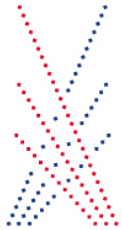

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Innovation Search and the Role of Innovation Intermediaries

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Summary: This paper focuses on innovation search activities of firms and how innovation intermediaries support this process. The paper is based on original case study research covering a range of firms and organizations and the innovation intermediaries facilitating the search process. The research discovered that innovation search activity is a much more extended and complex process than previously conceptualised and involves a set of search phases, which are associated with a loosely coupled iterative process. The paper presents a typology of these inter-linked search functions. It was found that most search activities were not restricted to a narrow search process, but were spread across several interlinked stages. The research identifies new frameworks, which innovation intermediaries operate under conditions of more open, collaborative innovation networks that have both theoretical and managerial implications. Lastly, intermediaries were found to be undertaking new, more extended and formative roles in the search process.

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1. Introduction

In an increasingly open innovation environment, where external solutions and collaboration are becoming more common and necessary, finding the right innovation solution or partner has become ever more important. Firms still frequently 'go it alone' in the innovation search process, but increasingly they are seeking organizations to support them in this process. This is because search processes are not only costly and time-consuming, but also that specialist 'searchers' can provide new and efficient search routines and practices that both speed up and enhance the client organization's innovation search processes. One body of organizations that are increasingly entering what might be termed this 'innovation search space' market are innovation intermediaries. They help the formation of relationships that would not exist if there were no need for complementary knowledge and resources among organizations involved in innovation. Innovation intermediaries are defined here as "An organization or body that acts an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between, bodies or organizations that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations." (Howells 2006, 720). Intermediaries, therefore, play a direct role in the innovation chain of the firm, performing activities knowingly relevant to Research and Development (R&D), but that were previously performed internally. They also provide a range of search services for the search and selection of other organizations with which firms and organizations may wish to collaborate with. Previous studies have suggested that innovation search is a solitary process by a firm or organization, and have largely ignored the role of external support or guidance in the search process.

The research here proposes to contribute to our knowledge of innovation intermediaries and the innovation search process. In this context, the research seeks to provide new insights into two extant bodies of research. Firstly, in terms of improving our understanding and knowledge around a range of new and existing activities innovation intermediaries are undertaking as part of their wider contribution to firm performance and the innovation ecosystem. More specifically and related to this, the study explores the emergent and evolving role innovation intermediaries are undertaking in the search process. Previous studies have suggested that innovation search is a solitary, dyadic process by a firm or organisation, which has largely ignored the role of external support or guidance in the search process. The second main strand relates to the innovation search process itself. The paper seeks to provide more information and better conceptualisation of the innovation search process itself and how it is understood as a strategic activity by the firm or organization. It also questions the wider notion of what is meant by the notion of 'innovation search' and the stages involved with this process.

The rest of the paper is structured as follows. Section 2 provides a brief literature review of the 'search' process and the role of innovation intermediaries in the process, followed by an outline of existing a priori conceptual and basic model of innovation search. Section 3 then provides an outline of the case study methodology and the case studies. Section 4 describes the wider search' process and more specifically the role of innovation intermediaries in this activity. Lastly, Section 5 then provides a conclusion and sets out a number of limitations of the research and future research avenues covering this field.

2. Innovation Search and Intermediaries: A Theoretical Overview

In a world where firms, even large multinational corporations, can no longer 'go it alone' in terms of their own research and innovation capacity firms seek external partners to collaborate and support them in this process. Increasingly, this has followed open innovation programmes that gained traction in the early and mid-2000s (Chesbrough 2003a; 2003b; Chesbrough 2006; West and Gallagher, 2006). Studies have shown that external innovation collaboration is associated with firm performance and that even searching for collaborators is linked to innovative performance, with Laursen and Salter (2006, p. 134) showing that the breadth of a firm's external search (here described as the diversity of external sources for innovation input) had a positive impact on a firm's innovation performance. Firms search among a range of different external actors, including customers (Nalebuff et al., 1996; Mina et al., 2014), end-consumers (Brockhoff, 1998; von Hippel, 1988), suppliers (Schiele, 2010; Walter et al., 2007) public research institutes (Steinmo and Rasmussen, 2016) and universities (Fontana et al., 2006; Wright et al., 2008; Howells et al., 2012). Well-tested technologies and novel ideas can also be found among actors from distant knowledge domains and from outside the firm's industry (Gassmann and Enkel, 2004; Gassmann, 2006). It is also associated with signalling activity, which is a way of flagging up a firm's capability in certain areas the firm wants to cooperate in through voluntarily disclosing information (Spence, 2002). In terms of research collaboration, signalling can be seen as highlighting to other firms the scientific and technical capability of the firm and as a way of enticing another capable partner to work on a project with complimentary capabilities (Penin, 2005).

The rise of open, collaborative and distributed innovation, and the models describing them, imply firms and organizations directly undertaking the search and implementing collaborative practices and frameworks on their own. Indeed, the rise of online markets and web-based interaction has allowed firms and organizations to directly interact with their customers, users, suppliers and research collaborators through different ways (West and Bogers, 2014). The web has therefore offered the opportunity to develop online platforms, which directly interact with potential partners and more particularly individual scientists and engineers, something that in the pre-internet era often involved high level of resources to cover even a limited set of institutions and individuals. Such forums gained particular traction amongst consumer care, health and pharmaceutical companies, notably Proctor & Gamble, Unilever, AstraZeneca, GlaxoSmithKline and Eli Lilly (Dodgson et al., 2006). More specifically in terms of innovation, firms have established their own open innovation platforms that have encouraged large firms to directly reach out to other firms and organizations seeking collaborative ties. These online innovation platforms are sometimes part of a simple 'crowdsourcing' initiatives, but for others they form a much wider, 'full spectrum' search outreach strategy increasingly operated by innovation intermediaries.

There have been a number of important papers recently focusing on the search process from a number of different perspectives and using different approaches. As such, they have covered: basic search formulation (Fontana et al., 2006), search processes (Fleming and Sorenson, 2004), the role of governance structures in the problem-solving process (Felin and Zenger, 2014), search paths and efficiency (Lopez-Vega, 2016; Stockstrom et al., 2016), the influence of absorptive capacity on the search activity (Fabrizio, 2009; Spithoven et al., 2010; Martín-de Castro, 2015; Zobel, 2016) and the role of intermediaries in many of these process (Nambisan and Sawhney, 2007; Yusuf, 2008; Kodama, 2008; Zhang and Li, 2010; Janssen et al., 2014; Lopez-Vega et al., 2016; Bianchi et al, 2016).

Increasingly open innovation strategies involve both complex partner relationships, but also ones which can involve disparate types of actors and roles within such links. These 'proto' initiatives, which have often been testing the innovation market and partnership networks, have, through their own success, become much harder to manage by firms on their own. This has led to a reassessment of whether using intermediaries to support this search and network function may once again be necessary (with parallels again with crowdsourcing platforms; Feller et al., 2012; Zogaj et al., 2014; Stefan and Bullinger, 2014). Many of the benefits have not realised as complexity has increased and intermediaries have crept back in to help manage such complex relationships. Thus, increasingly open innovation platforms have moved from initial 'go it alone' strategies to ones of 'supported openness' (Section 4). Thus, new forms of intermediary and activities have emerged, such as innovation contests and prizes, open innovation facilitators, such as 100%Open.

Research exploring how firms search for information, knowledge or complete 'off the shelf' solutions in innovation have grown steadily over recent years. Studies have made important strides in identifying a number of key parameters in the search process. Firms face various options regarding how they search and what they search for externally and search in many different ways (Pisano and Verganti, 2008). The three key search dimensions that have been highlighted by recent research are: 1) breadth versus depth of search (Laursen and Salter, 2006; Chiang and Hung, 2010; Leiponen and Helfat, 2010 Classen et al., 2012); 2) distant (far) versus local (near) search (Wang, 2015; Lopez-Vega et al., 2016); and, 3) 'early' (search for ideas) rather than 'late' (market-ready products) associated with innovation maturity (Nambisan and Sawhney, 2007). This decision also depends on the accepted risk, costs, speed and expected number of ideas. Raw ideas are relatively easy to obtain and do not cause noteworthy costs, however commercialisation time tends to be long. Marketable products carry lower risk and faster commercialization potential, but they are not easily accessible, and they are more expensive. Linked to unformulated ideas has also been the "novelty" level of the knowledge being searched in the search field (Brunswicker and Hutschek, 2010, p. 692). It also highlights the important issue of the contractual incompleteness problem (Kultti and Takalo, 2000) of searching for and buying research and innovation. This is where neither the seeker/buyer nor the sought/seller often know what is actually being sought or sold as it the solution and the knowledge upon which it is founded is still being 'produced'. Lastly, there have been studies that have focused on search efficiency, and possible declining returns to search, and search costs and risks (Nambisan and Sawhney, 2007). Most studies have suggested that decreasing returns to technological search may occur, as the set of available combinations is exhausted (Kim and Kogut, 1996; Fleming, 2001). Laursen and Salter (2006) however discovered a more curvilinear effect of search breadth on product innovation, thereby indicating a potential "oversearch" by firms. Indeed, not only the transaction costs, but also the transaction values guide decisions about how to implement analogical problem solving (Vanhaverbeke and Cloodt, 2006). There have been other dimensions that have also been highlighted in studies, including contrasts between experiential (feedback) and situated (abstract) search heuristics (Lopez-Vega et al., 2016)

3. Research Methods

Methodological Framework

The research is based on qualitative research through descriptive multiple case studies that were used to analyse real-life contexts in which the phenomena occurred (Yin, 1994). As a qualitative research process, the case analysis enabled a more in-depth understanding of the phenomenon

of innovation search and the role of intermediaries in such search processes. The combination of multiple eliciting data (from interviews, secondary data and direct observation) was aimed at improving the research validity. The selection of in-depth case studies is regarded as a crucial element in the case study method (Eisenhardt, 1989; Yin, 1994) and the fifteen case studies involved innovation intermediaries from Brazil, Norway and the United Kingdom and their clients over the period, 2013-18. The three countries selected offer different forms of 'varieties of capitalism' (Soskice and Hall, 2001) and institutional frameworks (Whitley 1999), which can lead to different innovative patterns and behaviours within the countries' organizations (Hall and Soskice, 2001, p. 21). Indeed the three countries represent what Fan et al. (2017) call different national innovation 'configurations' or models. Thus, Brazil represents a transformational or emergent innovation system (Group III), Norway a 'time robust' institutionally strong innovation system (Group I) and the UK (Group II) a more individualistic innovation system undergoing institutional change (Fan et al., 2017, pp. 48-51). These differences can be expected therefore to lead to different innovation behaviours, including innovation search, by firms and organizations. Case studies were selected on the basis of innovation search activity and the involvement of innovation intermediaries in this process (Appendix 1).

Previous literature on search processes and intermediaries gave rise to the research protocol for the interviews. The main purpose of the protocol of interview was to increase reliability of the case study. For triangulation reasons and for the better understanding of the phenomenon, different questions were developed for intermediaries and for organizations performing innovation projects. The protocol was applied to cases selected for this research to ensure that the data collection procedures were implemented in the same way for all cases. The protocol also served as a guide during the process of data collection so that all criteria and procedures were adhered to. Most interviews were audio-recorded to allow further listening and consultation. The amount of interviews was not pre-determined when defining the cases to be studied. The research considered it to be enough when there was no new information coming from the sources about the search process and the intermediaries' activities on search processes and that satisfied the *collective instrumental* methodological framework that was being used.

Data Sources

Data was collected in two phases by the authors with interviews with selected intermediaries and clients, where the main interviewees were managers, directors, project leaders and companies' researchers. The first phase focused initially on cases in which innovation intermediaries were involved in the wider innovation search process, namely scanning, searching and screening. It should be noted that the unit of observation for the analysis in terms of the 'case' was an 'innovation search' that covered some part of the search activity stages. Innovation search is defined as an activity that a firm or organization undertakes to find new ideas, concepts, processes and partners in order to find an innovative solution to an opportunity, problems or issue that it is seeking to accomplish or resolve in the future. Innovation search may a be highly focused, short term and targeted process based on clear, existing strategic objectives and search fields in terms of innovation, or it may be a broad based, longer term iterative process exploring and seeking solutions to, as yet, less well defined or articulated innovation objectives.

Initial case studies were therefore selected within the shortened search framework outlined by the previous literature (although it should be noted that the innovation search stage process were not there primary focus; see, for example, Fleming and Sorenson, 2004; Fontana et al., 2006; Laursen and Salter, 2006; Nambisan and Sawhney, 2007; Pisano and Verganti, 2008;

Chiang and Hung, 2010; Leiponen and Helfat, 2010; Classen et al., 2012; Wang, 2015; Lopez-Vega et al., 2016). For the second phase of data collection, case studies were sought that were *diverse* in nature to achieve maximum variance along the dimensions, which covered the six stages. However, within this variance, cases were sought which were also seen as being *typical* of their case within that search stage. Indeed, the initial case framework was extended to include this variance and the sampling frame is seen as a hybrid of diverse and typical case method analysis (Seawright and Gerring, 2008, pp. 299-301).

Data Analysis

In this context, the research involved a 'ranging' case study approach that sought to include all stages of the innovation search process by firms and organizations. As will be highlighted in Analysis and Results, was subsequently revised and extended on the basis of the ranging case study method (and indeed going back to review a wider and disparate set of literature). As such, the framework can be defined as a set of *collective instrumental* cases, combining instrumental cases which are selected to provide insight on an issue or is used to refine theory (Stake, 1995), which are studied as 'nested cases' observed in unison, parallel or sequential order. The selection process also involved pragmatic logistical criteria decisions across the three countries selected. Lastly, to ensure research reliability and validity on the basis of "intersubjectivity" (Kvale, 1995) and to better trust the findings (Eisenhardt, 1989), interviewees' feedbacks was used and relied upon. Follow-up questions were discusses over phone calls and emails to confirm information and to ask specific details when the authors were writing up the research. All organizations in the study agreed to have their names identified in the final research. Some sensitive material relating to intellectual property or commercial data remained confidential.

4. Analysis and Results: Stages in the Innovation Search Process

Introduction

The research explored innovation search practices and strategies with varying levels of support from innovation intermediaries using in-depth case studies. In this latter context, this was associated within a search spectrum, ranging from no outside support to one where the intermediary undertook a high level of screening, decision and control activities. Natalicchio et al. (2014) note that the use of intermediaries is consistent with the increasing tendency to decompose the whole innovation process into distinct phases. This research seeks to show that although this sometimes may be the case, innovation intermediaries have a new role to play within a wider socially mediated network role. The research also wanted to reassess how firms accessed new knowledge and partners. In particular, certain platforms allow a more *passive* role in partner selection than before. There is also the need to differentiate between search for partners and specific projects or problems. On this basis, a six stage *ex post* search model (Table 1) was used to explore when and how innovation intermediaries intervened in the search process for their partners. A framework of the results is illustrated at Figure 1 followed by the discussion of each stage and how intermediaries operationalize them.

1. Search Articulation

Pre-formulation and articulation of what is to be searched is key in the successful outcome of the search process. It was found from the research that innovation intermediaries spend a lot of time with their clients about helping them to articulate what they want out of the search

process. The articulation stage starts as a process around a collection of themes or areas a firm or organization wants to explore. For firms that have a clear innovation problem and/or seeking a specific innovation solution to it, the articulation stage is not necessary or can be abbreviated. Search articulation is iterative in nature, often involving system and functional analysis to generate novel solution principles, which start from customer and market needs and then identify technological components that might help solve or meet these needs. From the case study analysis, there was a significant proportion of innovation intermediaries supporting this articulation process, guiding clients to know "where to look in the first place" (Howells, 2006, p. 723), based on their earlier learning experiences of where to and who to partner with (Case 14). Indeed, in the case of RID (Case 9), a key role for it as an organization was to identify problems and articulate future scenarios to develop a set of innovation strategies and pathways for partnerships with organizations in the region, including industry associations, firms and public sector organizations.

As such, this articulation stage helps define the 'search field'. For Brunswicker and Hutschek (2010, p. 696) this stage can also involve formal assessment and 'exploitation preparation' of what a useful search outcome might look like, although in the case studies it was felt that the 'seekers' would know a good result if they came by it. Time spent around this stage can save a huge amount of time and energy and lead to improved outcomes (Khurana and Rosenthal, 1997; Koen et al., 2001; Kim and Wilemon, 2002). Even for established firms, the start of the search process, can still be chaotic and un-systemised (Takey and Carvalho, 2016) and this may reflect that firms have not adequately articulated what they want from the search process.

2. Scanning

As part of their wider search process and as a precursor to a targeted search process, firms engage in scanning their task environment for competitive advantage and is associated with seeking and collecting information about changes and trends beyond a firm's organizational boundaries to guide the strategic orientation of the firm (Aguilar, 1967). This capability not only allows firms to identify 'weak signals' (Ansoff, 1975) in key technology and market domains, but more particularly to inform the firm's decision-making (Jain, 1984). Others have suggested that scanning is not such a specific activity, more of a general alert 'watch' activity that is about exploring technology options on a broad and non-specific level. Haeckel (1999) goes further and suggests it is this non-specific 'peripheral vision' element that is so important in helping to identify 'left field' technology trends that are important for a firm to be aware of, especially in highly dynamic technological environments.

Scanning activity can range from being general and routine to specific and targeted set on identifying a particular technology or market condition. Batterink et al. (2010, p. 52) sees an intermediary's activity of scanning the environment as often a precursor for then going out searching and selecting possible partners through comparing and matchmaking complementary assets, such as knowledge, materials and funding. Scanning activity is different from the initial stage of ideation in which the focus of scanning is the technology environment. When scanning, the intermediary directs its attention to problems and innovation possibilities for the client, and sources of knowledge and resources in other firms. At RIS (Case 7), the collaboration managers keep track of companies where alumni were working so that the University of Southampton had an easier way to get in contact with those companies. RIS is also involved in the registration of partnerships that it has supported, for example, through searching for partners or looking for funding. These practices help to build a list of companies in different areas that helps narrow down the scope of scanning activity.

3. Signalling

Signalling as a means of highlighting a firm's technical capability was also seen as a precursor for the core search process and as a way of firms to help other firms in their search for new, capable partners. The case study analysis revealed two related, but types of signalling activities: broadcast or passive signalling and targeted signalling that is not searching in terms of what they do. There were significant differences between broadcast and targeted signalling in terms of the degree of proactivity and specificity of what the firm or organization is signalling. Rather confusingly some studies have used the term 'broadcast search' to denote the activity of targeted signalling even though it is not a firm or organization going out and actively searching for partners with a problem or issue to be solved, but rather posing an issue and waiting for organizations coming to them with a solution or partnership idea. These two activities often involve online intermediaries. Verona et al. (2006) emphasize that innovation brokers play an important role in collecting dispersed sources of knowledge (often outside the network), recombining it and transferring it to new sources, firstly, by extending network access through enhancing network reach in engaging with both producers and consumers and, secondly, through enhancing the richness of and quality of contact through bi-directional links. Dong and Pourmohamadi (2014) and Ye et al. (2012) have outlined how intermediaries have entered the online space by structuring knowledge to identify providers who can provide solutions beyond the immediate exigencies of the problem and helping to choose a provider among many potential matches.

Thus, in b*roadcast or passive signalling* a number of firms, such as AstraZeneca (Case 1), online platforms represent a way for firms and organizations not to fully articulate what they are seeking. Instead, it may rather be considered a process of wide-ranging, broadcast signalling in a more open innovation environment and outlining *general* areas of interest. In this sense, although part of a wider crowdsourcing phenomenon, it is more passive in its nature. Here the firm does little more than describe what they do now, listing in general terms the scientific, technical or market areas they actually work in now. 100%Open (Case 4) describes this activity, where a client has no specific problem or need they want to solve as 'Jam'. The Jam method was used with clients, such as McLaren, Oracle, Tesco and Virgin Atlantic. Within this category there can be activities described as general networking events and with, for example, 100%Open running 'The Union'.

By contrast, in *targeted signalling f*irms identify a specific solution, opportunity space or problem they are seeking to resolve or find. Here specifications are outlined in detail as well as desired outcomes and financial reward if a solution is found. Again, this can be on a general online platform, which invites crowdsourced solutions to a problem. A specific amount of money may be cited, especially if it is in terms of an innovation tournament with a monetary prize and a closing date. Targeted signalling is a problem solving approach that is leveraged via online communities, such as InnoCentive (AstraZeneca, Case 2). It implies that firms provide "problem information" to a large group of "unknown" outsiders in order to open the solution space; it has been proven successful for scientific problems, and it provides access to a large variety of new ideas (Lakhani et al., 2006; Pisano and Verganti, 2008). Similarly, OSCR (Case 3) ran an innovation competition with NESTA for Orange aimed at establishing a long-term link between the winning small firm and Orange. Although becoming active once the search process started, the competition, unlike a specific challenge tournament, had no a priori idea of the target to be selected except in very general terms, i.e. an innovative high tech start-up that could benefit from (and benefit) Orange through collaborating with it.

4. Core Searching

Search by firms is about gathering information based on a search strategy that seeks sources of valuable information (Laursen and Salter, 2004; 2006). How you search can be important. Instead of putting out your stall and waiting for potential partners or solutions coming to you, firms and organizations can more actively undertake a search process. After going through some or all of Stages 1-3, firms will then undertake the core search process which will involve both information searches as well as through personal contacts of the in-house staff. As noted earlier, studies have tended to divide search processes between depth versus breadth of search (Laursen and Salter, 2006; Chiang and Hung, 2010; Leiponen and Helfat, 2010 Classen et al., 2012) and between local versus distant search patterns (Lopez-Vega et al., 2016). Firms face various options regarding how they search and what they search for externally and search in many different ways (Pisano and Verganti, 2008). New and emerging intermediary markets can also create a range of additional search channels and methods that reduce search and transaction costs (Nambisan and Sawhney, 2007; Pisano and Verganti, 2008) and intermediaries will take their client through a formal, staged process associated with this. However, this normative view of the innovation search process is challenged by this case study research for several reasons.

Firstly, the case studies suggest that rarely do firms seek either breadth versus depth or local versus distant. As Garriga et al. (2013) have noted there is usually at least two (or more) strategy stage with broad searches followed by deeper ones and distant ones followed by more targeted, localised searches. However, in this latter context for Small- and Medium-sized Enterprises (SMEs), localised geographical searches remain more common. In this sense, geographical search is more associated with a stepped process with broad, ranging multimedia-based searches followed by more localised second stage searches made often through personal contacts and involving face-to-face contacts. In terms of the case studies, search patterns went through a complex set of iterative stages, which rarely stayed at one 'level', unless it was a very specific technical problem where the firm or the intermediary had a good idea of where to undertake localised searches.

Secondly, search procedures still largely assume that the search process starts once a formed, clearly identified research, innovation or market need is identified. However, as noted earlier, Nambisan and Sawhney (2007) differentiated innovation inputs between two contrasting ends: raw ideas, at one end, versus market-ready products, at the other. Searches involving raw ideas for research inputs with incomplete known outcomes are more common than often supposed. Particularly with the case of intermediaries with a close relational partnership searching for possible partners, potential problem fixing and solutions often begins near start of the R&D phase. RIS in the case of the StarStream project (Case 6) therefore started searching for potential commercial partners in the early stages of the development process in 2006 over six years before the project delivered a commercially viable outcome. Similar searches were performed by the competence broker (Case 15) when a start-up needed partners to test the prototype, and the intermediary brought Sintef, an applied research institute, to the project. From this relationship, the new firm got access to laboratory to verify the product and move forward for the intellectual property registration.

Thirdly, search processes are still viewed largely as a one-to-one process triadic 'one-to-one-to-one' basis between, for example, a supplier and its customer in some kind of vertical relationship. However, in distributed innovation systems, intermediaries are increasingly involved in more complex relationships, such as 'many-to-one-to-one', 'one-to-one-to-many', 'many-to-one-to-many', or even 'many-to-many-to-many' collaborations, forming both vertical and horizontal relationships in increasingly distributed innovation networks (Howells 2006, 734). Thus, in the StarStream project, searching began for one partner, but resulted with

Philips and Ultrawave and then Sellafield Ltd and two further firms (Case 6). Searching therefore does not necessarily lead to identification of a single partner; it is often much more complex than that. As an example, the Innovation Dialogue organized by the broker of VRI (Case 13) led to the creation of a network of firms, public agencies and the university that led to the establishment of a formalized cluster. Lastly, there is the role of the individual in the search process and informal personal contacts. Again much of the literature emphasizes the search by the firm or organization, when in reality it is left to individuals or teams of individuals delegated with the responsibility for the search process. In one of the case studies, with SEDETEC acting as intermediary on the project, Frenzel was chosen as a partner because of existing and localised informal contacts between the partners (Case 8).

5. Screening and Selecting

To gather information, firms implement a search strategy coupled with an in-depth screening activity. While searching implies a general attitude of looking at potential valuable sources of information, screening involves identifying and selecting the best within the set of possible partners (Stieglitz, 2002). Searching then involves a screening and selection process, even if it leads to non-selection and another iteration of the search process or a decision to solve the problem or identify and develop a new product or process internally. Decisions are not made just about the specific 'solution' (unless it is something already developed and/or off the shelf) because most collaborations are about predicting future outcomes on a research or innovation project whose outcomes are uncertain. A technology buyer will also need to have sufficient absorptive capacity (Cohen and Levinthal, 1989; 1990; Zahra and George, 2002; Lane et al., 2006) to be able to understand, evaluate, adapt and implement new external solutions. This function was exhibited when a representative of the VRI approached several companies from her personal network and at NordicEdge forum to present the program Demola *to* firms and find interested partners; thus, two major Norwegian companies (Statoil and Kolumbus) were partners of the programme (Case 10). Some other companies were interested, but did not fit the requirements of the program and therefore the representative did not go forward with those partnerships. Similarly, RIS filtered out some companies that approached the university regarding technologies when the terms of possible partnerships were not suitable for the University (Case 6). In OSCR (Case 3), the intermediary chose seven out of almost 100 applicants to tailor their projects according to the client's (in this case, Orange) demands.

6. Post Selection and Feedback

As in any feedback and 'learning by doing' model, after selection and use of the knowledge or solution, this will then shape further innovation search processes for the organization concerned. This may be about where to search, how to search (including efficiency practices in the search process) and what to search for. Thus, post selection and feedback processes will lead back to earlier stages, such as ideation or search, where learnt experiences and routines can be passed on. Thus, the OSCR's competition activities (Case 3) led to a broader open innovation program for France Telecom called 'Arc Bretagne Atlantique' with a French innovation intermediary. Post-selection and Feedback stages can also lead to the development of longer term arrangements once trust, successful relationship building and past successful outcomes have been established. Positive feedback about a specific partner of an innovation project could lead to the start of another project or another negotiation with the same partner. In this way one-off innovation collaborations move into longer term, 'relational' partnerships that lead to ongoing contact and further links. RIS had developed a long-term collaboration between Philips and the Department of Mechanical Engineering at University of Southampton

(Case 7). This, in turn, led the collaboration manager at RIS to offer StarStream technology from the Institute of Sound and Vibration Research in the University to Philips initiating another partnership with the company (Case 6). The Brazilian case also had a similar partnership extension when SEDETEC arranged the start a second project between UFRGS and Frenzel when the first project had reached a successful outcome (Case 8). ITSA (case 12), organized by Validé, invites investors for a pitch meeting whenever there is a set of new start-ups with fresh offers. Several of these investors are partners of Validé in previous projects signalling that Validé already knows about their interest, commitments and trustworthiness.

The six identified stages and the way innovation intermediaries operationalize each one of them is summarized in Table 1. Table 2 presents a list of the cases where each of the search stages could be identified during the research.

5. Conclusions

Innovation intermediaries have been shown to play an important role right across search process, from articulation and scanning through to final screening and selection and post feedback, and intermediaries have built up experience in this area. Innovation intermediaries involved in these search activities build upon prior search strategies that have been honed on a set of previous client relationships. For many firms, especially SMEs, innovation searching may be a rare or even unique position for them and where they lack both experience and resources to undertake efficiently. This is something which innovation intermediaries have clear advantages over them. Thus, the development of these search routines allows considerable opportunities for efficiency and success in the overall innovation search process.

Increasingly open innovation strategies involve both complex partner relationships, but also ones which can involve disparate types of actors and roles within such links. These initiatives, which have often been testing the innovation market and partnership networks, have become much harder to manage by firms on their own. This has led to a reassessment of whether using intermediaries to support this function may once again be necessary. Many of the hypothesised benefits of disintermediation surrounding partnership, research or innovation search have not been realised, as complexity has increased and intermediaries have crept back in to help manage such complex relationships. Frequently firms and organizations seek help in their innovation searches and innovation intermediaries have sought to provide a search function for them. This paper has extended the analysis and conceptualisation of innovation intermediaries (see, for example, Zogaj et al., 2014; Lauritzen, 2017; de Silva et al., 2018). The innovation intermediary is, however, not limited to only one activity. In fact, intermediaries frequently follow more than one search strategy in order to provide the best solution for its clients. Increasingly have aided the development of open innovation platforms that have moved from ‘go it alone’ strategies to ones of ‘supported openness’ (Case 2, 3, 6, 10, 11 and 13). New forms of intermediation activities have therefore emerged around the innovation search space, such as innovation contests and prizes, open innovation facilitators, (Cases 4 and 5). They have also emerged in other roles associated with the design, implementation and ‘after-contest’ provision of services to both winners and losers.

In the context of the case studies, innovation intermediaries not only searched for potential partners and solutions, but also in later stages went further by tailoring and supporting the applications and selecting partners (Cases 3, 6, 10, 12 and 15). Thus, 100%Open chose the most suitable candidates according to the brief and to the client’s needs. The next stage of the competition, ‘The Airlock’, where short-listed proposals get help from the intermediary to improve their technologies, to tailor their offerings according to the needs of the client and to protect it (Case 3). Technical information provided by the candidates to the ‘Trusted Agent’ is

held under a confidentiality agreement within the Airlock and is not disclosed to the client. Candidates therefore are free to disclose full details of their innovations to the intermediary. All these activities were within the "tailored" search method of the intermediary, which was not a one-step decision. After this stage, the Airlock is "broken" with direct contact allowed with the client firm with, for example, a formal pitch. Thus, intermediaries aggregate and anonymize information before they pass it on to third parties providing an additional safeguard by creating a safe boundary between a client firm and external firms and organizations. Intermediaries also became involved in mediation and conflict resolution in collaborations post-selection (see also Lauritzen, 2017). In addition, as the intermediary undertakes new roles, when searching for partners includes a level of controlling the activity, which will shape innovation in the near future, it may be important to understand to what extent the intermediary acts as a *system coordinator* of collaborative projects apart from just searching for partners. Connected to this is the role of trust that the intermediary plays to make up for the lack of trust between unknown partners. The cases involving selective revealing and negotiation between partners have shown that the intermediary has a major role involving trust in relationships, however it has not been fully explained by scholars. The case study work in this paper therefore highlights a newer, more significant role for boundary spanning organizations, such as innovation intermediaries, in open data and online communities of being trusted, third party 'revealers', although in a wider intermediary context such neutrality may be altered by regulatory or institutional changes (De Beer and Clemmer, 2009). Alexy et al. (2013) outlines how the selective revealing of knowledge offers a newer, different form of collaborative mechanism that can provide an alternative to more traditional forms of partnership, particularly under conditions of high uncertainty (see also Henkel, 2006; Henkel et al., 2014; Perkmann and Schildt; 2014).

The research has also highlighted some important observations and findings about the innovation search process itself. The research has identified a much wider spectrum of innovation search activity by firms or organizations than has been formally acknowledged. Previous research of innovation search has lacked granularity and search processes may not be as targeted or as specific as formerly suggested. The research found that search activity was not concentrated in the core search stage, but spread much more widely across several, inter-linked and loosely-coupled stages. The study has sought to show these inter-linked and iterative processes with search behaviours in relation to innovation and their important feedback loops. Not all search stages may be necessary or complete as part of the search process, but the case studies revealed that these stages were distinct and apparent across the range of cases. Detailed information on decision-making surrounding search behaviours however remains very limited (Greve, 2003) and further research is required to determine what factors actually important in shaping innovation search decision-making.

Lastly, the research raises the more fundamental theoretical question of "When is 'searching' not searching?" Innovation intermediaries have been heavily involved in supporting online crowdsourcing platforms associated with broadcast calls, which may be seen more as a process of what has been termed here as 'passive netting' (passive, non-targeted search). Online platforms and crowdsourcing have therefore allowed in one way much less *a priori* about what they are thinking for in relation to innovations. Is simply informing other people, teams or organizations that one is open to interesting, novel and innovative suggestions and then making ex post decisions about them really a search process? This is very much open to question, but equally the two are closely coupled here. How we incorporate signalling and passive broadcast search or netting into our wider conceptualisation of the innovation search process is important here.

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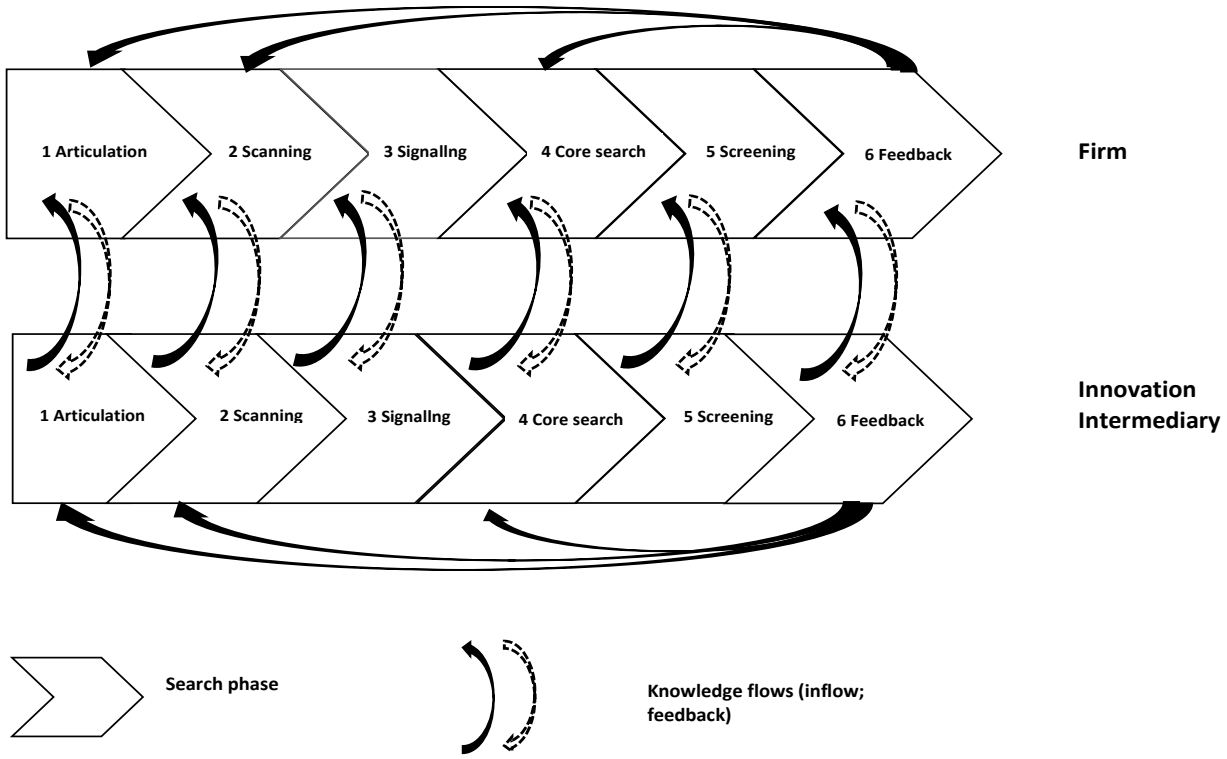
Table 1. Phasing and typology of innovation search and innovation intermediaries' support

Phase and search type	Description	Intermediaries' operationalization
1. Articulation	▪ Search for themes or areas a firm or organization wants to explore. ▪ Guiding clients to know "where to look in the first place." ▪ Articulating future scenarios to develop a set of innovation strategies and pathways for partnerships.	Participation in several forums with firm and public agencies from the region.
2. Scanning	▪ Collecting information about changes and trends in the firm's task environment. ▪ Searching innovation possibilities for the firm. ▪ Getting knowledge about other firms as sources of knowledge and resources.	Portfolio of previous partnerships and of firms with former students. Attendance to several conferences and trade fairs of different industries.
3. Signalling	3A. Broadcast signalling: ▪ Highlighting a firm's technical capability. ▪ Outlining general areas of interest. Listing scientific, technical or market areas the firm works in. 3B. Targeted signalling: ▪ Identifying a specific solution, opportunity space or problem. ▪ Posing an issue and waiting for organizations coming to them with a solution or partnership idea.	Crowdsourcing; online platform; untargeted meetings among several organizations seeking innovation. Online platform; innovation tournaments.
4. Core Searching	▪ Active search process.	May include personal contacts. It can be a formal, staged process.
5. Screening and Selecting	▪ Identifying the best within the set of possible information providers. ▪ It may lead to non-selection.	Comparing and matchmaking complementary assets (as knowledge and funding) and absorptive capacity.
6. Post Selection and Feedback	▪ After selection and use of the knowledge or solution. ▪ Shaping further innovation search processes in regards to where to search, how to search and what to search for.	Evaluation of positive and negative outcomes from search activities and from relationships.

Table 2. Search phases and case studies where they appear

	Search Phases		**Cases**
1.	Articulation		1, 2, 9, 13, 14
2.	Scanning		1, 2, 3, 5, 7, 12, 13, 14
3	Signalling	3A Targeted	2, 4, 5, 12, 13
		3B Broadcast	1, 3, 10
4.	Core Searching		3, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15
5.	Screening and Selecting		3, 6, 10, 12, 15
6.	Post Selection and Feedback		3, 6, 7, 8, 12

Figure 1. Innovation search phases and innovation intermediary support



Appendix 1 Case Studies

Case Study	'Search' Case Study	By: Innovation Intermediary	Scope	Interview country
1	Online platform I	Innocentive	The website posts innovation needs from clients, such as AstraZeneca, which can be openly accessed by any external organization or individuals interested in offering a solution to the need. Called challenges, they include financial award for the solver.	UK
2	Online platform II	AstraZeneca's own platform	AstraZeneca posts key focus areas for innovation in their own website through which it can receive target proposals from researchers or firms interested in offering a solution or suggestion. Through the website, AstraZeneca also gets requests for technology licensing and new partners for new research using the firm's existing technologies.	UK
3	OSCR	Livework/ Wireless Innovation/ NESTA	In 2009, the competition Orange Service Call and Reward (OSCR) was ran by the National Endowment for Science, Technology and the Arts (NESTA) for the telecom company Orange UK. The project also had the involvement of LiveWork, a service design consultancy, and Wireless Innovation, an incubator of small and medium companies from Scotland. The competition aimed to create long-term business relationships between small firms and Orange around innovative services and business models. The winner was a service called Last Second Tickets, an online and mobile platform specialised in unsold tickets for events.	UK
4	Jam	100%Open	This physical event consists of untargeted activities involving unconnected organizations to find possibilities for creative endeavours. The work method joins a group of people or organizations that could work well together, sharing both their aims and the workload as the relationship develops. As there is not a previous specific innovation needs to be solved, the discussions generate open briefs for partnerships.	UK
5	The Union	100%Open	The Union is an event with the presence of organizations wanting to meet possible partners to innovate. The participants are senior innovation and venturing professionals with the purpose of creating value through contacts. The gatherings include 10 x 5 minute presentations around a theme when members outline their needs or their offers.	UK

			There is also an online community to join the network between meetings because they happen only four times per year.	
6	StarStream	Research and Innovation Services (RIS)	StarStream was a research project that led to an invention that was patented by the university. The researched involved many partners from different industries and funding agencies, such as DSTL, Philips, Ultrawave and Sellafield. The ultrasound technology enhances the ability of water to clean and has the potential to generate savings in water and power use in a range of applications including decontamination.	UK
7	Partners portfolio	RIS	Collaboration managers from RIS frequently attend to several conferences and trade fairs of different industries to get to know possible partners and to introduce the university's innovation possibilities.	UK
8	Force for Elastomers	Secretary for Technological Development (SEDETEC)	Research, which began in 2011 in industrial chemistry, led to an invention that was patented in partnership with a local, family-owned firm (Frenzel). The technology introduces a new inorganic force in the formulation of elastomeric compound used in the manufacture of rubber sealing devices. After the patenting process and use of the technology, the firm and the university formalized another collaborative project to keep researching a related subject.	Brazil
9	Broad partnership strategy	Research and Innovation Department (RID)	Representatives of the university frequently participate in several forums that join public administration and private organizations in the region. As there is not a previous specific innovation needs to be solved, the discussions generate briefs for partnerships.	Norway
10	Demola - InGenious	Research and Innovation Department (RID) and the Center for Entrepreneurship	In 2017, the University of Stavanger ran innovation projects developed locally through the method by Demola from Finland. Innovation projects are performed in co-creation between university students and companies (in 2017 with the firms Kolumbus and Statoil). In 2018, the University of Stavanger replaced Demola for InGenious, a more flexible method in the establishment of contracts therefore facilitating more local partnerships to happen.	Norway
11	Scale-up partnership	Validé	Validé is an organization that combines technology transfer, incubation and investment functions. It searched and recommended a partner in London for the incubated firm Huddlestock, established by	Norway

			students from the University of Stavanger.	
12	Meet the investors	ITSA/Validé	The Ipark Tech Startup Accelerator (ITSA), which is business accelerator program run by Validé, organizes an event where the participant start-ups pitch their products to several investors (Pre-Seed, Angels etc.) invited by Validé. Start-ups and investors also have time for informal talks at the same day.	Norway
13	Innovation Dialogue	Programme for Regional R&D and Innovation VRI (Programme for Regional R&D and Innovation)	The Programme for Regional R&D and Innovation (VRI) organizes various activities to promote cooperation between companies and R&D institutions. One of them is Innovation Dialogue, where firms or industry sectors can ask for a day workshop to present problems they are facing. The workshop runs in a structured way and has participants from industry and from academia. It should be concluded with a document of problems and possible ways to solve them. This document could be the foundation for joint-research projects.	Norway
14	Satellite technology	Centre for Ecology & Hydrology (CEH)	Use of data streaming using radar satellite imagery within satellite technology systems and applications. The articulation and scanning process staged were important because it involved multiple partners from disparate sectors and technologies	UK
15	Applied research partnership	VRI (Programme for Regional R&D and Innovation)	The broker from VRI put the entrepreneur in contact with Sintef, an applied research institute, to test his new product regarding offshore insulation of pipes. The collaboration with Sintef generated credibility for the start-up firm, that later got a partnership with a German manufacturer and with the California Institute of Technology.	Norway