actual service. The degree of involvement depends on the specific partnership agreement. The collaboration may involve the sharing of costs, resources, and activities. The partnership may also take the form of a new organization or of a shared structure to provide the service. In the first case, we talk of equity partnerships because the two organizations become shareholders of a new enterprise; in all the other cases (contracts, creation of new organizational units, etc.), we refer to non-equity partnerships. The primary advantage of a partnership is that the STP develops the capabilities to provide the service by collaborating with a partner internally. Also, the STP has high control over the quality of the service provided. On the other hand, building and maintaining a partnership with an external organization is the form of service intermediation with the highest costs and risks. It takes time and requires a significantly higher commitment by both parties. Both partners have to invest in the relationship both in terms of resources, personnel, and top management involvement and in terms of critical decisions regarding activities, reporting, responsibilities, and earning and cost sharing. All these aspects have to be agreed upon at the beginning of the partnership; however, they evolve over time and need to be constantly monitored. For example, STP2 created a partnership with an accredited inspection body to provide together knowledge-intensive services concerning HACCP (Hazard Analysis and Critical Control Points), which is a self-control system that prevents hygienic hazards of food contamination. STP5 funded a workroom with a high-tech company and other institutional subjects in its region to develop specific applied research and to provide related consulting and operative services to firms operating in the field of environmental electromagnetism. STP5 stated that a partnership is fundamental because they do not have an "*all-round knowledge to provide a high-level service*." Moreover, STP1 is creating a Venture Capital fund in partnership with other external organizations to improve their financial services.

4.2. FUNDAMENTAL DRIVERS INFLUENCING THE CHOICE BETWEEN THE DIFFERENT ALTERNATIVES

As explained in the methodology section, a list of 14 possible macro drivers influencing the choices regarding innovation services has been developed through a literature review. Then, the STP managers have been interviewed regarding the reasons behind the choices of inclusion in the STP's portfolio. As suggested by the literature (e.g., Eisenhardt, 1991), we performed an analysis ex-post (content analysis) of the interviews based on occurrences. As a result of this activity, we identified the number of times each driver has been cited as relevant in the portfolio decisions. The analysis led us to identify the drivers with a higher frequency and, thus, the most important in terms of portfolio selection (Table 4).

	Drivers	Occurrences	%	Cum. %
1	Organizational and institutional context	82	25.87%	25.87%
2	Specificity	42	13.25%	39.12%
3	Intensity of Competition	40	12.62%	51.74%
4	Replacement rate	39	12.30%	64.04%
5	Experience	37	11.67%	75.71%
6	Capital intensiveness	26	8.20%	83.91%
7	Market demand	20	6.31%	90.22%
8	Cost (margin) intensiveness	15	4.73%	94.95%
9	Relevance	6	1.89%	96.85%

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10	Uncertainty	3	0.95%	97.79%
11	Easiness to monitor	3	0.95%	98.74%
12	Level of internationalization	2	0.63%	99.37%
13	Complexity	1	0.32%	99.68%
14	Appropriability	1	0.32%	100.00%
	Total occurrences	*317*		

Table 4. Distribution of drivers influencing the selection of innovation services for a portfolio based on occurrences

The first six drivers sum up 84% of the total occurrences, with the "organizational and institutional context" playing a central role in the choices regarding the innovation services selection and management.

From the analyses emerged some overlaps in terms of contents and occurrences of some drivers. This evidence, and the objective of identifying the most relevant drivers for the portfolio strategy from a managerial point of view, led to merging some drivers together by leveraging their correlations and, thus, reducing the complexity of the managerial model. In particular, we observed that the main investments (driver no.6 - capital intensiveness) in the analyzed services are due to human resources and that these investments are in many cases close to operating costs (driver no.8 – cost (margin) intensiveness). For these reasons, we consider as a fundamental driver to choose among different services the driver resulting from the merging of drivers no.6 and no.8, i.e., the Capital & Cost intensiveness driver. This driver may be seen as a summary of the financial aspects of the service because it considers both the investment and the operating costs. Similarly, the analysis showed that the intensity of competition is strong where the market demand is high. Then, because both "Intensity of competition" and "Market demand" refer to the size and complexity of the market, we discarded the less frequent driver to summarize the framework better and deliver an easier-to-use tool.

In conclusion, the six drivers influencing the selection of innovation services for a portfolio in an STP are: Organizational and institutional context; Specificity; Intensity of Competition; Replacement rate; Experience; Capital and Cost intensiveness.

Finally, the drivers have been divided into two categories, depending on the nature of each driver: service characteristics and contingency factors. The first category refers to the features of the service, and the second one refers to the service context both inside the STP (internal context) and in the market (external context).

The resulting framework explaining the decisions regarding the service innovation portfolio of an STP is illustrated in Figure 2 and further detailed in the following sections.

4.2.1. Service Characteristics

The three service characteristics that directly influence the choice of if and how to include a service in the portfolio are Specificity, Capital & Cost intensiveness, and Replacement rate.

The "Specificity" driver measures the specific skills and resources required to offer the service. On the one hand, it usually is more convenient for an STP to outsource highly specific services because those services are typically required by a limited number of the supported firms. On the other hand, specialized external providers may leverage economies of scale or economies of learning that the STP would not be able to reach. For instance, an STP3 manager stated, "*We outsource specific bureaucratic activities, such as support to participate in calls for projects, to external experts. These activities are too sophisticated and need specific investments and professionalism.*"

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The "Capital & Costs intensiveness" driver represents investments and operating costs required to offer the service. Their increase is associated with a higher risk and exposure of the STP, and, thus, it is usually linked to outsourcing decisions. On the contrary, when the costs are low and the capital required is limited, the STP may be more prone to investing in the specific service. However, the evaluation of these investments and costs has to be related to the size of the STP and to the potential beneficiaries of the service. For instance, STP2 invested in dedicated laboratories for testing food security issues because it could spread the investments (and the operating costs) among the many firms it hosts that are active in the agriculture, biotechnology, and food sectors.

The "Replacement rate" driver measures how often a company requires the service. Generally, if this driver has a high level, it is more convenient to develop the service internally due to the possibility of developing economies of scale. As stated by one of the STP4 managers, "*We cannot develop internally services that are not frequently requested by companies*."

4.2.2. Contingency Factors

The three contingency factors that influence the choice of if and how to include a service in the portfolio are Intensity of competition, Experience, and Organizational and institutional context.

The "Intensity of competition" driver measures the number of actors offering the service on the market. When the intensity of competition in the market is high, the STP is usually able to obtain higher quality levels at lower costs by outsourcing the service than by offering it internally. In some cases, the provider of these services may be located in the STP; as noted by an STP1 manager, "*Tenants expect benefits from staying here because we act as an intermediary for their potential customers*."

The "Experience" driver refers to the past experience in activities concerning the service. If an STP has administered a service in the past or has developed the related competencies, it has lower costs in providing the service and may provide it with a higher level of quality. On the contrary, if the STP has no previous experience, it could be costly and challenging to develop the necessary competencies to administer the service. As noted by an STP4 manager, "*Outside the park, there are actors able to offer these market-related services; we address these opportunities to them because it is not mandatory to have all the competencies into the Science and Technology Park*."

Finally, the "Organizational and institutional context" driver includes both external incentives and internal incentives. Depending on the case, these incentives may lead the STP either to directly providing the service, resorting to intermediation mechanisms, or not providing the service at all. External incentives and norms are related to existing national or local programs or laws. The portfolios of the STPs' innovation services often depend on the national political decisions that push the market, such as in the case of the significant incentives for renewable energies provided in Italy. Moreover, internal incentives and influencing factors are related to previous decisions, overall strategies of the STP, etc. For example, many STPs decide to use only one typology of intermediation for all the services that they intermediate, or they choose to offer an innovation service despite some difficulties because they consider it strictly related to the objectives of a public institution that finance them. Furthermore, in many cases, the intermediation typology is linked to norms and other organizational aspects; for instance, an STP4 manager stated, "*We evaluated each service by itself in order to find the best supplier and, in some cases, when the collaboration is with political institutions, we cannot subcontract, but we have to establish a partnership*." Finally, STP4 used to furnish technical certifications to specific types of heating plants because the government provided economic incentives. This program lasted for three years and, after its end, the STP stopped providing the service. Moreover, the organizational context takes into account the dimension and the industry focus of the STP. It is easier for the STP to provide a wide range of services if many tenant companies benefit from the

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services and deplete the offer: the bigger the number of firms inside the STP, the more convenient it is to provide a differentiated portfolio.

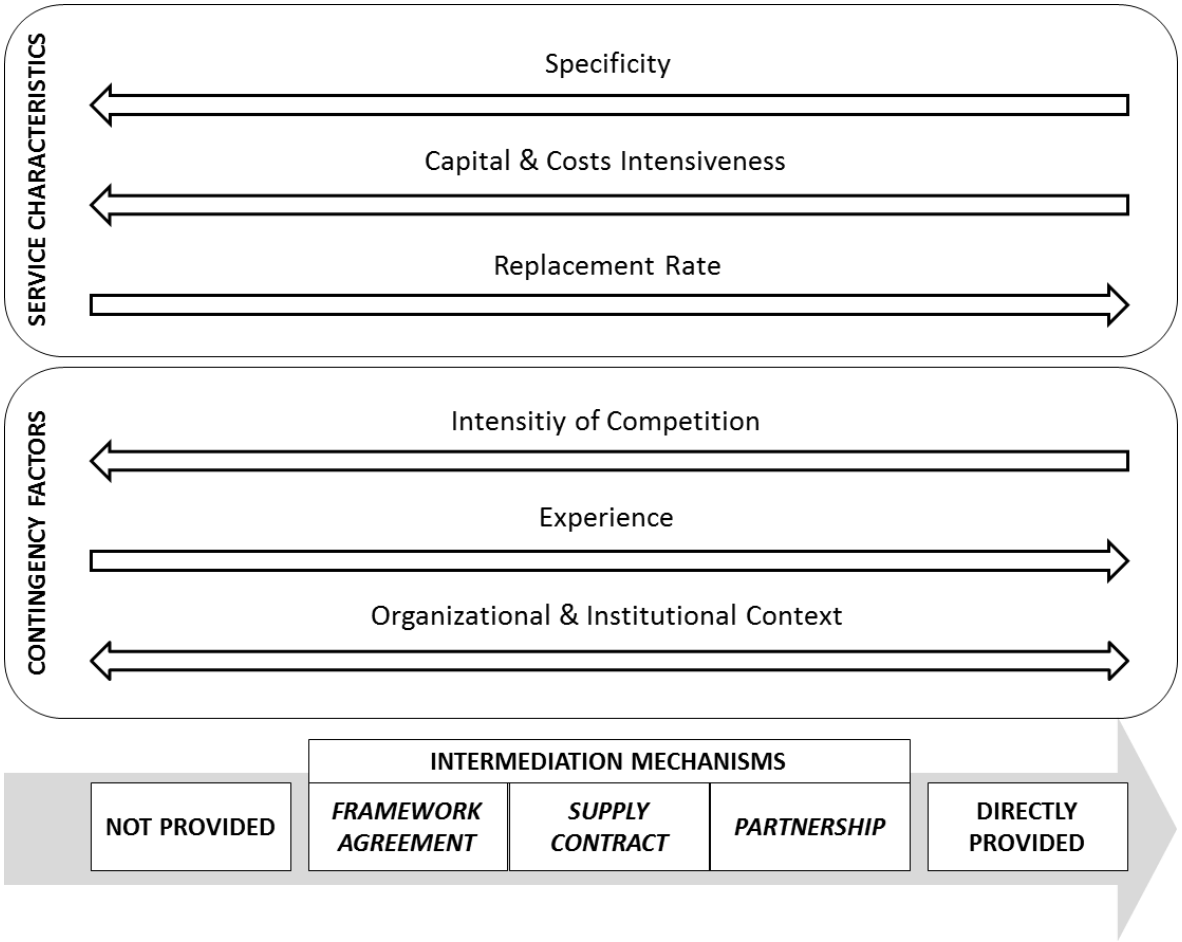

Figure 2. Framework of innovation services portfolio and fundamental drivers influencing the selection of innovation services for an STP portfolio

Figure 2 highlights the impact of the drivers on the choice between the underlying alternatives for the innovation services. For instance, a service that presents a high level of specificity, that needs significant resources, and that faces a high level of competition from other organizations in the market will probably be excluded from the portfolio or be included weakly by intermediating with a framework agreement.

5. Conclusions

In recent years, several studies have analyzed STPs considering different aspects and by employing several methodologies (e.g., Tan, 2006; Filatotchev et al., 2011; Díez-Vial and Montoro-Sánchez 2016; Albahari et al., 2018; Ng et al., 2021). However, limited evidence has been provided regarding how STPs organize their portfolio of innovation services. In order to understand it, we focused our paper on two aims: a) to highlight the main alternatives of inclusion of innovation services in an STP

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portfolio, and b) to identify the fundamental drivers influencing the choice between the different alternatives.

By analyzing the literature, we developed a service list presented in Annex 1. Moreover, as a result of the literature review, we discovered 14 macro drivers. Then, we applied an ethnographic case study realized in six European STPs. Four of these STPs are located in Italy, one in Spain, and one in Switzerland. Based on our interviews, we discovered five core options when evaluating the inclusion of an innovation service in an STP portfolio. These five options are: not providing the service; directly providing the service without the involvement of other organizations; providing the service with a framework agreement as an intermediation mechanism; providing the service with a supply contract as an intermediation mechanism; providing the service with a partnership as an intermediation mechanism. Therefore, there are four main alternatives to include an innovation service in an STP portfolio, considering both insourcing and outsourcing decisions and three typologies of intermediation. Furthermore, we identified six fundamental drivers influencing the choice between the different alternatives in STPs. These six drivers are: Organizational and institutional context; Specificity; Intensity of Competition; Replacement rate; Experience; Capital and Cost intensiveness.

Our findings present some implications for practice. For instance, our results may help STPs' managers to analyze and improve their own portfolio of innovation services and their choices regarding the different intermediation typologies. We have shown that the organizational and institutional context plays a pivotal role, while the variables more related to the economic performance of the service are important but less relevant. Moreover, we have shown how each of the main variables plays a different role by fostering the externalization or internalization of innovation services depending on the case. In addition to this, the findings may be useful to managers of incubators, accelerators, and startup studios since they all have similar objectives to STPs.

Our results also have some implications for theory. We introduce in the literature a list of innovation services for STPs, based on previous studies. Moreover, from the interviews, we developed four main alternatives to include an innovation service in an STP portfolio, and we showed six fundamental drivers influencing the choice between these different alternatives. We hope these results may be applied in future theories regarding business support organizations.

Although this study provides some interesting findings, some limitations should be noted. First, despite the sample being based on different countries, Italy is present with a higher percentage than the other countries in the sample. STPs from several countries may differ because of different legislation and culture; however, Italy and Spain are similar countries with similar economies. Additionally, the analysis was only conducted in Europe. Therefore, we suggest the importance of extending the analysis beyond European countries and collecting quantitative data to shed further light on the management and strategies of service innovation portfolios. In fact, as suggested by Vaidyanathan (2008) and Radosevic and Myrzakhmet (2009), it is important to analyze STPs in emerging economies as well. In addition to this, we did not include STPs owned by one or more than one university in our sample. Future research may include them in the analyses as well. Moreover, future studies may analyze Science Parks focused on specific sectors to understand how their specialization affects the composition of their portfolios of innovation services. Furthermore, we have identified a set of drivers influencing the development of a service innovation portfolio, but further research could be useful to understand the relative importance of these drivers, their relationships, and how the portfolio choices may evolve over time. In addition, it could be interesting to focus on how STPs collaborate with the local entrepreneurship ecosystem in order to improve entrepreneurial activities. One way of enhancing these results would be to analyze how STPs collaborate with universities and their technology transfer offices to strengthen academic and student entrepreneurship. Moreover, it is important to analyze the impact of the COVID-19 pandemic on the business support initiatives such as STPs, incubators,

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accelerators, and startup studios. The pandemic may be the input for a new generation of virtual business support organizations. Future studies may analyze if and how STPs will be able to offer their innovation services virtually.

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ANNEX 1: SERVICES LIST AND CASE STUDY PROTOCOL

CATEGORY OF SERVICE	MACROACTIVITY	ACTIVITY	NOT OFFERED	OFFERED **WITHOUT** THE INVOLVEMENT OF OTHER ORGANISATIONS	OFFERED **WITH** THE INVOLVEMENT OF OTHER ORGANISATIONS	Description of the service + name of the other organisations involved
Product and process Innovation	TECHNICAL CONSULTANCY (PROCESS)	Consulting on environmental issues				
		Consulting on issues related to quality and certification				
		Consulting on issues related to safety				
	TECHNOLOGY FORECASTING	Technology forecasting, roadmapping and technological due diligence (analysis of existing technologies and exploratory studies on the development of technologies)				
	PROTECTION OF INTELLECTUAL PROPERTY AND LICENSING	Intellectual property protection				
		Licensing out				
		Licensing in				
	LOGISTICS	Logistics services (physical space, connectivity, office equipment)				
	PRODUCT AND PROCESS INNOVATION	Design services and new product / service development support				
		Design services and support in improving production processes and technologies				
	SOURCING	Support to the participation to online Innovation Marketplace (e.g. Innocentive)				
		Support the organization of innovation competitions (crowdosurcing)				
		Support in identifying technology partners, research and test laboratories, etc.				
		Support in managing the user centered innovation (focus groups, test beds, Living Labs)				
	SCOUTING	Scouting for ideas, innovations and technologies (proactive by the service center)				
		Scouting for needs (proactive by the service center)				
Finance	FUND RAISING	Contacts management and accreditation with institutional and non-institutional investors				
		Support in obtaining credit, loans and guarantees				
	PARTICIPATION to CALLS for projects	Information (newsletter) on public and private calls for projects and innovation funding opportunities				
		Support in establishing the consurtium to participate to calls for projects				
		Support in preparing the documentation to partecipate to calls for projects				
		Support in coordinating the funded project (ongoing coordination)				
		Administrative and financial reporting of the funded projects (at the end of each year of the project)				
	ADMINISTRATION & FINANCE	Legal, administrative and accounting services				
		Support relationships with institutions (e.g., adaptation to new laws and rules, incentives)				
		Consulting on financial management				
Market	INTERNATIONALIZATION	Internationalization out				
		Internationalization in				
	MARKETING	Market research (e.g., analysis of customers, suppliers, market potential for technologies and products)				
		Communication, press and corporate website				
		Promotion through trade fairs, events and social networks (networking)				
	MANAGEMENT CONSULTING	Business plan writing support (start up phase)				
		Industrial and investment plan writing support				
		Consulting on strategy and CSR				
		Support in defining the marketing plan and in managing the product lifecycle				
Human resources	TRAINING	Programs of technical and managerial training and coaching				
		Support to Job rotation programs and researchers mobility				
		Conferences, seminars, training and update events (networking)				
	ORGANIZATION	Reputational services (Management, supervision and coordination of partnerships and alliances between organisations)				
		Support in human resources research and selection (hiring process)				
		Support in human resources management (HR) (career advancement, psychologists, motivators)				
		Business Process Reenginering (BPR) consultancy				

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