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Abstract

This article is dedicated to a consideration of the tertiarization of innovation networks. While the concept of traditional innovation network has been the object of an extensive literature, new expressions of the innovation network appear in a service economy: in particular Public Private Innovation Networks in Services, Market Service Innovation Networks, Public Service Innovation Networks and Public Service Innovation Networks for Social Innovation. They reflect the rise of market and non-market services and of the public-private relationship in collaborative innovation. Based on a literature survey, this article investigates these different expressions of innovation networks and sheds light on the different roles played by public services in each of them.

Keywords: public services, market services, innovation, networks

Introduction

In contemporary economies, innovation is a universal and ubiquitous phenomenon present in every economic sector and every sphere of social life. However, whatever the discipline considered (economics, management, sociology, political science and so on), our analytical and conceptual tools have often been unable to grasp this innovation dynamic in its full magnitude. Thus, entire sectors of our economies (in particular, the service sectors, including non-market services) and essential forms of innovation (non-technological innovations, including social innovations) have long remained marginal in the field of "Innovation Studies". This innovation or measurement gap may largely be explained by the inertia of our conceptual tools designed in and for manufacturing economies. It reflects, after all, invisible or hidden innovations, which do not fall within the traditional industrial and market indicators such as R&D, patents, and material technologies.

Considerable efforts have been made in recent years to bridge this innovation gap (recognition and measurement gap), taking into account both hidden forms of innovation and forgotten sectors. Thus, a field of "Service Innovation Studies" has enriched the traditional field of "Innovation Studies" that focuses on technological and industrial innovation (Gallouj and Djellal 2015; Djellal and Gallouj 2018a). An additional step forward in reducing the innovation gap has been achieved by taking into account the innovation dynamics and the dynamic capabilities in public services (Moore and Hartley 2008; Windrum and Koch 2008; Djellal et al. 2013; De Vries et al. 2015; Osborne and Brown 2013; Miles 2013; Potts and Kastelle 2010; Fuglsang and Sundbo 2016; Fuglsang et al. 2014; Piening 2013; Jordan 2014; Arundel et al. 2019; Gieske et al. 2019).

Ben Martin (2015) considers this gradual opening (to services and service innovation) of the field of innovation as one of the twenty main challenges in "Innovation Studies", since their advent, nearly a half-century ago. Djellal and Gallouj (2018a) for their part consider this opening as one of the fifteen main advances in "Service Innovation Studies", since their

advent, nearly a quarter century ago. It is also described as "the shift from visible innovation to invisible innovation". It is parallel to another fundamental evolution in "Innovation Studies" which is the shift from a linear and closed model of innovation to an interactive and open or network model (Martin 2015).

This rise of services, of service innovation and of the networked organization of innovation also lies at the heart of the shifts in public administration paradigms (Osborne 2006, 2010). Indeed, in the *traditional public administration paradigm*, innovation is, for the most part, associated with the industrial rationalization of production processes and the adoption of technical systems, the aim being to provide passive citizens with homogeneous quasi-products. This innovation activity, which excludes the user, is organized in a linear and top-down way. In the *new public management paradigm*, the industrialist perspective remains dominant, and innovation continues to be organized in a linear (non-interactive) way. The main novelty compared to the previous paradigm is the introduction of market management techniques in public services. The *new public governance paradigm*, currently at work in all developed countries, fundamentally changes the perspective of innovation. Indeed, this new paradigm considers public services as services and not as goods, and thus allows a broad and open concept of innovation integrating both technological and non-technological dimensions (new services, new processes, new organizations…). From the point of view of the organization of innovation, this paradigm emphasizes the collaborative dimension, and in particular the participation of citizens in innovation networks (Osborne 2006, 2010; Voorberg et al. 2015; Mergel I., 2018; Crosby et al. 2017; Torfing 2018). The importance given to networks, whether they be production or innovation networks, also leads to designating this new paradigm as a paradigm of "Networked Governance" (Kelly et al. 2002).

This article discusses the concept of innovation networks and the place that is given to services and especially public services in them. Its purpose is not to develop a conceptual framework or a new theory, but to provide an original mapping of the innovation network concept, in the context of the service economy. The aim is to show how, in parallel with the shift from visible innovation to invisible innovation, services in general and public services in particular are gradually moving from a peripheral to a central position in the innovation networks. Based on a review of the literature, we discuss how traditional innovation networks can be enriched by other types of networks more focused on services and public services, namely Public-Private Innovation Networks in Services (PPINSs), Market Service Innovation Networks (MSINs), Public Service Innovation Networks (PSINs) and Public Service Innovation Networks for Social Innovation (PSINSIs).

The tertiarization of the innovation network concept which is addressed in this paper encompasses both market services and public services. While the definition of *market service* does not pose much problem, the term "public" in its various uses (public sector, public administration, public agent/actor...) and in its relationships with innovation (public sector innovation, public service innovation, public innovation...) deserves some clarifications.

According to Flynn (2007, p. 2), the *public sector* is "those parts of the economy that are either in state ownership or under contract to the state, plus those parts that are regulated or subsidized in the public context". The public sector is composed of *public agents/actors* that consist in both public organizations (including governmental bodies, healthcare and education organizations...) and public enterprises. *Public service* is the service (i.e. a set of use values) which is delivered not only by entities belonging to the public sector, but also to the private sector (for example, NGOs). Public service is therefore somehow synonymous with "service of general interest".

When the focus is on innovation associated with these different terms, *public service innovation* or *public innovation* can be said to go beyond the boundaries of *public sector*

innovation, since it also includes the innovation developed within networks where the main actors are citizens and not-for-profit organizations.

This article is organized into four sections. In section 1, we provide a general description of these different expressions of innovation networks, to compare them from a morphological and functional point of view and to identify the relationships among them. The following sections are devoted to a more in-depth discussion of each of these network forms. Special attention is given in the last section to the most recent and least known expression of innovation networks, namely Public Service Innovation Networks (PSINs).

1. A General Description of the Different Expressions of Innovation networks: TINs, PPINSs, MSINs, PSINs and PSINSIs

The notion of innovation network is often defined according to two complementary functional and morphological perspectives. In the functional perspective, the innovation network is defined as a mode of coordination between economic agents, intermediary between market and hierarchy, considered to be more effective than them (Hakansson 1989; Powell 1990; Hakansson and Johanso, 1993; Powell and Grodal 2005), in that it prevents the risk of bureaucratization of innovation that can occur in the hierarchy and the risk of disclosure of strategic secrets that characterizes the market. In the morphological perspective, the innovation network is defined as a structural arrangement for bringing together multiple actors around a common objective, namely innovation (Pyka and Kueppers 2003; Ahrweiler and Kean 2013). While hierarchal governance is based on a central authority and market governance is based on contracts, innovation network governance is based on trust, reputation and mutual dependence between selected partners (Möllering 2001; Sztompka 1999; Dodgson 1993; Powell and Grodal 2005; Kolleck and Bormann 2014).

The notion of innovation network has been a great success in the literature, a success that is manifested on the theoretical, methodological, empirical and political levels. This success of what are called here traditional innovation networks (TINs), is confirmed, in a way, by its spread to new socio-economic contexts (services in general, market services, public services) and the emergence of new forms of innovation networks, namely the public private innovation networks in services (PPINSs) highlighted in the European ServPPIN project (Gallouj et al. 2013)[1], the market service innovation networks (MSINs), the public service innovation networks (PSINs) and the public service innovation networks for social innovation (PSINSIs) discussed in the COVAL European project[2]. In this first section, following a presentation of the methodology used for the survey of the literature, we provide an overview, from a morphological (or structural) and functional point of view, of these different forms of innovation networks and the possible relationships among them.

1.1 Methodology

To map innovation networks, we carried out a review of the literature, based on SCOPUS and Web of Science databases, and the PRISMA method (Mohrer et al. 2009). We used the following search stream: [“innovation network” OR “innovation collaboration” OR “innovation cooperation” OR “innovation partnership”]. The search was limited to articles, books and book chapters published in English over the period 1990-2018.

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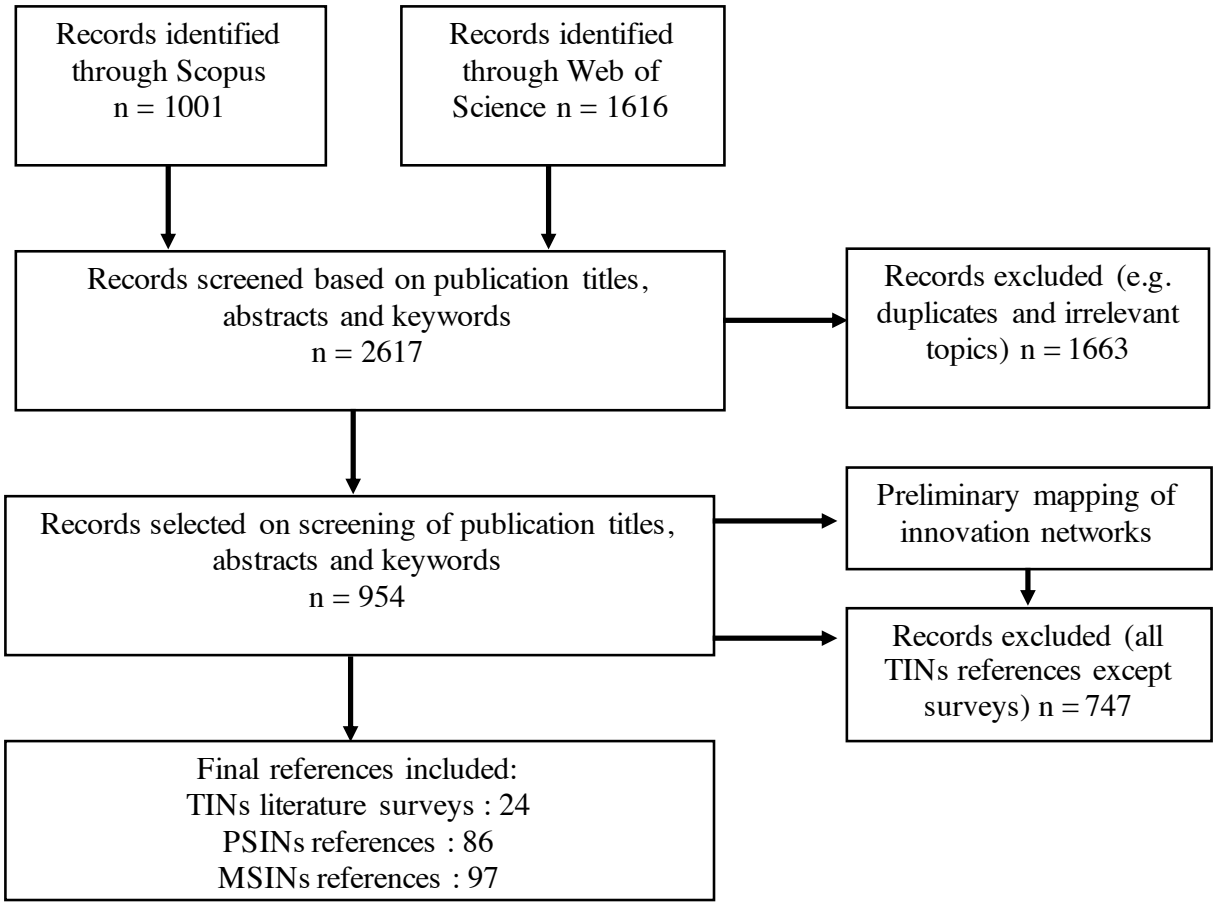
[1] ServPPIN: The Contribution of Public and Private Services to European Growth and Welfare, and the Role of Public-Private Innovation Networks, FP7-SSH project 2008-2011.

[2] COVAL: Understanding value co-creation in public services for transforming European public administrations, H2020 project 2017-2020.

The search strategy and the record selection process are presented in Figure 1. Scopus and Web of Science data bases made it possible to identify 2617 references. Screening the titles, abstracts and keywords made it possible to exclude a certain number of them, in particular the duplicates and the publications addressing the innovation network topic in a marginal way or in a way than doesn't fit our mapping objective. This leads to the selection of 954 references.

Figure 1: Diagram of the search strategy and the selection process



We then screened the abstracts (and when needed skimmed through the full text) according to a first simple criterion namely the main sector (manufacturing, market services or public services) concerned by the innovation in the network. This made it possible to identify and quantify the references on traditional (manufacturing-based) innovation networks (TINs) (771), on market services innovation networks (MSINs) (97) and on public service innovation networks (PSINs) (86).

To achieve a more detailed mapping of these innovation networks and identify some of their characteristics, we introduced three other criteria namely: the types of agents involved in the network, the role played by the public agent (when any), the nature of the targeted innovation. To identify these criteria, reading (or at list skimming through) the full texts is necessary. We skimmed through all the references on servitized networks, while regarding TINs, given the considerable number of references, we can do no more than reading the existing literature surveys (Table 1).

Table 1: Surveys of the literature on traditional innovation networks

Aarikka-Stenroos and Ritala (2017) Ozman (2009) Freeman (1991) Hoang and Antoncic (2003) Pittaway et al. (2005) Powell and Grodal (2005) Hamdouch (2007) Jensen and Nybakk (2013) Zirulia (2009) Almodovar and Teiweira (2012) Jones, Conway and Steward (1999) Silva and Guerrini (2018) Breschi and Malerba (2005)	DeBresson and Amesse (1991) Meeus and Faber (2006) Aarikka-Stenroos, Sandberg and Lehtimäki (2014) Trapczynski, Puslecki and Staszkow (2018) Najafian and Colabi (2014) Dagnino, Levanti, Mina and Picone (2015) Giuliani (2011) Hagedoorn, Link and Vonortas (2000) Woodward, Eylem Yoruk, Bohata, Fonfria Mesa, O'Donnell and Sass (2005) Noteboom (2006) Bergenholtz and Walderstrom (2011)

1.2 The Different Forms of Networks from a Morphological and Functional Point of View

Although the literature gives precise examples of sectors, types of agents, roles of the public agent, types of innovation, we will confine ourselves to provide a simplified framework here (see Figure 2).

The actors involved in the network may belong to the following sectors (Tether 2002; Corsara et al. 2012; Nieto and Santamarina 2007; Arranz and Fernandez de Arroyabe 2008; Windrum 2014):

- the manufacturing sector (M) and the market services sector (MS), which both encompass firms of various sizes, ranging from SMEs to multinational corporations (Ahrweiler and Keane 2013), which can be competitors, suppliers, clients to each other.
- the public services sector (PS) bringing together, on the one hand, universities and public research centers, and on the other hand, all other public service organizations (government bodies at different levels – local, regional, national and even international –, public bodies such as hospitals, public enterprises).
- the third sector (TS) consisting of associations, non-governmental organizations (NGOs), voluntary groups, social enterprises, cooperatives and mutual societies.

The network can also involve individuals (C) considered from different facets: individual citizens, users and especially lead users and consumers. In theory, actors belonging to each of these categories (M, MS, PS, TS, C) can play a role, in one way or another, in each of the types of networks. But, in reality, depending on the type of network considered, some of these sectors or agents are predominant in the network.

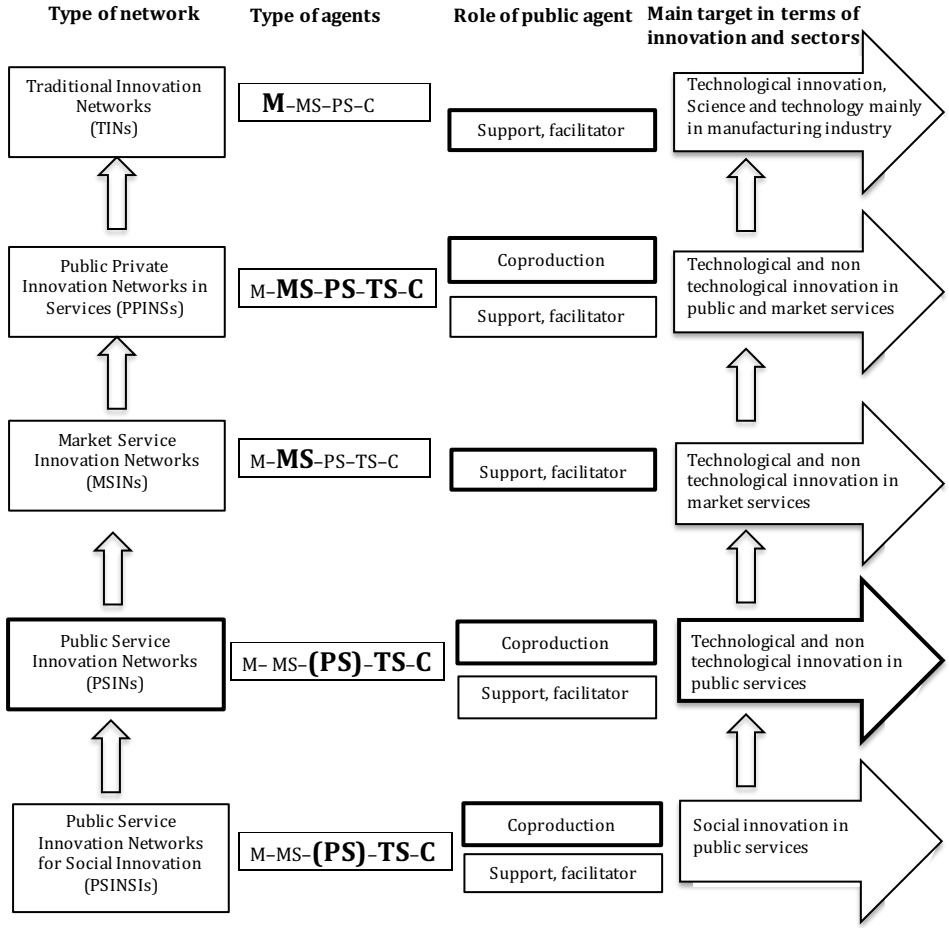
These networks may be set up to achieve different forms of innovation (technological and/or non-technological innovations), different scales of innovation (incremental or radical innovation, simple innovation or complex/architectural innovation) and innovations originating from different sources (adopted innovation or produced innovation). These innovations can be aimed at different sectors (manufacturing industry, market services, public services). Thus, for example, TINs are often high-tech networks (Powell and Grodal 2005), MSINs are often devoted to service (non-technological) innovations (Mustak 2014; Burdon et al. 2015; Nätti et al. 2014), some PSINs (that we call PSINSIs) are targeted towards social innovation.

The public agent (governmental body or any other public organization) can play two different roles, exclusively or jointly, in innovation networks: on the one hand, a role of co-production of the innovation strictly speaking (innovator in its own right) and, on the other hand, a role of support/facilitator of the innovation or the constitution of the network.

On the basis of the main sector concerned by the innovation, and according to the different criteria suggested, our review of the literature makes it possible to sketch the different types of innovation networks, which we briefly define here, and will discuss further in the following paragraphs (see Figure 2).

TINs are networks that focus on the manufacturing industry and technological innovation and in which the public administration is not a co-producer of innovation, but a facilitator. PPINSs, that were the subject of the European ServPPIN project are systems of service-oriented collaborations, public-private collaborations, open to non-technological innovation. MSINs are innovation networks focused on market services and service innovation. PSINs focus on innovation in public services. The main actors in this type of network are citizens, public sector and third sector organizations. Finally, PSINSIs are a special subcategory of PSINs dedicated to social innovation.

Figure 2. Different types of innovation networks: TINs, PPINSs, MSINs, PSINs, PSINSIs

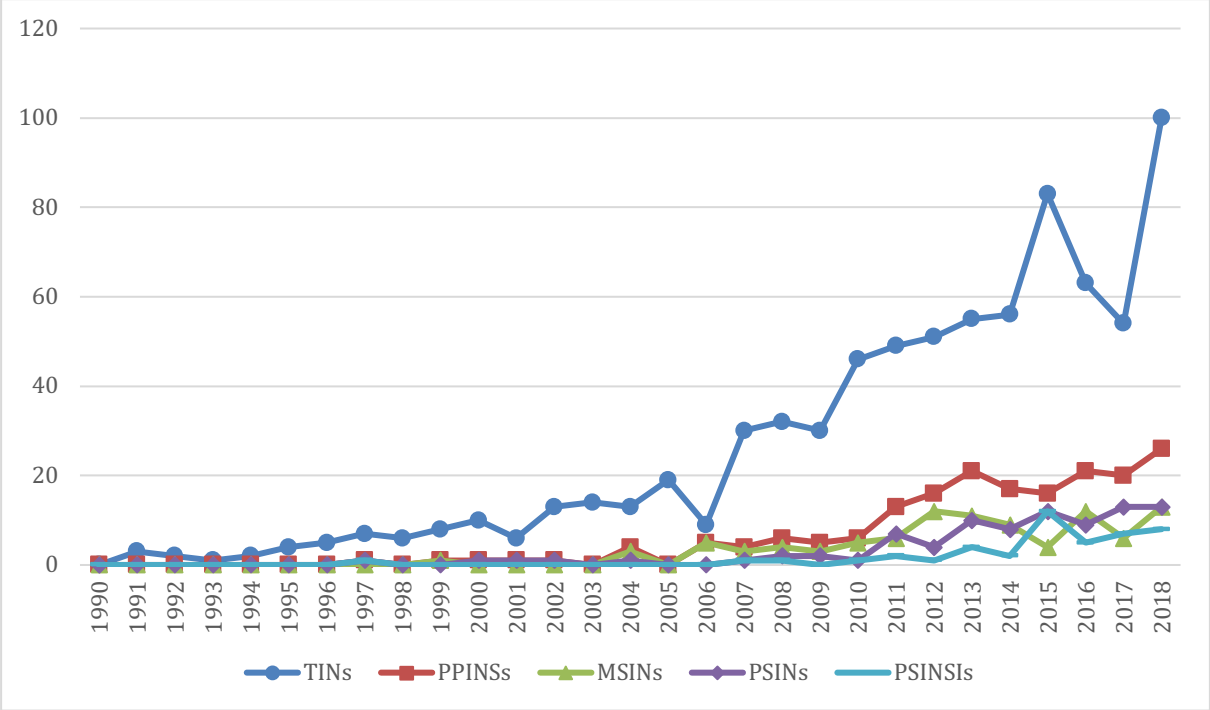


M = Manufacturing. PS = Public Service. MS = Market Service. TS = Third Sector. C = Citizens, Users (Lead-Users), Consumers
Bold and larger letters reflect the relative importance of the agent in the network

1.3 The Visibility of the Different Types of Networks and the Relationships among them

Over the last 30 years, the concept of (traditional) innovation network based on manufacturing industry, especially high-tech R-D intensive industry (Powell and Grodal 205), has been quite successful and has given rise to a great deal of literature that is exponentially increasing (Figure 3).

Figure 3: Number of annual publications according to types of innovation networks



The extension of innovation networks to services and service innovation has attracted attention from researchers more recently, whatever the type of network considered. The emergence of the literature on these new types of tertiarised networks can be dated back to the mid-2000s.

In the European ServPPIN project (Gallouj et al. 2013), the awareness of this conceptual tertiarisation emerged in a general way, integrating market and non-market services. However, our review of the literature suggests to distinguish networks focused on market services (MSINs) from networks focused on public services (PSINs and PSINSIs).

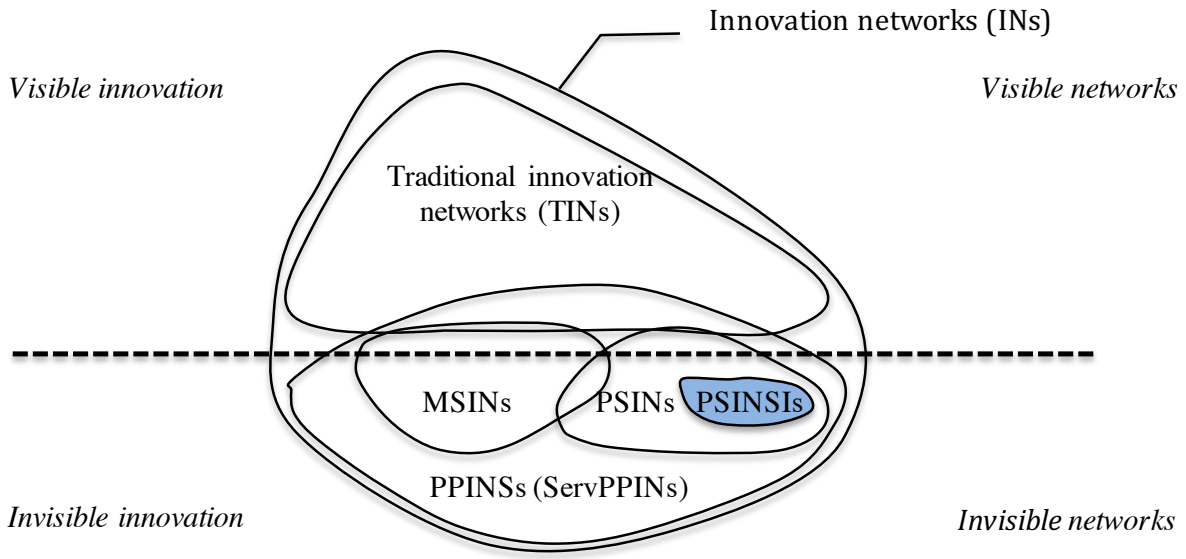
The literature on PSINs and PSINSIs is the least extensive. It is still in its "infancy" (Sørensen and Torfing 2010). This gap in the literature can be explained by the existence of a certain mistrust vis-à-vis notions (collaboration, partnership, network) which, in the case of immaterial, non-spectacular and frugal innovations, at work in PSINs and PSINSIs, may appear to be mere rhetorical tools (Atkinson 1999; Hastings 1996; Lyon 2013) rather than desirable and effective innovation arrangements. This is not the case for traditional innovation networks, which are taken seriously because they are designed to develop and implement sophisticated R&D-based industrial and technological innovations.

To sum up, traditional innovation networks (TINs) can be said to constitute the visible tip of the iceberg of innovation networks (see Figure 4), while the other less known types of innovation networks are the submerged parts. However, the different types of innovation

networks are not independent of each other. There is an intersection between TINs and PPINSs. This intersection equates to certain PPINSs which are focused on technological innovation. These include certain health innovation networks (Djellal and Gallouj 2007; Ii et al. 2018; Windrum and Garçia-Goñi 2008) and certain public-private multi-agent partnerships devoted to innovative heavy infrastructures (what Rostgaard et al. 2014 calls Public-Private Innovation-PPI). There is also an intersection between MSINs and PSINs. This reflects in particular the ambiguous position of public utilities vis-à-vis market and non-market spheres (privatization, delegation of public service). In our survey of the literature, we have assigned to PSINs the innovation networks involving utilities, while they could be integrated in MSINs.

PSINSIs are a sub-category of PSINs whose target is social innovation in public services. These two forms of innovation networks (PSINs and PSINSIs) are themselves sub-categories of PPINSs.

Figure 4. The innovation network iceberg



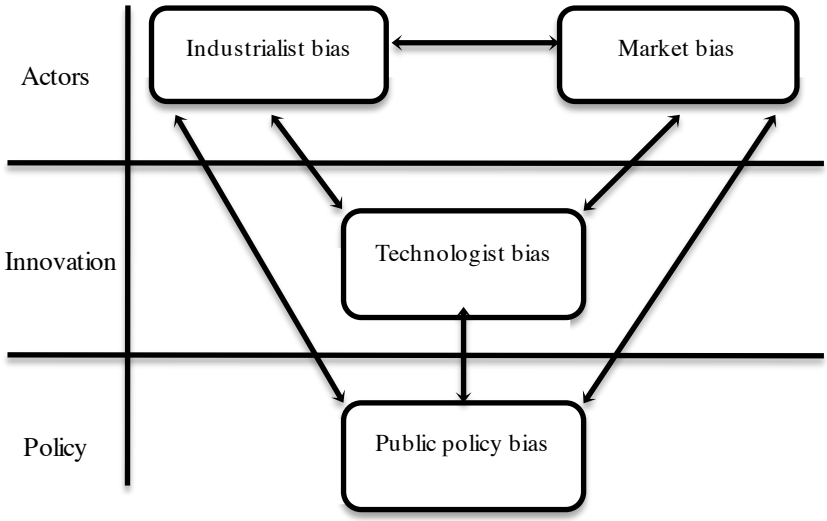
2. Traditional Innovation Networks (TINs)

Traditional innovation networks are multiagent collaboration systems, of varying size, dedicated to technological innovation. They have been the subject of an extensive literature (including many reviews: see Table 1), for several decades. The undeniable success of this concept of TIN can be explained in different ways (Gallouj et al. 2013). It is explained, first of all, theoretically, by its great simplicity and its great heuristic value. After all, an innovation network seems to be nothing more than a set of nodes and links. The strong theoretical scope of this concept is, moreover, reinforced by its ability to be part of concepts that are themselves quite successful, in particular the concepts of innovation systems in their various expressions (local, regional, national systems, sectoral systems, innovative milieus, technology districts, technopoles or clusters). Indeed, (innovation) networks constitute the core elements of these concepts (Grabher 2006; Glückler 2007; Freeman 1987; Carlsson and Stankiewicz 1991; Ahrweiler 2010). The strong theoretical scope of this concept also owes much to its ability to assimilate itself to other concepts (learning, absorption capacity, scale,

scope and agglomeration economies, transaction costs, network externalities, etc.) and other theories (collective innovation, user-driven innovation, open innovation, innovation communities...). The success of the traditional innovation network concept is also due to its operational and political use. The notion of innovation network and the associated notion of innovation system, in its various forms, give rise to interesting operational frameworks for mapping innovation dynamics for auditing, performance comparison and benchmarking. The concept of innovation network is also a key component of many public policies supporting innovation at different levels (supra-national, national, regional, local). Thus, the notions of National Systems of Innovation (NSI) and the networks that constitute them remain key components of national and European innovation policies. The notions of regional innovation systems (RIS) and clusters (like innovative milieus or industrial districts in past decades) are today central to local and national policies in many countries.

However, as theorized and experienced, innovation networks, have a number of weaknesses, particularly when viewed from the perspective of a service and sustainable development economy. These weaknesses concern the nature of the stakeholders involved in the network and the nature of the innovation addressed by the collaboration. They reflect three biases (industrialist, market and technologist), which are not independent of each other and which contribute to a fourth bias in terms of public policy (see Figure 5).

Figure 5. The biases characterizing TINs



Traditional innovation networks (TINs) are characterized by an industrial, technological and market bias. After all, the dominant agents within these networks generally belong to the industrial sector (M) and the market sector, and the main targets of the network are technological innovations with a strong scientific and technical R&D dimension (see Figure 2). The pre-eminence of manufacturing firms among TINs leads to say that TINs are manufacturing innovation networks (MINs) (as opposed to service innovation networks, whether MSINs or PSINs). The pre-eminence of agents from the industrial and market sectors does not mean that agents belonging to other sectors are totally absent from these networks, just that their "role" is less important.

Thus, certain market services (MS) can take part in TINs. But the market services concerned are usually limited to Knowledge Intensive Business Services (KIBS): consultants of all types and financial services (investment banks or business angels) (Miozzo et al. 2016; Andreas and Harald 2008; Bolisani and Scaros 2009; Smedlund and Toivonen 2007; Bustinza et al. 2017; Braga et al., 2017; Den Hertog 2000; Huggins 2011). These KIBS are not core

elements of the network: after all, most generally, they only play a support role in favour of manufacturing firms that are the central agents. Other (peripheral) services which purpose is to support goods can also be mentioned: for example the so-called "services around the product", i.e. pre-sales, after-sales services (Furrer 2010).

Similarly, even if TINs are dominated by a market logic, public service actors (PS) also frequently take part in them. However, here again, as for market services, the public services concerned and, for some of them, their scope for action in terms of innovation are limited. Only two groups of public services are involved: universities and public research laboratories on the one hand, and local, regional or national public administrations on the other (Ahrweiler and Keane 2013; Etzkovitch and Leydesdorff 2000). The functions assigned to each of these groups in TINs are well known and documented: for public research bodies in science and technology (research centres, universities), the purpose is *to participate upstream in the production* of technological innovation (basic and applied research), and for public administrations, the purpose is to ensure meta-governance, in other words *to promote an environment conducive to innovation* and to the formation of partnerships (establish a favourable legal environment, provide financial support, encourage industrial firms to work more closely with universities and research centres). It is important to emphasize that the technological and market bias that characterizes TINs makes it impossible to consider innovation activity specific to public administrations that would be the fruit of collaboration between different agents.

It should be noted that, especially starting from the precursor work of Von Hippel (1986), these (traditional) innovation networks also begin to take into consideration the user (C) and in particular the lead user as a significant actor in innovation dynamics.

TINs do not necessarily bring together all the types of actors envisaged in Figure 2. In particular, Government and public research organizations may be absent. Thus the literature distinguishes two generic types of traditional innovation networks: public-private and private-private innovation networks[3] (Drejer and Jørgensen 2005; Schilling and Phelps 2005; Fogelberg and Thorpenberg 2012; Hagedoornet al. 2010).

Private-private innovation networks encompass strategic alliances, joint ventures, supply chain arrangements (Hagedoorn 2002; Powell and Grodal 2005; Zirulia 2009; Ahrweiler and Keans 2013; Caloghirou 2003; Gulati and al. 2000). However, the triad composed of an industrial firm (producer of innovation), public research (co-producer of innovation) and public administration (promoter of innovation), which is the standard form of TIN, is a public-private network. It has been the subject of many theoretical models. These include, for example, the so-called "triple helix" model (Etzkovitch and Leydesdorff 2000), which describes the processes of knowledge production in hybrid networks involving companies, universities and government agencies. These also include the so-called "mode 2" of knowledge production developed by Gibbons et al. (1994, see also Gibbons 2000) which describes a network of multidisciplinary actors, interacting to find solutions to the technological problems raised by industry. It is the industrial firm that is the centre of these collaborative modes of knowledge production, or which is intended to be their centre, as the life cycle of the network evolves. The analyses of network life cycles illustrate a decline in the participation of public actors over time. The maturity phase of innovation networks is clearly dominated by private industrial firms.

[3] There are also public-public networks, but they are generally research rather than innovation networks.

Whatever their form, TINs can be of various size (from a few to a considerable number of actors) and be established at different spatial scales: local, regional, national or even global. Their lifespan is also very variable, which makes it possible to envisage a continuum between innovation networks established for a given transitory project and permanent innovations networks.

The industrial, technological and market biases that characterize TINs, and which interact with each other, lead to a bias in the public policy designed to promote innovation (see Figure 5). Indeed, TINs, whether as a public policy instrument or as a public policy target, mainly promote technological innovation based on R&D and science and technology. The PPINSs addressed in the next section help to reduce all four of these biases.

3. Public-Private Innovation Networks in Services (PPINSs)

PPINSs are networks that have begun to interest research more recently (ServPPIN project funded by the European Commission, see Gallouj et al. 2013). They describe collaborations in the field of innovation between public and private service organizations. They should not be confused with public-private partnerships (PPPs). PPPs are generally focused on service production and not on innovation, and their rationale is based on the idea that introducing a market logic is good for performance, whereas in PPINSs, what is good for performance is the hybridization of knowledge and skills. Finally, PPPs are formalized in contracts while PPINSs are more flexible structural arrangements.

In this new type of innovation network, the dominant agents belong to market services (MS) and non-market services (PS and TS) (see Figure 2). In addition, a new target appears alongside technological innovation, namely non-technological innovation which is given great importance. Thus, PPINSs bypass the technological, industrial and market biases of TINs that we have outlined previously.

- PPINSs correct the industrial bias of traditional INs by giving a central place to market services (MS). The status of services is raised both in terms of the nature of the services concerned and their function/place in the innovation process. *First of all*, in PPINSs, not just KIBS and financial services, but any service activity can be part of the innovation network. The PPINSs database of the ServPPIN project provides the following examples (Djellal and Gallouj, 2013): consultants, a TV channel, travel agencies and tour operators, private elder care services, transport companies, etc. *Second,* in PPINSs, these services no longer occupy a peripheral position in the innovation network, but rather a central one. They are now the key actors, the nodes of the networks and the main actors of innovation, which itself is broader in nature, since it includes the different forms of so-called invisible innovation (see Figure 6).
- PPINSs also correct the market bias of TINs by giving a central place to public and non-market services and to public-private collaboration in the network. Thus, a wide range of organizations belonging to the public sector (PS), but also to the semi-public and the so-called third sector (TS) (associations, non-governmental organizations, etc.) take part and occupy an important place in the network. The PPINs database of the ServPPIN project provides the following examples of public and non-market services (PS and TS) (Djellal and Gallouj, 2013): the Red Cross, a municipality, a development agency, a chamber of commerce and industry, a tourism union, a transport union, the institutions of the labour market (collaboration between employers and unions), a health regulation agency, a federal state government, a foundation and so on. The new public actors involved also include research networks in human and social sciences.

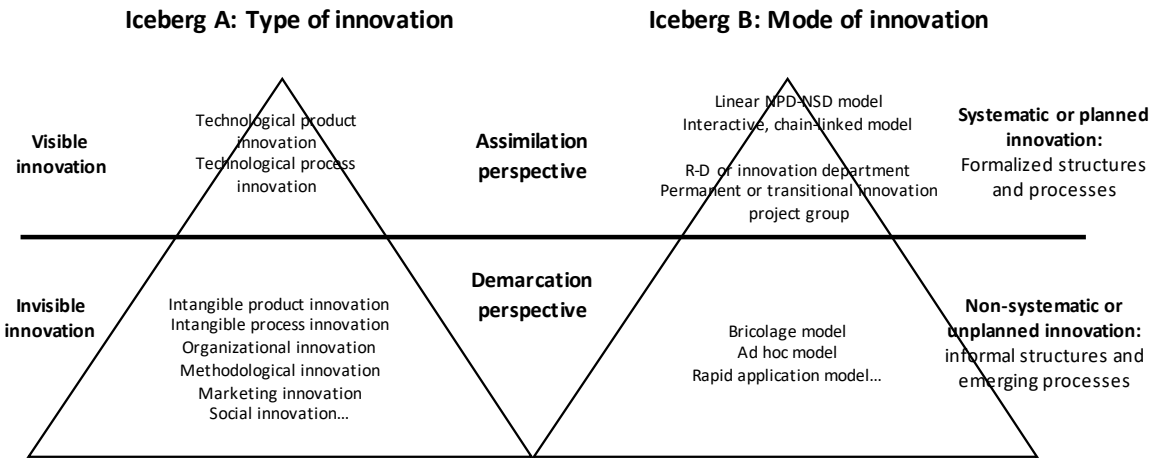
• One of the key characteristics of PPINSs that distinguishes them from TINs is that any public service activity/organization, and not just public research organizations (universities, research laboratories), can perform a co-innovation activity strictly speaking. As in the case of services, PPINSs thus make it possible to include non-technological forms of innovation in networks. They also make it possible to account for an area of innovation that is still largely under-exploited, namely innovation in public services (Windrum and Koch 2008; Djellal et al. 2013; Fuglsang et al. 2014; Moore and Hartley 2008; Djellal et al. 2013; Osborne and Brown 2013; Jordan 2014; Arundel et al. 2019; Hanneke et al., 2019).

Thus, while TINs are focused, for the most part, on technological innovation, PPINSs are based on a broader and open concept of innovation that includes both visible (technological) innovations and invisible (non-technological) innovations, systematic (planned) innovations and non-systematic (unplanned or emerging) innovations (see Figure 6).

Visible innovations are those that are perceived by traditional analytical tools, such as R&D and patents. They reflect a technologist and assimilationist conception of innovation in services, which renders much of the innovation dynamics in services invisible (Gallouj 2002). Invisible innovations are a heterogeneous category, often grouped under the term non-technological innovations. They can take different forms: organizational, social, marketing, and so on. They reflect a service-oriented or demarcative conception of innovation in services (Gallouj 2002) (Iceberg A in Figure 6).

Systematic or planned innovations are incorporated into well-identified and formalized structures (for example, R&D or innovation departments, permanent or transitional innovation project groups and so on) and into well-established, more or less complex, stage-gate processes (linear NPD-NSD models) or interactive, chain-linked models as described by Kline and Rosenberg (Kline and Rosenberg 1986). These models are the application to services of traditional (manufacturing) innovation models. They therefore reflect an assimilation view of innovation organization modes, and they are included in the visible tip of Iceberg B in Figure 6. Non-systematic, unprogrammed or non-planned innovations are embedded into informal and loosely coupled structures and in "emerging" spontaneous processes. Within this general category, the literature distinguishes several types of innovation models that were for many years underestimated (submerged part of Iceberg B): bricolage model (Fuglsang 2010), ad hoc or a posteriori recognition model (Gallouj 2002), rapid application model (Toivonen 2010) and so on.

Figure 6. The service innovation icebergs



4. Market Services Innovation Networks (MSINs)

Although research on innovation in services has experienced an undeniable growth in recent years, research on innovation networks in services (MSINs) is still limited. MSINs represent only 10% (97 out of a total of 954) of the references selected in our survey. In contemporary service-dominated economies, and regarding activities that are supposed to be characterized by co-production (especially with the customer), the small number of references on innovation networks is paradoxical. Anyhow, our review of the literature (see Figure 3) illustrates a growing interest for MSINs since the mid-2000s.

MSINs are innovation networks established around dominating service firms (MS) (see Figure 2), in order to implement service innovations, whether technological or non-technological (Syson and Perks 2004; and O'Sullivan 2007; Agarwal and Selen 2009; Tether and Tajar 2008; Agarwal et al. 2011; Kandampully 2002; Mustak 2013; Mention 2011; Nattti et al. 2014).

As already pointed out above, individual consumers (C) are often discussed in the literature as co-producers of the service. Interactivity (or inseparability) that's to say the fact that services are co-produced by a provider and a consumer who are inseparable is one of the main technical characteristics of services. This consumer is also sometimes seen as a co-innovator. However, co-production and co-innovation are most often considered in the context of bilateral (dyadic) rather than multi-party relationships. That's why, while the actor "C" is included in the simplified representsation of MSINs (Figure 2), it is not in bold and enlarged letters.

Our review of the literature made it possible to identify the existence of such networks, particularly in the following sectors: tourism (Sundbo et al. 2007; Kofler et al. 2018; Høegh-Guldberg et al. 2018; Brandão et al. 2018; Zach and Hill 2017; Booyens and Rogerson 2017), retailing (Cox and Mowatt 2004; Hidalgo and D'Alvano 2014), financial services (for example, strategic alliance between banks and fintechs), mobile services (Heikkinen and Still 2008; De Reuver and Bouwman 2012), transportation/logistics (Steinicke et al. 2011), ICT services (Zhao et al. 2010; Kim et al. 2015), engineering services (Burdon et al. 2015), cultural industry (Lin 2014), restaurants (Cho et al. 2018), exhibition industry (Dawson et al. 2014), etc. It should be noted that knowledge intensive business services, which are support agents for manufacturing firms in TINs, can be the main players in MSINs (Zhao et al. 2010; Burdon et al. 2015).

When they are focused on technological innovations, MSINs differ little from TINs. They can encompass traditional technological alliances and even the triple helix model associating university, administration and service firms. This similarity is reflected by the overlap between MSINs and TINs in Figure 4. However, MSINs are most often private-private partnerships, especially cooperation between service firms (Steinicke et al. 2011; Burdon et al. 2015) or between service firms and KIBS. Symmetrically to service firms role in TINs, when manufacturing firms are included in MSINs, they play a peripheral role, for example, as suppliers.

When the innovations in question are non-technological (new services), the multi-agent collaboration within PSINs and particularly the horizontal (intra-industry) collaboration, can raise serious problems of protection of innovation (Hurmelinna-Laukkanen and Ritala 2010; Ritala et al. 2009).

The distinction between TINs based on manufacturing industry and technological innovation and MSINs based on market services and service innovation falls within the scope of what services studies call the demarcation (as opposed to the assimilation) perspective

(Gallouj 2002). However, in a context of blurring boundaries between goods and services, an integration perspective has been emerging. This seeks to develop unifying theoretical models for goods and services, innovation in manufacturing, and innovation in services (Gallouj and Weinstein 1997; de Vries 2006; Windrum and Garcia-Goñi 2008; Lusch and Vargo 2006). The Product-Service Systems (SPS) approach, which reflects the rise of integrated "product-service" offerings (Mont 2002; Bryson 2010; Paschou et al. 2018) falls within the scope of these integrative models. SPS reflects a certain hybridization of TINs and MSINs, since the construction of the SPS requires a balanced participation of manufacturing and service firms in the production and innovation network. In an SPS, the competitive advantage of the manufacturing firm may spring from the innovation activity of its partner service firms (Gebauer et al. 2008; Kindström and Kowalkowski 2009; Spring and Araujao 201; Feng and Sivakumar 2016).

5. Public Service Innovation Networks (PSINs) and Public Service Innovation Networks for Social Innovation (PSINSIs)

The latest application of the concept of innovation network is to public services themselves and collaborative innovation in public services. We call these new kinds of innovation networks Public Service Innovation Networks (PSINs). In our review of the literature, we have identified 87 references PSINs and underlined their steady growth since the mid-2000s. We start by providing a general definition of PSINs, and then we examine their general characteristics using various typologies.

5.1 The Definition of PSINs

PSINs, which are very successful within the "new public governance paradigm", are collaborative arrangements implemented in public services in order to create value through a process of co-innovation. They bring into play various public and private agents, especially citizens, in order to co-produce innovations in the field *of public services (sector) or of public service (function)*, whatever the nature of the innovation in question: new service, new organization, new process or new delivery method, mix of these innovations, new reform.

As Figure 2 illustrates, although any type of public and private actor can be part of PSINs, the main actors generally belong to the following three groups: public services (PS), third sector (TS) and individual citizens (C). A key element in PSINs is that *the target of collaborative innovation is the public service itself*. It is the public service that is the subject of innovation. If when it is present, the public actor plays a central role in PSINs, it should nevertheless be noted that it may happen in some cases for the public actor to be absent from the PSINs throughout their life cycle or at certain periods of the life cycle (This is what we express by putting PS into brackets in the figure, while keeping bold and enlarged letters). The explanation of this paradox, as already stated, is that PSINs are concerned with both innovation *in* public services as an activity or sector and with public service innovation with public service viewed as a function of general interest even beyond public sectors. In such conditions, an innovation of general interest can be provided by a network of private (market or non-market) actors, specifically because the public actor has been failing on a given "market", either because it has withdrawn from or does not have the resources or the desire to serve that market. This failure or lack of interest of the public actor is not uncommon in the particular case of PSINs centred on the resolution of wicked social problems and promoters of social innovation, networks that we call PSINSIs.

5.2 Different Typologies of PSINs

PSINs can be described by using a number of typologies, which can be based on the following criteria: 1) the (sectoral or functional) fields where networks are set up; 2) the type of actors involved; 3) the nature of the innovation provided by the network; 4) the mode of formation and functioning of the network.

1. PSINs according to the Fields where they are set up

The fields where PSINs are set up can be addressed in different ways: for example, through accountancy-based typologies of public service activities or through typologies that reflect the major problems or social needs of the moment.

In accountancy-based typologies, a distinction can be made, for example, between the following sub-sectors:

- sovereign public services (order and security),
- public services regulating private activities,
- public health and social protection services,
- educational and cultural public services,
- industrial and commercial public services.

This typology can be simplified by distinguishing between general services, social services and utilities. PSINs can be created in any one of these categories, as illustrated by the following references identified in our survey of the literature: for general services (Faerman et al. 2001), for social services (Kaminski 2016; Windrum 2014; Kolleck, 2014; Mandel and Keast 2013), for utilities (Schmidt et al. 2018; Kolloch and Reck 2017; Compagnucci and Spigarelli 2018; Shaw and Burgess 2013). However, it should be noted that social services constitute a particularly favourable ground for PSINs set up for the implementation of social innovation (i.e. PSINSIs).

In typologies that reflect major social problems or needs, a distinction can be made, for example, between: health (Windrum 2014; Mandel and Keast 2013; Andersson et al. 2012), ageing (Rvensivu et al. 2012; Pekkarinen and Harmaakorpi 2006; Sorensen and Torfing 2017; Grudinschi et al. 2013); education (Kolleck 2014), transportation and mobility (Cahoon et al. 2013), employment (Kallio and Lappalainen 2015; Rangel and Galende 2010), security (Mandel and Keast 2013), endangered childhood (Leonardo et al. 2018; Mulroy and Shay 1997) and so on. All these major social problems or needs can be the subject of PSINs or PSINSIs. For example, the Danish CLIPS project presents 14 case studies of collaborative public service innovation related to crime prevention in a local environment (Sørensen and Torfing 2013). Social problems at the origin of PSINs include what the literature calls "wicked problems". Wicked problems are complex, multiform, systemic and often conflicting problems, which cannot be solved by a single actor, but which require multi-stakeholder collaboration. They include problems related to caring for an aging population (in terms of health, housing, mobility and so on), the decay of certain suburbs, environmental degradation, caring for refugees and so on. Regardless of the field of activity, PSINs are concerned by wicked problems, but PSINSIs centred on social innovation are even more focused on these problems. It is this focus on solving major social problems (in a corrective or proactive way) through social innovation that defines PSINSIs and distinguishes them from PSINs in general.

If they can be analytically broken down into broad, distinct categories, major social problems are in reality interconnected and should be addressed in a comprehensive way. Thus some PSINSIs are developing to provide innovative solutions to social situations involving simultaneously several problems, for example, youth unemployment, long-term unemployment, education and security (Kallio and Lappalainen 2015). The literature on

PSINs also includes references on smart cities, which seek to innovatively solve multiple urban problems by mobilizing multiple actors (Lytras and Visvizi 2018; Cardullo and Kitchin 2018; Ratten 2017).

2. PSINs according to the Type of Actors Involved

A typology of PSINs based on the nature of the actors involved in the network can be envisaged. Such a typology would include the following categories:

(1) Networks made up of both public and private agents (Kallio and Lappalainen 2015; Brown and Keast 2003; Jamali et al. 2011; Bland et al. 2010; Rostgaard et al. 2014). This first group can itself be broken down into different sub-types, in particular by dividing the category of private actors into market private actors (companies, consultants) and non-market private actors (associations, citizens, and so on). The triple helix configuration (university-industry-government network focused on technological innovation) which is the canonical form of TINs is also present in this first group. The references identified relate in particular to public utilities, for example the water sector (Compagnucci and Spigarelli 2018) and health services (Ii et al. 2018). By analogy with this traditional triple helix, we identify here a "social triple helix", composed of the university, government bodies and citizens (independent individuals or represented by third sector organizations) (Shindler, 2017). This "social triple helix" is different from the traditional triple helix by one actor (the citizen or the third sector organization instead of the firm), and by the nature of the innovation that is pursued (social and service innovation instead of technological innovation).

(2) Networks consisting only of public agents belonging to different public organizations. It is necessary to distinguish, on the one hand, the relationships between different levels of the same administration, which do not constitute a network strictly speaking (since these relationships remain embedded in a given hierarchy: a given administration being the equivalent of a company, which can be broken down at different geographical levels), and, on the other hand, the relationships between different public organizations, which do involve a networked structure. Such networks are more often formed in the context of non-social public service innovations (PSIs) rather than social PSIs. They may seek economies of scale when they involve public actors who deliver the same services in different geographical areas (for example, waste processing) or when they involve public actors which deliver different but complementary services, e.g. health and social care or police, fire and housing (Entwistle 2014).

(3) Networks consisting only of private agents, working collectively to co-produce an innovation that falls within the scope of public service, not in its sectoral sense but in its functional sense (i.e. services of general interest). Private agents can be market agents (firms) or non-market agents (citizens, associations) (Sanzo et al. 2015). As already mentioned above, this configuration is a public service innovation network but not an innovation network *in* public services. These networks are more often formed to develop social innovations strictly speaking. They are therefore PSINSIs.

The distribution of these different types of networks follows a Gaussian law, in which the dominant form is the first one (networks made up of both public and private agents). Taking the public organization as a point of reference, these three types of networks might be called, respectively, hybrid PSINs, endogenous PSINs and exogenous PSINs.

3. PSINs according to the Nature of the Innovation

As we pointed out in section 2, traditional innovation networks are essentially devoted to technological innovation. PPINSs break away from this technological bias, as they take into account both technological and non-technological innovation. The same is true, in theory, for PSINs, that are a sub-category of PPINSs. But, in reality, PSINs are formed, above all, in order to design and implement non-technological innovations (demarcation perspective): for example a new service, a new process, a new delivery mode, a new organization or, more generally, a mix of all of the above. Non-technological innovation can also take the form of a new public reform or a new public policy. The term "public innovation" is often used to encompass innovations in both service and policy.

Among the innovations developed within PSINs, social innovation occupies an important place. It is incidentally the only object of the sub-category of PSINs that we called PSINSIs. Social innovation can cut across all the categories mentioned above, insofar as it may concern a new service, a new process, a new organization, a new reform, a new social model (as opposed to a business model) or a mix of them. Whatever its form, social innovation is social "in its ends and means", according to a now standard definition attributed to the European Commission (European Commission 2013). Given the particular nature of public services and their purposes, some authors have no hesitation in considering all public innovations as social innovations, or even in considering these two categories as synonyms (Sorensen and Torfing 2013; Bekkers et al. 2014). In our opinion, this is neither correct nor helpful. These two sets intersect, but they are not identical. After all, the scope of social innovation goes far beyond public innovation and the scope of public innovation far beyond social innovation alone. Not all public service innovations are social innovations and not all social innovations are public service innovations. PSINs are dedicated to all forms of public service innovation, and social innovation is just one form among others, which can go beyond the scope of public service. For example, a network that is formed to facilitate the implementation of an electronic service in the administration (for example an online tax system) has no (or little) reason to be considered as involving a social innovation. The same applies to a network of municipalities, chambers of commerce and private stakeholders set up to improve the efficiency and usability of business support services (OECD 2014). Many other examples of these types of PSINs (not focused on social innovation) can be found in the field of general public services and support services for economic activities.

The nature of innovation can provide the basis for a fairly simple typology of PSINs that distinguishes:

(1) Networks created for social innovation in public services. (Kallio and Lappalainen 2015; Rubalcaba et al. 2013; Leonardo et al. 2018; Voltan and De Fuentes 2016; Moore and Westley 2011). This is what we call PSINSIs (see Figures 2 and 4).

(2) Networks created for other forms of public service innovations (i.e. non-social public service innovations). In the latter group, we can distinguish between networks built for service innovations and networks built for policy innovations (Faerman et al. 2001).

Our review of the literature made it possible to identify 37 references on PSINSIs among the 86 references on PSINs. However, it should be acknowledged that the distinction between PSINs and PSINSIs is basically dependent on the definition of (and the boundaries fixed to) this complex and difficult-to-grasp object that is social innovation.

4. PSINS according to their Mode of Formation and Functioning

The question of network formation distinguishes *planned* networks from *spontaneous* networks (Powell and Grodal 2005; Doz et al. 2000; Schön and Pyka 2012; Green et al. 2013).

Planned or engineered PSINs are established under the impetus of an initiating agent, a triggering entity that will invite other potential members to join the network. In theory, the initiator of the network may be any agent. In reality, however, it seems that in PSINs, the initiating agent is very often the public administration itself. The situation is different for planned PSINSIs which are most often initiated by private agents (citizens, associations and so on).

Spontaneous or emerging PSINs emerge in a self-organized way because of the convergence of the activities of agents facing a given problem, in a given context (a district, a city, a region, etc.). Here again, although, in theory, the spontaneous emergence may involve any agent, the *spontaneous (self-organized)* networks more often involve citizens (and not government). The principle of "self-organization", also called "self-governance", reflects the emergence of collective action within non-public agents without the intervention of the public decision-maker (government) (Bekkers et al. 2014). The spontaneous emergence of this type of network can be explained by the lack of public solutions to a given social problem or the ineffectiveness of the existing solutions.

The modes of *formation* of PSINs lead to a (simplified) distinction between two opposite modes of *functioning* (Dhanaraj and Parkhe 2006; Jarillo 1988; Doz et al. 2000; Hurmelinna-Laukkanen and Sätti 2018; Pyka and Schön 2009; Sundbo 2009; Ferraro and Iovanella 2015):

- a vertical or institutional or top-down mode of functioning, in which, after the network is established, the initiating agent continues to enjoy a privileged "hierarchical" position: it is the conductor, the hub actor or the system integrator.

- a horizontal or bottom-up mode of functioning, which favours local interactions and in which responsibilities and leadership are more shared. The terms "distributed networks" or "distributed leadership" (as opposed to traditional entrepreneurial (heroic) leadership) are used to describe this second mode of functioning. However, horizontal networks are not homogeneous. Brown and Keast (2003) and Keast et al. (2007) propose to distinguish three different types of networks according to a growing degree of connectivity and reciprocal commitment regarding the exchange of information and knowledge: cooperative networks, coordinative networks and collaborative networks.

Conclusion

Recognition of the importance of collaborative innovation occupies a key place in Innovation Studies. Thus, in the list of the 20 main advances in this field, over the last fifty years, established by Ben Martin (2015), four explicitly concern the collaborative and network nature of research and innovation. Martin states these advances in the following terms: 1) From the linear model to an interactive "chain-link" model; 2) From individual actors to systems of innovation; 3) From closed to open innovation; 4) From "Mode 1" to "Mode 2".

The advances discussed by Martin mainly concern collaborations and networks whose key actors are manufacturing firms and whose main purpose is technological innovation, based on scientific and technical research. For the most part, market services are absent from this type of collaboration, and public services are only present through research laboratories and universities and certain regulatory (metagovernance) activities targeting innovation and networks. In this traditional collaborative arrangement, non-technological innovation (new

services, new organizations, new methods, etc.) is not considered as being the possible target of a network activity.

However, collaboration and networks are also at work in the field of *services in general,* and they may focus on non-technological innovations, as was extensively analysed, from a theoretical and empirical view point, in the ServPPIN European project (Gallouj et al. 2013). Our review of the literature made it possible to confirm the existence and the rise of these tertiarized forms of innovation networks, but also to distinguish between networks based on market services (MSINs) and networks based on public service(s) (PSINs).

Collaborative innovation and innovation networks are also increasingly at work in the field of *public services* themselves (or of *public service* as a function of general interest beyond public sectors strictly speaking), as the paradigm of "new public management" gives way to the paradigm of "new public governance", and as the perspective of assimilation (to industrial goods, then to market services), gives way to a perspective of integration (through the Public Service-Dominant Logic: PSDL) and demarcation (through the Public Service Logic - PSL). The rise of this type of network (in the field of public services or public service) can be explained by economic and social reasons: the limited resources of public administrations to carry out (or carry out on their own) certain existing public service activities (or new/potential and necessary ones), and the complex and multifaceted nature of "wicked" social problems which, by their nature, cannot be solved (or not satisfactorily) by the activity of a single actor.

In this article, we have discussed and compared all these old and new expressions of the notion of innovation network. The emergence of new expressions of the innovation network reflects the tertiarisation of this concept, a tertiarisation that itself reflects a broadening of the forms of innovation taken into account (not just technological innovation, but any form of innovation) and the modes of organization of innovation taken into account (not just the formal and linear modes, but also the informal and interactive modes).

The new "tertiarised" forms of innovation networks that we have discussed, whether they be PPINSs, MSINs, PSINs or PSINSIs, constitute an important socio-economic issue now acknowledged by the public authorities at the national and European level. They therefore require further study by academic researchers. In the future, research should strive in particular to i) consolidate our theoretical and empirical knowledge of the modes of formation and functioning of these tertiarised networks, ii) define and build the systems to accurately measure the results and the performance of these networks, iii) suggest public policies (in particular vertical or specific ones) that would help support the formation, functioning and performance of these networks.

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