



The different roles of innovation intermediaries to generate value

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Abstract

The development of innovation management practices toward openness, societal-grand challenges and emerging technologies have changed the roles and supporting activities of innovation intermediaries. Innovation intermediaries are considered to be organizations that generate value to other institutions or societies within an innovation system. Despite the growth of innovation intermediary research in recent years, there is still a lack of clarity about the different roles that intermediaries can play and the way in which they generate value to the other institutions, industry and/or society. This paper reviews current research to identify contemporary roles of innovation intermediaries and explore the mechanisms they use to generate value. Through the use of bibliographic coupling the paper presents a robust analysis of the intellectual streams and key concepts underpinning innovation intermediary research. The paper makes a contribution to the ongoing debate by proposing a framework that explains the different roles of innovation intermediaries (knowledge broker, knowledge transfer enabler, orchestrator, and value generator) and the functions embedded within the roles at different levels of analysis, i.e., firm, industry, and national. The paper concludes by discussing the theoretical and practical implications of the framework and details key areas for future research.

Keywords Innovation intermediaries · Orchestration · Innovation management

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1 Introduction

The pace of innovation intermediary research has accelerated in recent years, spurred on by new socio-economic models, digital technologies, the local and global challenges of population growth and emerging societal challenges. Research on innovation intermediaries is predicated on the idea that intermediaries act as a catalyst for innovation to address these changes and challenges. Innovation intermediaries are defined as “organizations that provide a supportive role for collaboration between two or more parties during various stages of the innovation process” (Howells 2006, 721). Innovation intermediaries consist of different kinds of agents, such as individuals, organizations and networks or spaces, which link people, organizations, ideas and resources within the innovation network (Lee et al. 2010).

Since Howells’ (2006) definition, the role of innovation intermediaries has expanded from only bridging institutions for collaboration (de Silva et al. 2018) to bringing a wider range of institutions and societies (Klerkx and Leeuwis 2008; Rossi et al. 2010) for the creation of innovation ecosystems. There have been important shifts in intermediaries’ roles toward openness Sieg et al. (2010) to address grand societal challenges (Kivimaa et al. 2019). Their roles vary and may include tapping into sharing and co-creating the knowledge and experience of actors, bridging and buffering roles with the information and knowledge sharing (Liu 2021), assisting with the innovation search process (Howells and Thomas 2022), helping with sustainable development (Kivimaa et al. 2019) and forming linkages between external and internal knowledge providers to address societal needs.

Innovation intermediaries have been considered as organizations that generate value to other institutions or society within an innovation system (Arnold et al. 2010; Tran et al. 2011). The development of new global challenges and digitization impact how intermediaries may support innovation to generate different types of value. They help organizations and communities in a number of ways, from building inclusive markets for the ‘base of the pyramid’ (Mair et al. 2012) to developing ecosystems of resources and participants during the innovation process or sustainable development (van Rijnsoever 2022).

Despite the importance of innovation intermediaries there is a substantial lack of research that contributes to the knowledge base regarding how different roles of intermediaries generate value. Current literature lacks cohesion regarding the emergent roles of intermediaries to generate value. Not only it is currently difficult to gauge what, exactly, is known in the field and how research may be consolidated, but the field also lacks specific conceptualizations of new developments and an explicit future research agenda that may provide consolidation and push future progress in the domain of innovation intermediary research.

The goal of this article is to present a comprehensive analysis of existing research related to the roles of innovation intermediaries and, in doing so, identify knowledge gaps and develop a future research agenda. Future research should be embedded within an integrated innovation intermediary framework; we propose one such in this paper. In order to advance conceptual understanding of innovation intermediaries, we interpret the results of the bibliometric analysis based on new intermediary

roles in addressing global challenges across different levels of analysis (firm, industry and national system). The different levels of analysis of the structure and content of the field led to the identification of specific research gaps which these recommendations are designed to address. We used the bibliographic coupling method, a bibliometric analysis method that uses a quantitative approach, in analyzing the innovation intermediary literature. This paper is among the first to use the bibliographic coupling method to identify the intellectual structure of innovation intermediary research. With the support of cluster mapping, we discuss the development of this field of research over the years, provide a visualization of the state of the art of intermediation in innovation research, present an integrative framework of the role of the intermediary and suggest relevant topics for further development of this area of research.

Our article is organized in the following sequence. Firstly, we briefly review the development of innovation intermediary research alongside the shift of innovation management research. Secondly, we outline the bibliometric coupling method that was used in collecting, identifying and analyzing the relevant roles of intermediaries in the innovation literature. We then use the bibliographic coupling method to summarize the current understanding of intermediaries' roles while also examining the activities of innovation intermediaries at different levels, from firm to national level, together with divergences in the current interpretation of intermediaries' roles in the innovation context. We conclude the review by suggesting directions for future research.

2 Innovation intermediary research

Previous research in innovation has shown how the role of innovation intermediaries has developed in line with changes in innovation management research. Earlier studies on intermediaries in the innovation context captured innovation as a way to find a competitive advantage. They were focused on internal firm resources, such as the R&D department which relies on researchers' capabilities (Dyer and Singh 1998). At this time, innovation intermediaries assisted the innovation processes of a firm in the form of consultants or university faculty (Billington and Davidson 2013) with intermediary firms acting as 'bridging institutions' (Watkins et al. 2015). The role of intermediaries described in earlier publications tends to be very task-focused, e.g., helping firms to transfer technology and generally operating on a hub-on-spoke model.

Hub research has mainly focused on activities of intermediaries that vary in terms of what knowledge and information is provided, facilitated, or orchestrated and whose interests are served (Clayton et al. 2018; Gomulya et al. 2019), with a particular focus on the bridging or orchestrating role of intermediaries to connect different parties (Littlewood and Kiyumbu 2018). On the other hand, a spoke is conceptualized as an implementation actor that can develop business and innovation strategies, locating key sources of new knowledge and so on. Examples of these kinds of intermediaries include specialized government agencies, university

technology transfer offices, regional technology centers, and cross-national networks.

Subsequent studies on innovation intermediaries have mainly focused on intermediary institutions as facilitators of knowledge transfer between policy makers and innovators. These papers are focused generally on technology or knowledge transfer aspects, based on the realization that firms have different competencies and capabilities in absorbing and assimilating new inputs of technology. Firms could use consultants as intermediaries to assist and advise them during the knowledge or technology transfer process to compensate for a lack of capability (Bozeman 2000). These organizations as intermediaries offer technological or networking facilities that organizations may not independently possess, allowing them to generate innovation to solve their problems (Saxenian 1990).

More recently, studies on innovation intermediaries have started focusing on social network interactions and the associated learning processes (i.e., Mair et al. 2012; Watkins et al. 2015). It consists of various types of companies and individuals embedded in different kinds of networks. The activities of this intermediary facilitate and build new forms of collaborations whilst reinforcing long-term relationships between participants in the innovation ecosystem, bringing people together around common areas of interest to address societal grand challenges (De Silva et al. 2018). Moreover, there are virtual knowledge brokers or open innovation accelerators (e.g., InnoCentive), which provide virtual environments for an innovating institution to connect effectively with relevant experts, customers, or value chain actors wherever they might reside (Lauritzen 2017).

3 Methodology

3.1 Sample selection

In searching the literature, we restricted the review to include only peer-reviewed journal articles; we excluded books and non-refereed publications. We used the Thomson Reuters' Web of Science database which provides the Social Science Citation Index (SSCI) as the main data source. The database is generally considered as the most comprehensive database for scholar work and includes thousands of high-quality journals (Dahlander and Gann 2010). The use of validated knowledge serves to strengthen the robustness of the review. We then chose articles which were published between January 2003 and December 2022.

First, we identified concepts that are relevant to the topic area. We searched articles with the titles and abstracts of journals using combinations of the keywords 'intermedia*' and 'innovation'. The reason these key words were used was in order to restrict results to only articles discussing the innovation intermediary. The results of this search found 4375 articles, that came from various research fields, e.g., business economics, engineering, public administration, science technology, geography, operation research management science, and various other research fields. Second, based on peer discussions with experienced researchers in the field, the keywords were expanded and a broad spectrum of terms related to innovation intermediary

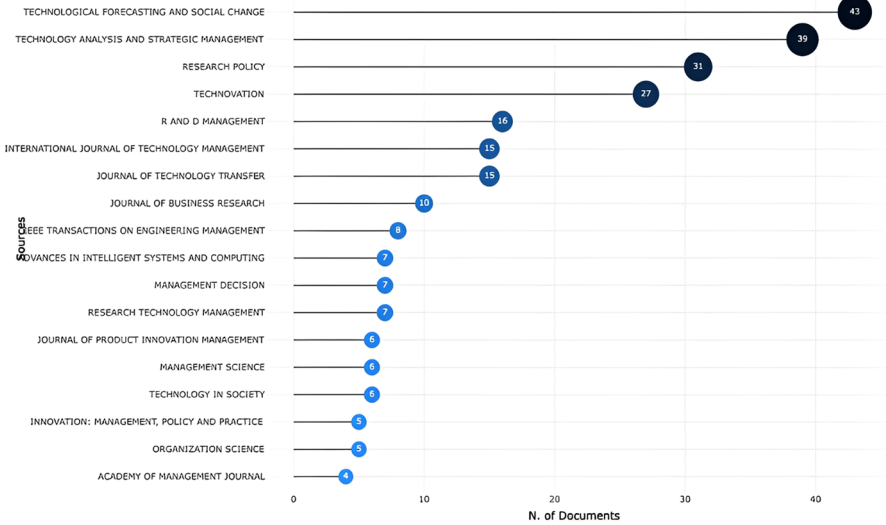


Fig. 1 Number of articles from journals reviewed in this paper

research, like technology or knowledge broker were added. We then searched the titles and abstracts of journals using combinations of the keywords ‘knowledge’ AND ‘broker’ or ‘technology’ AND ‘broker’ or ‘intermedia*’ AND ‘innovation’. because researchers use different words to express the innovation intermediary (Howells 2006); therefore, the key words were added. By following West and Bogers (2014), we looked for articles that were published in these top 18 journals (Fig. 1). Third, the results of previous steps in selecting articles resulted in an initial database of 345 journal articles from top 18 journals. The total social science journal papers were 4745. With the aim of minimizing subjective selection biases, each of the 345 articles’ titles and abstracts was read by the authors to ensure the relevance of the innovation intermediary research. This review process led to the exclusion of articles that were not related, such as external institutions that help innovation to happen, e.g., financial institution. Through the process, 257 articles were finally selected from 345 articles.

Figure 2 provides a look at highly cited articles in the innovation intermediary literature. Howells’s (2006) article, which gave a brief explanation of the definition and the typology of innovation intermediaries, sits at the top of the list. The second most cited article was Lee et al. (2010) which shows that open innovation is used by most researchers as a perspective to investigate the concept of innovation intermediaries, especially in the context of SMEs. In addition, the absorptive capacity article by Cohen and Levinthal (1990), a book by Burt (2004) about the social structure of competition, and a network learning article by Powell et al. (1996) are also included.

The themes of research evolved over the years, as shown in Fig. 3. Between 2003 and 2011, entrepreneurship, patents and inventions and competition were the most relevant areas in relation to intermediary research. Between 2012 and 2017, cognition, national innovation system, strategic approach and public policy became more

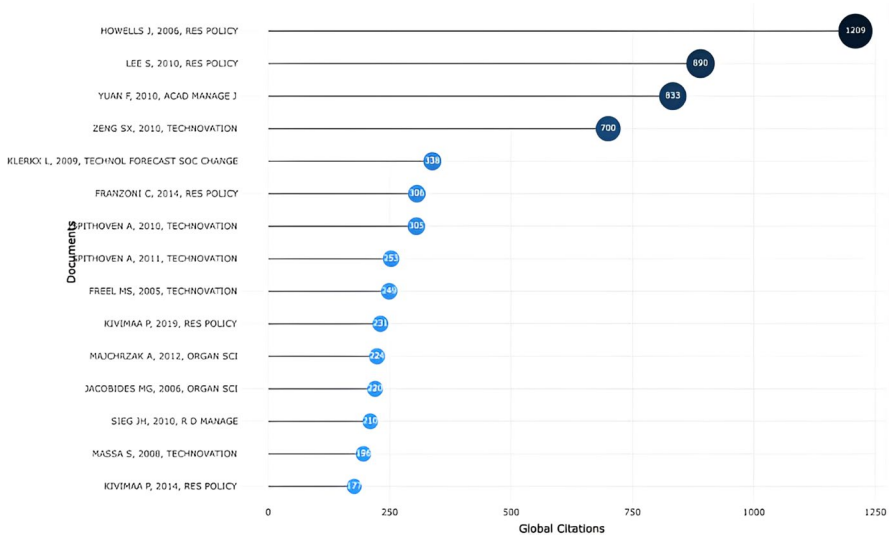


Fig. 2 The top-15 most-cited references

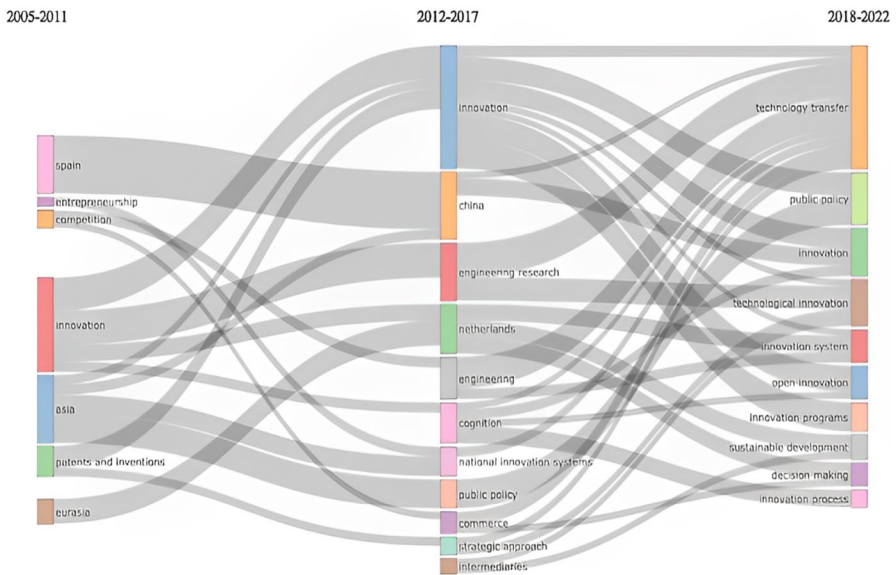


Fig. 3 Trends in Innovation Intermediary Research

important whereas between 2018 and 2022, innovation systems, programs, technology transfer, open innovation, decision making and sustainable development became more important for the intermediary research field.

3.2 Bibliometric analysis

To analyze the structure of innovation intermediary research and identify future research opportunities, this study uses the quantitative approach of bibliometric research methods (Zupic and Carter 2014). Bibliometric analysis reviewed the extensive literature on the innovation intermediary, suggesting an underlying thematic and conceptual structure, and identifying key research drivers (Cobo et al. 2011; Aria and Cuccurullo 2017).

The first stage of the bibliometric analysis is to examine and organize the literature on innovation intermediaries—this analysis aimed to identify and chart patterns that illustrate intermediary literature's underlying conceptual structure. The conceptual structure describes the most relevant topics discussed in the literature and the interconnection between disciplines and authors. In the second stage we used the bibliometric coupling method to map the current research front (Vogel and Guettel 2013) as well as capture and analyze recent publications in a particular area of research. The unit of analysis is the identified articles, not the citing references.

3.2.1 Conceptual structure

We used the co-occurrence analysis technique to understand conceptual structure changes of innovation intermediary research. A co-occurrence analysis focuses on themes arising from a network of keywords used together within documents. A two-dimensional thematic map illustrates the density (how strong the links are between keywords) and the centrality (how diverse the keywords are within themes) to characterize the importance and maturity of the themes addressed in a specific literature field (Cobo et al. 2011). This analysis does not provide a definition or description of an emerging topic; rather, it shows the patterns appearing among the examined publications' keywords.

A thematic map uses the centrality and density of the themes to describe a literature body's diversity and maturity. The two-dimensional map divides its space into four quadrants, towards the right, the more central themes (those appearing more often), and towards the top, the densest ones (those using the exact keywords).

Figure 4 shows the thematic map that emerged from the innovation intermediary literature's co-occurrence analysis. The horizontal axis indicates the innovation intermediary theme's relevance; topics appearing more frequently throughout the literature are more important for their underlying structure. The vertical axis shows the innovation intermediary literature's development; more mature topics are better defined, with some recurrent keywords describing them.

The map depicts eleven themes as circles of varying sizes corresponding to their occurrence; popular themes appear as larger circles (see Fig. 4). Each theme also shows the three most common keywords in their network.

- The *Basic Themes* quadrant indicates the intermediary literature's introductory themes describing concepts commonly agreed upon by the community and how the literature agrees on common themes such as technology transfer role of intermediaries as well as assisting role of patents and inventions.

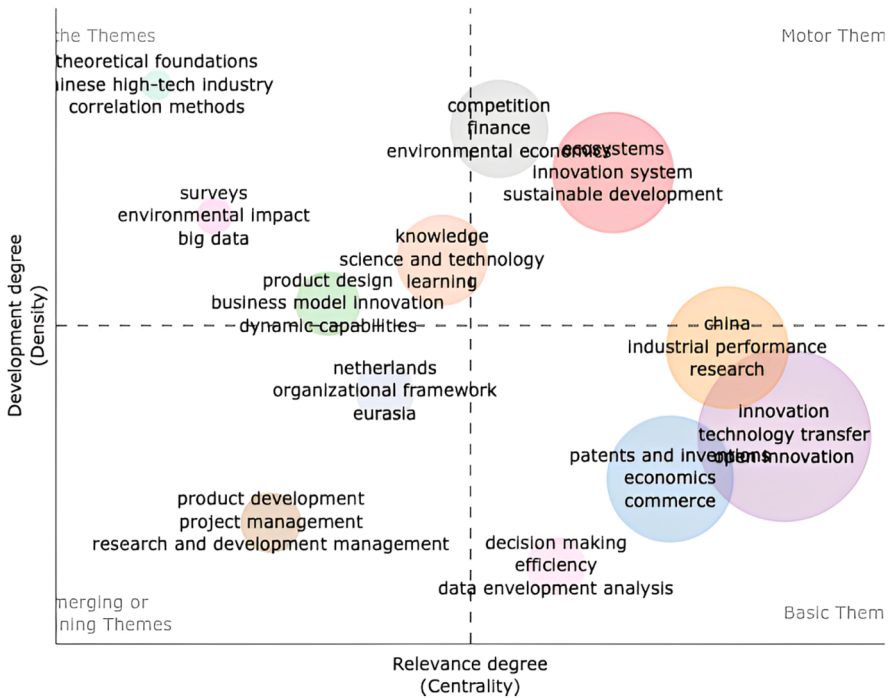


Fig. 4 Thematic map emerged from the co-occurrence analysis

- The *Motor Themes* quadrant indicates promising growth areas of intermediary research such as sustainable development, ecosystem, and national innovation ecosystem.
- The *Niche Themes* quadrant shows clearly defined but less common themes; these are recognizable topics with modest community interest concerning intermediary literature such as environmental impact, big data, high tech industry.
- The *Emerging or Declining Themes* quadrant illustrates topics just beginning to develop groups of keywords that start to appear together more often. It might also refer to dwindling topics: themes appearing less often as the community's interest diminishes, or the keywords that compose it are no longer used together, giving way to new terms or combinations such as product development, project management.

We reviewed each quadrant in detail and renamed according to its overarching theme. Table 1 provides details on the composition of the themes, showing their centrality and density rank.

Each keyword network comprises multiple terms, ranging from five to 113. We reviewed the most frequent keywords in each cluster in order to label them. This initial organization of the literature offers insights into the academic interest described by the popular topics found in the existing literature body which will be linked to the bibliometric coupling analysis which will show the role of intermediaries.

Table 1 Thematic map composition order by centrality rank

Theme Table	Centrality Rank	Density Rank	Keyword	Keyword Occurrence
Innovation-facilitating knowledge or technology transfer role	1	20	Innovation	113
			Tech transfer	28
			Open innovation	25
			Innovation intermediaries	17
			Knowledge management	15
Societies and institutions-the bridging knowledge role	2	7	Societies and institutions	21
			Technology	1
			Technological forecasting	1
			Absorptive capacity	1
			Innovation process	1
Value generation-the assisting role	3	5	Patents and inventions	20
			Commerce	13
			Investments	13
			Technological innovation	11
			Innovation performance	9
The orchestrating role	4	13	Technological development	16
			China	16
			Economics	15
			Ecosystems	12
			Research and development	5

3.2.2 Bibliometric coupling analysis

We performed a bibliometric coupling analysis of database of the 257 focal publications on innovation intermediaries to identify patterns between them and examine the current state of the art. This has been widely utilized by researchers to identify connections between two texts and determine the relationship between them. A larger number of connections between the bibliographies of texts indicates a greater association. The connection is based on the number of the same articles being cited in both documents. If two documents cite the same articles, it can be identified as bibliographic coupling. The frequency of the two articles citing the same articles shows the level of connection. The more frequently they cite the same articles, the stronger the connection. References to several articles can be analyzed and clustered based on their citations. Bibliographic coupling analysis produces a grouped map of connected articles based on similarity in references.

The first step produced data metrics by using statistical software. This started with importing bibliometric data from Web of Science and restructuring the data so they comply with the chosen bibliometric analysis software. Secondly, we calculated the frequency of particular substrings selected from the study (e.g., cited articles). Thirdly, we conducted the co-occurrence analysis: studying mutual appearances of pairs of articles over a consecutive number of bibliographic data by identifying co-occurrence relations

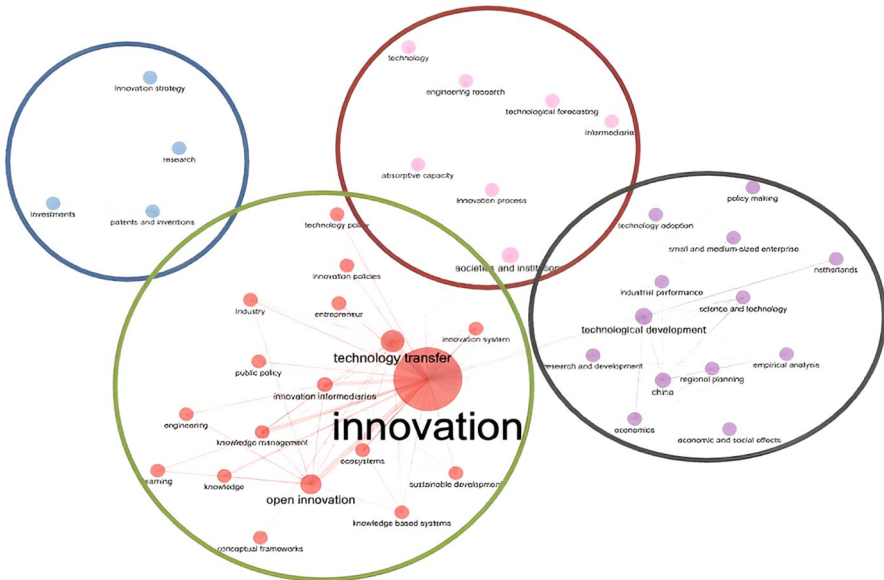


Fig. 5 Clusters and their article members resulting from bibliographic coupling

between the selected articles. Frequency of co-occurrence relations shows how many times they appear together across the records. Fourthly, this study applied an analysis cluster algorithm. This method produces a dendrogram based on the similarity of analyzed articles and chooses a rule to cut the dendrogram into a number of clusters. The output results in information about the number of clusters, their article members, and links between and within clusters.

All clusters developed through the bibliographic coupling process are presented in Fig. 5. Extracting the shared references from the innovation intermediary literature provides a visualization of a dense network document, clustered according to similarity. To label the clusters, first, the authors read the 257 publications in their entirety and discussed the structure of the results until a consensus on interpretation was achieved. Through a detailed review of the references in each cluster, we distinguished the key ideas and themes that take priority within this field of research. Interpretation of the themes and concepts, along with the reading of samples of text that form them, allowed this study to define four areas of research into the role of an innovation intermediary: (1) The facilitating knowledge or technology transfer role; (2) The bridging role of intermediaries: Knowledge broker via technology and absorptive capacity (societies and institutions); (3) The orchestrating role of intermediaries for technology adoption and implementation (industrial performance-external); and, (4) The assisting role of intermediaries (innovation performance - internal). Research into the technology transfer role of an innovation intermediary in the open innovation context has received the most attention (cluster 1).

The following sections contain the interpretation of each cluster based on the keywords, paper titles, and article content.

Cluster 1: Facilitating knowledge or technology transfer role

This cluster contained the most articles and we labeled it as ‘facilitating knowledge or technology transfer’. Articles in this cluster mainly discussed the innovation intermediary as an organization that took on the role of transition management in facilitating the transfer of technology and knowledge. There are a variety of organizations that act as innovation intermediaries in this cluster: (1) KTTO – knowledge and technology transfer offices (Landry et al. 2013; Alexander and Martin 2013); (2) Incubator/service intermediaries (Dutt et al. 2016; Zhang and Li 2010); and (3) Collective research centers (Knockaert et al. 2014; Spithoven et al. 2010; Spithoven and Knockaert 2012). These types of innovation intermediaries play the role to support the process of transferring knowledge or technology between organizations (Villani et al. 2017).

Related to their role in knowledge transfer, intermediary innovation in this cluster exists within a variety of types and functions. A transfer office is one type of intermediary that transfers knowledge or technology from university to industry. It is a showcase for new technologies developed by a university that are ready to be amplified and commercialized by industry (Alexander and Martin 2013; Landry et al. 2013; Yusuf 2008; Villani et al. 2017). Another innovation intermediary type is a collective research center, an innovation intermediary that is usually initiated by the government, plays a role in conducting R&D collaboration and forms a network with downstream sectors (Lee and Park 2006; Spithoven and Knockaert 2012).

Most of the articles discussing the transfer of technology or knowledge from university to industry (Villani et al. 2017; Taheri and van Geenhuizen 2016; Wurmseher 2017; Yusuf 2008) focus on product commercialization or solving new social challenges like environmental issues, urban planning, etc. Innovation intermediaries also take part in the triple helix innovation system model in order to systematically apply foresight to the renewal of products (Frykfors and Jonsson 2010; Mendonca and Heitor 2016; Raven et al. 2010).

Some of articles shed light on the conditions that support technological transitions or knowledge transfers of connected firms by innovation intermediaries through the triple helix (Frykfors and Jonsson 2010) in cities where the firms and innovation intermediaries are located (Mas-Verdu et al. 2016; Hodson and Marvin 2009). Some articles deal with strategic niche management as a tool to develop instruments for governing technological transitions in socially desirable directions (Raven et al. 2010; Schreuer et al. 2010).

In this cluster, articles were also considered in the open innovation context where intermediaries break down traditional corporate boundaries and allow the free flow of intellectual property, ideas and people into and out of an organization (Chesbrough and Garman 2009). In open collaboration, innovators allow their innovation information to be freely accessed, used and diffused by others (Baldwin and von Hippel 2011). The practice of open collaboration is particularly evident in open source software, which programmers use at various levels, collectively contributing to create and improve software programs (Hutter et al. 2011). Wikis are an example of open collaboration in the context of knowledge creation, where participants voluntarily create and update information on a particular topic. Innovation

intermediaries with online platforms, such as InnoCentive, facilitate community forums for contributors who are willing to collaborate with others and cooperate in a group for innovation problem solving. From the evidence, open collaboration mostly works at the user level of network analysis and at the ideation and development phases of the innovation process.

The articles in this cluster show two different perspectives of open innovation facilitation by intermediaries: inside-out and outside-in innovation. Intermediaries help organizations in *inside-out open innovation* processes, in which a business places some of its assets or projects outside its own walls, through saving a firm time and money, nurturing new supplier and partner relationships, promoting innovative ecosystems and generating high-margin licensing income via IP management (Benassi and Di Minin 2009; Gredel et al. 2012; Adams et al. 2013; Harland and Nienaber 2014). The inside-out roles of intermediaries are: (1) patent broker, bridging the demand and offer for patents through licensing or reassignment (Benassi and Di Minin 2009; Harland and Nienaber 2014; Collinson et al. 2005; Caviggioli and Ughetto 2013; Steensma et al. 2016); and (2) facilitating the commercialization of technologies at an international scale (Gredel et al. 2012).

Intermediaries also help organizations in *outside-in open innovation processes*, in which outsiders' contributions enable firms to create offerings on a larger scale than could be otherwise achieved through internal capabilities. The role of intermediaries in these processes may include facilitating external knowledge acquisition but, primarily, focuses on solidifying the firm's position in a desirable innovation or idea generation network. This confers a strategic advantage for the firm in meeting upcoming knowledge or technology transaction needs, as innovation knowledge trading frequently occurs (Ritter and Walter 2003; Tran et al. 2011; Sandmeier 2009; Dong and Pourmohamadi 2014). Furthermore, few articles discuss the outside-in innovation process involving the crowd as a potential element in the open innovation process as an idea generator (Franzoni and Sauermann 2014) or provider of data analysis (Martinez and Walton 2014).

Cluster 2: The bridging knowledge role of intermediaries: knowledge broker via technology and absorptive capacity (societies and institutions)

We label this cluster of actors as knowledge brokers bridging institutions in innovation networks and alliances as well as society. This is the second biggest cluster and mostly discusses actors or individuals as innovation intermediaries (Aalbers and Dolfma 2015; Arora et al. 2014; Bidwell and Fernandez-Mateo 2010; Boari and Riboldazzi 2014; Kirkels and Duysters 2010; Lee 2010; Lin 2012; Obstfeld 2005; Quintane and Carnabuci 2016; Ryall and Sorenson 2007). As actors, the intermediaries' role is linking unconnected network members and combining members' respective knowledge and capabilities in new ways (Hakanson et al. 2011; Kim et al. 2010). As individuals, actors in this role may include: lead users (Arora et al. 2014); salespeople (Groza et al. 2016, van den Berg et al. 2014); academic inventors (Lissoni 2010); skilled return migrants (Wang 2015); and principal investigators in a transfer office (Kidwell 2013).

Roles supporting product development as an internet-based innovation intermediary, services connection innovation provider and innovation seeker are included at the firm level (Chesbrough and Brunswicker 2014; Colombo et al. 2015, Dong and Pourmohamadi 2014; Martinez and Walton 2014); the role of facilitating inter-firm connections as a coordinator in collaborative projects occurs at the industry level (Franzoni and Sauermann 2014, Harland and Nienaber 2014), while the role of policy maker in national innovation systems or cross-industry brokerage takes place at the national level (Wang et al. 2012).

Quintane and Carnabuci (2016) reveal two main discussions of the individual as innovation broker: (1) innovation broker as a structural position – an actor's network of long-term relationships; and (2) innovation broker as an information exchange process. Moreover, they also explore two different ways brokers can negotiate the exchange of information across a structural hole: (1) the *tertius gaudens* strategy, in which the exchange of information is intermediated between the brokered parties by the broker acting as the only passage through which information flows across the hole; and (2) the *tertius iungens* strategy in which the broker facilitates the flow of information across the structural hole by enabling a direct exchange between the brokered parties. Transcoding is how an actor, as an innovation intermediary, not only links but also translates and makes complex knowledge meaningful to others.

Cluster 3: The Orchestrating Role

We labeled the group of papers as orchestrating the innovation network because most of the articles discussed the role of an innovation intermediary in connecting elements at different levels of activities in an innovation network or ecosystem. The bridging role of innovation intermediaries from cluster 2 publications mainly connected societies and institutions. In this cluster, the articles expanded the bridging role, instead connecting one-to-one and recent articles focused on innovation intermediaries orchestrating outcomes by developing networks, ecosystems and leading the members to achieve particular purposes. The challenge in orchestrating is to embed all of the members who have different aims and backgrounds. Some articles conclude that the way to do this is understanding the nature and value of activities (Klerkx and Leeuwis 2009), building trust among members (Lee et al. 2010), new understandings of power, competence, and managing paradoxes between actors (Lauritzen 2017) balancing multiple interests (Klerkx and Leeuwis 2008), and/or building innovation intermediaries' dynamic capabilities (Tai and Davids 2016).

Articles in this cluster also shed light on how the innovation network members could work together in the innovation process. The innovation intermediary in this cluster plays the role of coordinator, such as in product development partnerships (Chataway et al. 2010; Rong et al. 2013) and commercialization (Vivas 2016). Some of the articles in this cluster do not specifically explore orchestrating but focus, rather, on topics related to innovation networks, including emphasizing the importance of networking for SMEs (Zeng et al. 2010; Vrgovic et al. 2012; Lee et al. 2010) and technology road mapping (Battistella et al. 2015) or innovation intermediaries' shape.

These publications in this cluster reveal the multi-level position orchestration roles of innovation intermediaries. Roles supporting product development as an internet-based innovation intermediary, services connection innovation provider and innovation seeker are included at the firm level (Chesbrough and Brunswicker 2014; Colombo et al. 2015; Dong and Pourmohamadi 2014; Martinez and Walton 2014); the role of facilitating inter-firm connections as a coordinator in collaborative projects occurs at the industry level (Franzoni and Sauermaun 2014; Harland and Nie-naber 2014); meanwhile, the role of policy maker in national innovation systems or cross-industry brokerage takes place at the national level (Wang et al. 2012).

Cluster 4: Value Generation - The Assisting Role

We choose to label the last cluster as the assistance that occurs when intermediaries act as a joining force to assist institutions to enhance internal performance; thus, intermediaries facilitate and assist a positive internal value creation of institutions such as patents and invention, corporate innovation (Lin et al. 2020), technology licensing (Hermosilla and Wu 2018), or technology investment decision.

A smaller group of articles in this cluster focus on the internal value generation impact of innovation intermediaries: such as increasing the level of absorptive capacity and innovation performance (Knockaert et al. 2014; Spithoven et al. 2010); or reducing cognitive, organizational, geographical, and social distance (Villani et al. 2017). The internal value could be multidimensional comprising both social, intellectual capital (i.e., patents) or financial capital. The immediate gain for innovation intermediaries comes from financial capital benefits in terms of revenues generated by activities they offer to their clients (De Silva et al. 2018). In joint projects, intermediaries with other institutions may develop social capital via new knowledge (Kale et al. 2000) as well as intellectual capital in terms of patents and invention (Martín-de Castro 2015) new business models (Delorme 2023) and useful ecosystem to address grand challenges (Matschoss and Heiskanen 2018).

4 Discussion

The previous section clustered and reviewed all of the publications related to innovation intermediaries. This section will further explore the roles identified and the functions that are embedded within the roles. The roles' arrangement was generated based on the cluster titles, which reflect development in the trends of innovation management research. We have identified the roles of innovation intermediaries as: (1) The facilitating knowledge or technology transfer role; (2) the bridging role of intermediaries: knowledge broker via technology and absorptive capacity (societies and institutions); (3) the orchestrating role of intermediaries; and, (4) the assisting role of intermediaries. Along with the identified roles of innovation intermediaries, we attempted to present the functions for each role and extended the function exploration into three levels where the innovation intermediary is employed.

Informed by Kivimaa (2014) research and multi-level perspectives in innovation research (West et al. 2014), we identify three levels of engagement of the role of innovation management: system, sector/industry, and firm. These levels of innovation intermediary services utilization compromise systematic intermediaries, as mentioned regarding the establishment of different levels of actors' arrangements to support innovation transitions.

At the system level, innovation intermediaries connect all elements of nation-specific contexts. Research on this level is related to national system innovation (Wang et al. 2012; Shapiro et al. 2010; Watkins et al. 2015) and the triple helix model (Johnson 2008), mostly exploring government and related agencies' support of innovation through regulation, standard setting, public-private partnerships and funding of basic research (Dong and Pourmohamadi 2014). Research at the industry level is more focused on the innovation intermediary's role within industry-specific contexts, such as biotechnology (Chen et al. 2015; Fontes 2007), manufacture (Adams et al. 2013; Skold and Karlsson 2012), renewable energy (Loya and Rawani 2016; Schreuer et al. 2010), and agriculture (Klerkx and Leeuwis 2009). Lastly, research at the firm level consists of firms which generate commercial innovations through experimentation, R&D, and product improvement (Colombo et al. 2015; Dong and Pourmohamadi 2014; Harland and Nienaber 2014; Holzmann et al. 2014) (Tables 2, 3).

The role of a knowledge/technology broker for an innovation intermediary is related to third parties and facilitates the ability of firms to seek out potential partners, resources and capabilities to engage in collaboration. At the firm level, the innovation intermediary functions to enable and facilitate joint development projects. The innovation intermediary links organizations and may coordinate and control the exchange of information and resources within networks. This engagement allows collaboration between members. Mostly occurring in the biotechnology sector, the role of innovation intermediaries at the industry level serves to form alliances and assist in vertical integration.

Vertical integration involves relatively distinct sets of activities, such as a biotechnology firm conducting research and development, then transferring the output to a pharmaceutical company for further development or marketing the product (Stuart et al. 2007). In some cases, the innovation intermediary also engages in university and industry linkages through science and technology parks (Diez-Vial and Montoro-Sanchez 2016) or industry associations (Watkins et al. 2015). Similar to an innovation capitalist, an innovation intermediary may also facilitate IP-related issues, including licensing and reassignment. Moving up to the network level, the innovation intermediary has a function in network development. At the national level, the innovation intermediary's role in alliance and transaction formation is to facilitate innovation diffusion enabled by policy makers or governments. The innovation outcome should have an economic and social impact; the government can incentivize innovation intermediaries that construct alliances and facilitate these outcomes via the production of supportive policies.

The innovation intermediary's second role is a knowledge and technology transfer proponent. This role is related to activities combining knowledge and technologies. At the firm level, the innovation intermediary's function is to facilitate inter-firm

Table 2 The innovation intermediary's roles and functions at different levels of analysis

Innovation implementation level	Roles of an innovation intermediary			
	Knowledge/ technology broker	Knowledge/ technology transfer enabler	Network orchestrator	Value Generator
System	Produce policy to facilitate innovation	Facilitate social and technology transitions	Create communities	Develop collaboration model Sustainable development Innovation ecosystem
Industry	Facilitate vertical integration	Predict and understand social and technological regimes that govern different institutions	Build and develop ecosystems Manage triple helix	Develop networks
Firm	Enable and facilitate joint development projects Manage IP licensing and reassignment	Facilitate inter-firm knowledge/technology transfer	Build social capital	Assist development of intellectual capital, social capital and human capital

Table 3 Research gaps and potential research questions

Roles	Level	Gaps	Research Questions	Concepts/Theories
Knowledge Broker	System	Develop a more comprehensive understanding of linking different levels of innovation and the implementation function	How can policy makers facilitate the flow of information across unlinked brokers to increase the collaborative ties of the nation? What role does an innovation intermediary play in open collaboration?	Structural holes (Burt 2004) ICT capabilities (Tsekouras et al. 2013); Open innovation intermediary (Howells 2006)
	Industry		How does an innovation intermediary play its role as a knowledge broker to create and grow organizations in a certain industry?	Technology brokering (Hargadon and Sutton 1997)
Knowledge transfer	Firm		How do innovation intermediaries facilitate organization' innovation in a knowledge or collaboration network?	Knowledge networks; collaborative innovation networks (Lee et al. 2010, Kirkels and Duysters 2010)
	System	Enhance focus on the role of the innovation intermediary in transition management as part of knowledge/technology transfer	What are the roles of innovation intermediaries at the system level in transferring of new technology?	Strategic niche management (Raven et al. 2010)
	Industry		How does a firm become the center of a collaboration network in its industry and use it as competitive advantage to occupy structural holes?	Social Network Analysis; Social capital (Quintane and Carnabuci 2016)
	Firm		How can a firm manage innovation from external sources and develop a business model to transfer it internally as an innovation outcome?	Business model innovation (Zott and Amit 2010; Howells 2006)

Table 3 (continued)

Roles	Level	Gaps	Research Questions	Concepts/Theories
Orchestrator	System	Leverage understanding on the role of established firms as innovation intermediary orchestrators	How does an innovation intermediary coordinate, direct, influence, and manage the other network members at the system level? How might an established firm take on the role of an innovation intermediary orchestrator in a given industry?	National innovation system (Kirkels and Duyters 2010; Kivimaa 2014); Innovation ecosystem (Klerkx and Aarts 2013; Klerkx and Leeuwis 2009) Platforms framework (Gawer and Cusumano 2014; Gawer 2014)
	Industry			
	Firm		What innovation outcomes might members of an innovation network intermediated by an established firm expect to see?	Social capital; Social Network Analyses (Vasudeva et al. 2013)
Value generator	System	Direct increased attention to the role of innovation intermediary towards assisting value generation	How does innovation intermediary generate value in ecosystem and society?	Addressing societal challenges through the simultaneous generation of social and business values (De Silva et al. 2018; Matschoss and Heiskanen 2018; Kivimaa et al. 2019)
	Industry		How does the innovation intermediary assist value generation in industry?	Delorme (2023)
	Firm		How does the innovation intermediary support an organization's innovation process simultaneous to generate value via social, intellectual, and human capital development?	Strategic innovation and value capture (Afuah and Tucci 2012) De Silva and Rossi (2018)

knowledge/technology transfers. The knowledge transfer office plays this role by transferring a university's research results/products to industry for further development or commercialization. Technological innovation thus induces social innovation and vice versa (Raven et al. 2010). At the industry level, the innovation intermediary functions strategically in understanding and predicting social and technological regimes that govern across institutions. This function serves to anticipate the social changes that will occur when a new technology is released on the market. The result is related to the innovation intermediary's function at the national level in planning sustainability transition in accordance with new socio-technological (the intersection of society and technology) visions.

The third role we have identified is that of innovation orchestrator. This role is related to the management of elements of innovation networks. Nambisan and Sawhney (2011) state that the innovation intermediary's role as an orchestrator is included in network-centric innovation. In our view, this orchestrator role comprises all previously explained roles: matchmaking, alliance formation, and knowledge integration. It aligns with the Klerkx and Aarts (2013) definition of orchestrator activities as demand articulation, network composition (matchmaking and alliances), and innovation process management (integration and management).

At the firm level, the innovation intermediary's function is to build social capital. Social capital at the firm level is related to the accumulation of resources connected to external parties. Some of the authors have used the term 'relational asset' as another way to express these valuable external relationships (Kim et al. 2010; Caiazza and Volpe 2017). At the industry level, the innovation intermediary's role [in the government?] is to create institutional arrangements or policies to facilitate network formation and establish platforms to achieve strong collaboration, mutual relationships, and a market for network actors. We prefer to label these activities as ecosystem building. At the national level, the innovation intermediary's role is an orchestrator function to build a collaboration model that arranges various combinations of actors, their roles and the ties between them. The biggest innovation intermediary at the national level is the government, creating policies to develop and facilitate a culture of collaboration.

Lastly, the role of innovation intermediary is related to generating value. The innovation intermediary at the firm level in the value creation context supports external knowledge-seeking and social and human capital-building. Creating a supply-demand network in a particular industry to facilitate the transfer of knowledge, technology and resources could assist in the development of an innovation market and support innovation processes for members. To support assisting value generation at the national level, the innovation intermediary has the role of building the national knowledge structure and developing competitiveness for the nations.

5 Directions for future research

Innovation intermediaries' roles have changed in response to global challenges and the proliferation of technology. Based on the current innovation intermediary roles that were explored in the previous section, we have identified four key research gaps for further research development. Along with each gap, we propose research questions and the corresponding theoretical background (Table 4).

Develop a more comprehensive understanding of linking different levels of innovation implementation

The source of organizations' innovation has shifted from internal initiatives to dyadic external collaboration, and now relies on network-centric innovation (Nambisan and Sawhney 2011; Billington and Davidson 2013). The role of the innovation intermediary as a knowledge broker emphasizes the linking functions, detecting unexplored structural holes and attempting to build new bridges (Quintane and Carnabuci 2016). As innovation management has evolved toward openness, the innovation intermediary has recently tended to play more of a role in networks than in one-to-one relationships. However, only a few studies have focused on the role of the innovation intermediary in linking different levels of networks.

Innovation intermediaries play a critical role in helping organizations, particularly SMEs, to overcome difficulties in creating innovation in the face of resource and competency constraints. Transitioning from a closed to an open business model makes it all the more imperative for SMEs to address their potential for innovation within the context of the overall innovation ecosystem, which consists of micro-innovation systems, ecologies of innovation and social technologies. The roles of the innovation intermediary within this ecosystem link organizations and serve as integrators and brokers (Chataway et al. 2010). At the national level, the innovation intermediary's role is related to facilitating institutional arrangements that increase the public wealth.

The trend in innovation management research toward openness and the proliferation of internet technology create research opportunities to understand the relationships among players, including policy makers, SMEs, corporations, financial institutions, incubators or accelerators. It is also important to investigate the physical and non-physical infrastructure of a country to develop a national institutional arrangement that allows innovation activity from various types of innovation intermediaries.

Furthermore, the analysis reveals that the discussion of the role of innovation intermediaries in open innovation is largely limited to firm level implementation that focuses on searching for ideas for innovation; most of the research is related to crowdsourcing (Colombo et al. 2015; Dong and Pourmohamadi 2014; Harland and Nienaber 2014; Holzmann et al. 2014; Katzy et al. 2013; Lin et al. 2016; Martinez and Walton 2014; Matsuno et al. 2014; Montelisciani et al. 2014), with only a few studies focusing on wider concerns in how implementation of those externally sourced innovations align with a firm's internal process (Colombo et al.

Table 4 Research gaps and potential research questions

Roles	Level	Gaps	Research Questions	Concepts/Theories
Knowledge Broker	System	Develop a more comprehensive understanding of linking different levels of innovation and the implementation function	How can policy makers facilitate the flow of information across unlinked brokers to increase the collaborative ties of the nation? What role does an innovation intermediary play in open collaboration?	Structural holes (Burt 2004) ICT capabilities (Tsekouras et al. 2013); Open innovation intermediary (Howells 2006)
	Industry		How does an innovation intermediary play its role as a knowledge broker to create and grow organizations in a certain industry?	Technology brokering (Hargadon and Sutton 1997)
Knowledge transfer	Firm		How do innovation intermediaries facilitate organization' innovation in a knowledge or collaboration network?	Knowledge networks; collaborative innovation networks (Lee et al. 2010; Kirkels and Duysters 2010)
	System	Enhance focus on the role of the innovation intermediary in transition management as part of knowledge/technology transfer	What are the roles of innovation intermediaries at the system level in transferring of new technology?	Strategic niche management (Raven et al. 2010)
	Industry		How does a firm become the center of a collaboration network in its industry and use it as competitive advantage to occupy structural holes?	Social Network Analysis; Social capital (Quintane and Carnabuci 2016)
	Firm		How can a firm manage innovation from external sources and develop a business model to transfer it internally as an innovation outcome?	Business model innovation (Zott and Amit 2010; Howells 2006)

Table 4 (continued)

Roles	Level	Gaps	Research Questions	Concepts/Theories
Orchestrator	System	Leverage understanding on the role of established firms as innovation intermediary orchestrators	How does an innovation intermediary coordinate, direct, influence, and manage the other network members at the system level? How might an established firm take on the role of an innovation intermediary orchestrator in a given industry?	National innovation system (Kirkels and Duysters 2010; Kivimaa 2014); Innovation ecosystem (Klerkx and Aarts 2013; Klerkx and Leeuwis 2009) Platforms framework (Gawer and Cusumano 2014; Gawer 2014)
	Industry		What innovation outcomes might members of an innovation network intermediated by an established firm expect to see?	Social capital; Social Network Analyses (Vasudeva et al. 2013)
Value generator	System	Direct increased attention to the role of innovation intermediary towards assisting value generation	How does innovation intermediary generate value in ecosystem and society?	Addressing societal challenges through the simultaneous generation of social and business values (De Silva et al. 2018; Matschoss and Heiskanen 2018; Kivimaa et al. 2019)
	Industry		How does the innovation intermediary assist value generation in industry?	Delorme (2023)
	Firm		How does the innovation intermediary support an organization's innovation process simultaneous to generate value via social, intellectual, and human capital development?	Strategic innovation and value capture (Afuah and Tucci 2012) De Silva and Rossi (2018)

2015). Research in aligning open innovation results into a firm's business model, as suggested by Chesbrough (2010), has just started to be explored. To address this gap, more research is needed to develop an understanding on the role of an innovation intermediary to support business model alignment with open innovation implementation.

Enhance focus on the roles of innovation intermediaries in transition management as part of knowledge/technology transfer

With the proliferation of internet technology, a firm can connect with various entities and link into networks around the world. As a part of these networks, firms exchange experiences, information and knowledge with other network members and initiate collaboration for innovation purposes. However, to find and gain access to the right partner within a network, firms need an intermediary that acts as a bridge, knowledge/technology broker or consultant to achieve effective performance of innovation collaboration.

Although scholars have begun to identify future research areas related to how intermediaries can facilitate and build fruitful collaborative networks during joint innovation processes (Huggins 2010), the literature is still in its infancy about how this happens. How can collaborative networks and knowledge flows be developed and managed by innovation intermediaries? As such, future studies on innovation intermediaries within the network level should be more focused on how knowledge flows and new collaborations emerge over time. Such research might explore initial ideas, how knowledge is shared and evolves within collaborative networks in response to innovation challenges, how these changes generate new directions for organizations and how organizations in networks collaborate and react to idea generation. One line for future research is the study of the role of the innovation intermediary as a social network builder or collaborative network developer by showing how the transfer of knowledge occurs within and across firms.

Related to knowledge transfer roles, recent research in the transition management role of innovation intermediaries has been growing. The innovation intermediary's role as part of transition management mainly focuses on strategic niche management, a strategy to develop instruments for governing transitions in socially desirable directions (Raven et al. 2010; Schreuer et al. 2010). Strategic niche management refers to the creation and nurturing of protected spaces for promising technology to facilitate ongoing interactive learning of participating actors (Schreuer et al. 2010). It is still unclear what the innovation intermediary's role is during this transition process; more empirical research will contribute to greater understanding of the process and developing a toolkit to support it. Moreover, ensuring a multi-level view of this research topic will facilitate a more comprehensive understanding of transition management.

Along with transition management, it is necessary to consider the importance of the business model intermediary and the role of knowledge brokerage in the context of business model heterogeneity (Nair et al. 2012; Frykfors and Jonsson 2010). This kind of research is best performed at the national level. The parties involved in transition management have different goals yet need a strategy for collaboration and

a good implementation plan in order for everyone to gain maximal value. Future research may address business models geared toward increasing the value created for all parties, increasing the social impact of new technology implementation, and increasing the wealth of a nation.

Leverage the understanding on the role of the corporation as an innovation intermediary orchestrator

Research in inter-firm relations and alliances based on social network analysis has acknowledged the role of hub-firms at the center of many networks in the formation, growth and success of the network. Our analysis indicates that while interest in the orchestration role of intermediaries seems to have increased, few scholars are working to connect innovation research with the various elements of the orchestration role of innovation intermediaries, indicating that this orchestrating role is not fully considered an innovation intermediary role. Orchestration encompasses ‘knowledge mobility, innovation appropriability, and network stability’ (p. 659, Dhanaraj and Parke, 2006). Informed by Dhanaraj and Parke (2006), we see the role of orchestration as the group of deliberate, purposeful actions of the innovation intermediary seeking to create and expand value from the network, both expanding and extracting more of the available ‘pie’.

Playing the role of an orchestrator, the hub firm could be an integrator or a platform leader with different functions (Nambisan and Sawhney 2011). In this situation, a hub firm is a corporation that tries to build an ecosystem to coordinate, influence and/or direct other firms in the innovation network. As an innovation integrator, the established firm owns the core technology, then invites the network’s members to develop and innovate different components for technology product development. The theories underpinning this role are related to product architecture, engineering design, and manufacturing (Gawer 2014). Meanwhile as a platform leader, an established firm offers the basic technology architecture, which then becomes a platform for other network members to build and develop products of their own innovation. The theory foundation of this concept is economic (Gawer 2014) and social network theory (Nambisan and Sawhney 2011). The corporation that plays the role of a hub firm is an innovation intermediary for the other network members and for the firm itself. However, it is still unclear how the established firm plays its role as an innovation intermediary.

Some research has focused on how the orchestrator provides benefits to its members (Klerkx and Aart 2013), however the outcome of the orchestration role in innovation networks for all members is still unclear. For guidance, the creation concept can be used to understand how the innovation intermediary creates value by orchestrating an innovation network for its members.

At this time, research utilizing social network analysis to determine how the structural position of a firm in a network is related to its impact on innovation outcomes has been increasing. Networking is believed to leverage a firm’s ties, whether they are strong or weak. Studies regarding a firm’s presence in an innovation network and its impact on innovation performance have had mixed results; outcomes appear to depend on network partners. More research is needed in order to understand the

innovation intermediary's role of orchestration in innovation appropriability and network stability at the industry and organizational level.

Another area for future research is in exploring the orchestration role of intermediaries as part of innovation systems. Innovation intermediaries can be private or public where the government supports their existence (Bakici et al. 2013). Public innovation intermediaries have additional roles compared to private firms. The differences are mainly with regard to its focus on orchestration to support the development of start-up companies or actors in rural areas (Dutrenit et al. 2012) where one of their tasks is facilitating the funding of solutions for their clients (Inkinen and Suorsa 2010). In contrast, the private innovation intermediary's main job is finding solutions for clients. Public innovation intermediaries contribute to building and activating ecosystems, in addition to providing structure and governance to the ecosystem (Bakici et al. 2013). Additionally, the public innovation intermediary's role is to know 'what works' regarding instruments for designing interventions. Therefore, such intermediaries' orchestration role is to know about future technology initiatives in order for innovation to flourish in particular systems. It is still unclear what capabilities a public innovation intermediary must have in terms of the orchestration role in order to face all of the challenges within innovation systems.

Direct increased attention to the role of innovation intermediaries towards assisting value generation

Whilst past research has focused on the role of innovation intermediaries and how they generate value for other institutions (Howells 2006; Nambisan and Sawhney, 2007:), there is a lack of understanding on how the different roles of intermediaries affect different levels of innovation as well as what kind of value generation they assist to different institutions, industries and society at large.

We identify three challenges for intermediaries. The first challenge is positioning; the innovation intermediary should decide the position it wants to take, considering that it will relate to many actors and balance the interests of the organization to help assist value generation. It may take a neutral, impartial, coordinating or more activist role. Secondly, there is the issue of representation. The innovation intermediary must have the capability to speak on behalf of their members and present their demands in representative ways. Thirdly, with regard to the level of proactivity, the innovation intermediary's role depends on its ability to be familiar with different situations and contexts. It should proactively clarify what clients expect and assume in relation to the innovation intermediary's roles. Theoretically, researchers have analyzed the benefits of intermediaries that can accumulate from involvement with various kinds of users to address these challenges. The open innovation and intermediary literature has integrated these ideas, resulting in growing interest from innovation scholars and users as well as policy makers. However, it is not clear how these three challenges influence the role of the innovation intermediary in value generation activities.

Some research has extended value generation activities to a higher level than the institution level, such as industry, sector and national systems. At these levels, the government and universities play an important role in producing policies facilitating

innovation and generating value at every level of implementation (Wang et al. 2012). The proliferation of information technology can facilitate government efforts to reach a wider network size (Tsekouras et al. 2013; Bakici et al. 2013). However, this has been the subject of only limited research focus. Therefore, research that explores how the government plays a role in encouraging firms to work together in multi-partner innovation collaborations to generate value using emerging technology has the opportunity to be more developed in the future.

Research regarding collaboration has identified communities as an important element of innovation. According to Bakici (2013), it is a challenge to connect and engage communities in an innovation ecosystem. Public open innovation intermediaries can play a role, but less research has focused on how the structure and governance of ecosystems in communities may be involved in the innovation process.

The more that users/online participants succeed in developing innovative ideas, the more challenging it is for firms to keep track of authorship. In this situation, the role of innovation intermediaries becomes crucial in facilitating open innovation processes and ensuring proper management of intellectual property issues. For example, who owns the authorship of submitted ideas that were developed over time through co-creation processes with online solvers and the focal firm? When and how is it appropriate to share or protect users' ideas is a timely and important research question in this regard. In summary, the impact of the open innovation model on the innovation-related roles of innovation intermediaries is to ensure the transparency of IP-related issues, the success of innovation and governance structures, as well as assisting cooperative behavior, which are far from being clear and require further research.

6 Conclusions and limitations

This study reviews the literature on innovation intermediary research, showing the growing relevance of this academic field and identifies opportunities for future research. By conducting a literature review using bibliographic coupling to synthesize the literature, this review complements and further develops insights from previous reviews conducted with a more qualitative approach.

This study shows that literature published in this research area can be clustered into four topic groups that represent the role of innovation intermediaries: (1) knowledge broker; (2) knowledge transfer enabler; (3) orchestrator; and (4) value generator. From those clusters, we built a framework to understand the widening role of innovation intermediaries corresponding with innovation management research development. The framework also shows the functions that are embedded within the roles of innovation intermediaries in multilevel positions where innovation management is employed. From this, we have identified various opportunities for future research activities.

The focus of previous studies has largely been on the knowledge broker role of the innovation intermediary, investigating innovation networks and alliances from the firm's perspective. In order to gain a more holistic view of the knowledge broker

role of innovation intermediaries, research must incorporate system and industry perspectives in addition to the firm's perspective. Other areas to direct attention include investigating the orchestrating role of intermediaries and the associated value capture and understanding innovation intermediaries in the context of open innovation through emphasis on business model development, innovation ecosystem development and conceptualizing 'open business model innovation'.

Our study supports Gobbo and Olsson's (2010) research stating that innovation intermediaries play a role at different levels of analysis and facilitate vertical and horizontal cooperation (Zeng et al. 2010). It also confirms that the ways intermediaries support a firm's innovation develop [change] along with innovation management practices, moving from firm-centric to network-centric and systemic to ecosystem-focused.

While our conceptual framework allowed to identify the key role of innovation intermediaries, our research has had to confront several issues, which must be considered when reviewing the research, of which two are most significant here. The first limitation is about our data selection which is based on only 18 top innovation-related journal publications within a period and we might have missed economic or other disciplines aspects. The second limitation is related to the value generation aspect linking to different roles of innovation. It is apparent that significant knowledge gaps remain regarding how the different roles of innovation intermediaries influence the dual nature of value co-created and which specific policy instruments or managerial implications should support value generation and what value metrics should be adopted in comparing not only policy but also managerial guides.

7 Implications for managerial practice

Understanding the role of innovation intermediaries is critical in managing innovation and as a result, firms need to carefully consider the role that intermediaries can play in the driving their innovation initiatives. Firms involving intermediaries in their innovation processes are required to identify the organizational factors that will enable effective intermediation to enhance innovation outcomes. Prior to engaging with innovation intermediaries managers will need to define the specific requirements based on which stage of the innovation process they are at and the innovation system level that they want to engage with. Firms may create lists of the needs, priorities and working styles that take account of both their circumstances and the innovation intermediaries' services. This will allow them to engage with intermediaries possessing the appropriate resources and capabilities to address their specific organizational challenges.

Innovation intermediary organizations need to be aware of the different types of networks they might be creating (e.g., professional network, supply chain network, or network of communities) and, depending on the expertise and capabilities of both the intermediary and other institutions linked within the network, define the appropriate position for the intermediary itself within the different networks. This will enhance their ability to influence network activities and enhance the outcomes of the innovation initiatives they intermediate.

The lack of understanding of the innovation intermediaries' capabilities, business models and working styles make it difficult for firms to either strategically invest or measure returns from their connection with innovation intermediaries. The findings from this paper provide an initial platform towards tackling these challenges.

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Declarations

Conflict of interest The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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