R&D MANAGEMENT

Innovation search: the role of innovation intermediaries in the search process

Jeremy Howells[1,*] and Elisa Thomas[2]

[1]Faculty of Business and Law, University of Portsmouth, Portsmouth, UK. jeremy.howells@port.ac.uk
[2]University of Stavanger Business School, University of Stavanger, Stavanger, Norway. elisa.thomas@uis.no

The aim of this paper is to explore how innovation search is conceptualised, given that firms increasingly use innovation intermediaries. The paper examines the search processes which involves the role of innovation intermediaries in different stages of the innovation search process. The study discovered that innovation search activity is a much more extended and complex process, not being as targeted or as specific than previously conceptualised, and involves a set of search stages, which are associated with a loosely coupled iterative search process. Innovation intermediaries were also discovered to be undertaking new, more extended roles in the search process, through, for example, combining new search procedures with online digital platforms.

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 (Lopez-Vega et al., 2016). However, innovation searching is a difficult and complex activity (McKelvey, 2016), with decreasing and undesirable returns to technological search often occurring, as the set of available combinations is exhausted (Kim and Kogut, 1996; Fleming, 2001). There is, therefore, the potential of 'oversearch' by firms (Laursen and Salter, 2004), which could be both costly and still sub-optimal in outcome. For many firms, especially smaller ones, innovation searches are infrequent. They are, therefore, not part of their normal set of routines and are undertaken in un-systematic way. Thus, although firms still frequently 'go it alone' in the innovation search process, increasingly they seek organisations to support them in this process (Lauritzen, 2017; De Silva et al., 2018). This is because search processes are not only costly and time consuming but also that specialist 'searchers' can provide new and more efficient routines and practices that speed up and enhance the client organisation's search (Natalicchio et al., 2014). One body of organisations increasingly entering this 'innovation search space' market is innovation intermediaries, which could be technology brokers, regional technology centres, technology transfer offices and private innovation agencies (Bessant and Rush, 1995; Thomas et al., 2017). Considering this diversity, it is hard to achieve an encompassing concept of the intermediary. In this article, innovation intermediary is the type of organisation located between the source and the seeker of knowledge and resources needed for innovation. These organisations can help the formation of relationships that combine complementary knowledge and resources from different organisations involved in innovation, providing a range of services for the search and selection of possible partners, covering the whole spectrum of the innovation process from

basic research through to final, 'off the shelf' innovation solutions.

Nevertheless, literature on search processes, specially mediated by a third party or surrogate, has been under-explored in terms of their contribution to different methods and stages of innovation search. Recent literature has raised issues concerning the conceptualisation and the complexity of firm-level search activity. Thus, McKelvey (2016, p. 796) has highlighted 'a high level of abstraction' relating to the various models of the nature and function of what firms do as they search under conditions of uncertainty, seeking to discovery new sources of value, and pointing out the need for more direct empirical studies about the search processes. Lopez-Vega et al. (2016) also stress that empirical research on open innovation intermediaries and their role in search activities are still scarce, whilst Mina et al. (2014) stress the need for an in-depth understanding of how innovation intermediaries operate in these open innovation regimes. This research therefore explores the role of innovation intermediaries in facilitating the innovation search process for their client firms as this is a function that has become increasingly important in the rapidly evolving open innovation environment. Although previous literature has sought to study aspects of this phenomenon particularly in terms of crowdsourcing and its orchestration (Feller et al., 2012; Garcia Martinez, 2015; Lauritzen, 2017; De Silva et al., 2018; Giudici et al., 2018; Piazza et al., 2019; Randhawa et al., 2019), this study seeks to explore and articulate a more developed model and set of search processes involving innovation intermediaries.

This study therefore seeks to answer fundamental questions (Grant and Pollock, 2011) about how innovation search is conceptualised especially now that firms increasingly use innovation intermediaries, and what processes it involves. The first research question which this study seeks to answer is about the conceptualisation of the innovation search model, namely: 'What is the nature of the innovation search process when it involves innovation intermediaries and how should it be conceptualised?' In this context, the study seeks to explore whether firms, and the intermediaries supporting them, have a *de facto* conceptual model or framework by which they conceive of the innovation process. On a more individual level, it also links to what Strike and Rerup (2016) have termed 'mediated sensemaking' by which individuals, or teams of individuals, create a conceptual and sensemaking framework from which to advise clients. Previous studies have tended to treat innovation search as a solitary, dyadic process by a firm or organisation, ignoring or reducing the role of external support and partners in the innovation search process, namely the role of *search surrogacy*. This is important because innovation intermediaries are becoming increasingly involved in the innovation process: and, secondly, where innovation search undertaken by intermediaries has been discussed in the literature, and it has been treated as a simplified manner. Previous studies have suggested a more foreshortened and uni-directional and linear approach to innovation search than in reality. It is argued here that the innovation search process is much more complex, iterative process than previously conceptualised. This study therefore aims to also answer the second key research question: 'What role do intermediaries or surrogates play in different stages and methods of innovation search process?'

The contribution of this research is to provide new insights into two extant bodies of research. Firstly, it provides better conceptualisation of the 'innovation search' model and the stages involved with this process. Secondly, the study seeks to improve our knowledge around a range of new and existing activities in which innovation intermediaries (as a set of processes) are undertaking as part of their wider contribution to firms' innovation search performance.

2. Innovation search and intermediaries: a theoretical overview

There have been several papers focusing on the search process from different perspectives: 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 et al., 2016; Stockstrom et al., 2016); and the influence of absorptive capacity on the search activity (Fabrizio, 2009; Spithoven et al., 2010; Martín-de Castro, 2015; Zobel, 2017). Thus, firms face various options regarding how they search and what they search for externally, and, therefore, search in different ways (Pisano and Verganti, 2008; Garriga et al., 2013). Nambisan and Sawhney's (2007) study focused on search efficiency, and possible declining returns to search, costs and risk, whilst Bengtsson et al. (2015) have stressed that the type of knowledge (exploratory or exploitative) is important in determining the optimum number of partners and the payoff in terms of novelty and efficiency effects. Other studies have also suggested that decreasing returns to technological search may occur, as the set of available combinations is exhausted (Kim and Kogut, 1996; Fleming, 2001), although Laursen and Salter (2004) discovered a more curvilinear effect of innovation search breadth, indicating potential 'oversearch' by firms.

The rise of open, collaborative and distributed innovation, and the models describing them, largely imply firms and organisations 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 organisations to directly interact with their customers, users, suppliers and research collaborators through different ways (West and Bogers, 2014). This was something that in the pre-Internet era often involved high level of resources to cover a limited set of institutions and individuals (Dodgson et al., 2006). These online innovation platforms are sometimes part of a simple 'crowdsourcing' initiatives, but for others, they form a much wider, 'full spectrum' search outreach strategies (Feller et al., 2012; Garcia Martinez, 2015; Piazza et al., 2019; Randhawa et al., 2019). Online platforms as well as direct search for innovation solutions are increasingly operated by innovation intermediaries (Howells, 2006; Lauritzen, 2017; De Silva et al., 2018). These agents support their clients' innovation efforts and decision making and help clients develop new value propositions (Li et al., 2020) and can be seen as providing a surrogate role in this process (Black and Tagg, 2007).

There have been no clear definitions of what innovation search is. In the context of this study, it is defined as: 'Innovation search can be defined as a search activity involving the seeking of an innovation or partner in the innovation process. This may range from a novel idea or new knowledge right through to a final 'off the shelf' solution in the form of a new product, service or process.' In turn, the search process involves a number of sequences or stages, which are outlined below. Even for established firms, the start of the search process can still be chaotic and un-systemised (Takey and Carvalho, 2016). Searches involving raw or unformulated ideas for research inputs with incomplete known outcomes with a high 'novelty' level of the knowledge being searched in the field (Brunswicker and Hutschek, 2010) are more common than often supposed (Nambisan and Sawhney, 2007). Time spent around this stage can save a huge amount of R&D time and energy and lead to improved outcomes (Khurana and Rosenthal, 1997; Koen et al., 2001; Kim and Wilemon, 2002). This pre-formulation and articulation stage is frequently ignored in the literature; the assumption being that firms know what they are actually looking for straight away can also be linked to literature around the wider fuzzy front-end (FFE) of the innovation process (see, for example, Khurana and Rosenthal, 1997; Koen et al., 2001; Kim and Wilemon, 2002; Brunswicker and Hutschek, 2010; Takey and Carvalho, 2016; Schemmann et al., 2016). The study by Spanjol et al. (2011) is an exception to this, as it links market search behaviours for new product ideas with ideation, in turn leading to the production of new product ideas, with intense search activity having a positive influence on ideation volume and novelty. This finding highlights the often 'fuzzy' nature of the fuzzy front-end process both in relation to ideation and generation of design and new product ideas (Appleyard et al., 2020; Dell'Era et al., 2020) and the generation of new search ideas and patterns (linked in turn by programmes connecting both active search and idea capture; Montoya-Weiss and O'Driscoll, 2000).

After this first stage, firms engage in scanning their task environment for competitive advantage. This stage is associated with seeking and collecting information about changes and trends beyond a firm's organisational 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 also more particularly to inform the firm's decision making (Jain, 1984). Haeckel (1999) goes further and suggests it is this non-specific 'peripheral vision' element that is crucial 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 enhances technology foresight by seeking major distinguishing features in the technological landscape' functioning as indicators of evolving technological and economic potentials (Van Wyk, 1997, p. 21). It may also involve considering old 'components', which may be recombined in new ways to provide such innovative solutions (Savino et al., 2017; see also Petruzzelli and Savino, 2014). This is linked to how existing knowledge stocks can facilitate recombination of components and the absorptive capacity of innovation and new solutions (Cohen and Levinthal, 1990; Mokyr, 2002; Arthur, 2007).

A third, closely associated activity, but coming from the other way, is when firms provide 'problem information' to outsiders in order to open the solution space. It is a way of helping firms in their search for new, capable partners. 'Signalling' activity is a way of flagging up a firm's capability in certain areas; the firm wants to cooperate through voluntarily disclosing information (Spence, 2002). Although signalling has been explored in parts of the literature, it has largely been treated separately from the innovation search process (Fontana et al., 2006 in their study raise it but use patents as proxy for this signalling activity in their high-level analysis, p. 317). Thus, in terms of research collaboration, signalling is highlighting

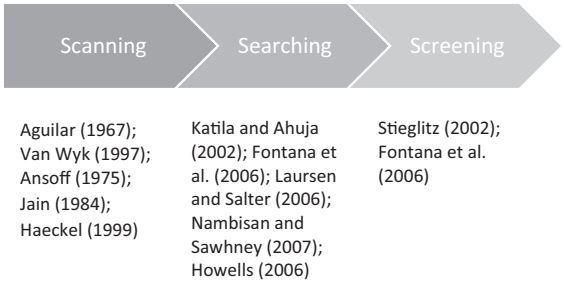

Figure 1. Innovation search phases according to previous literature.

to other firms the scientific and technical capability of the provider firm or university and as a way of enticing capable partners to work on a project with complimentary capabilities (Penin, 2005; Howells et al., 2012). It has been proven successful for highlighting scientific problems, and it provides access to a large variety of new ideas (Lakhani, 2006; Pisano and Verganti, 2008). It often involves online intermediaries that collect dispersed sources of knowledge by extending network access. This is through enhancing network reach in engaging with producers and consumers and through enhancing the richness and quality of contact through bi-directional links (Verona et al., 2006). Thus, intermediaries have entered the online space by structuring knowledge to identify providers who can provide solutions beyond the immediate exigencies of the problem and helps provider selection among many potential matches (Ye et al., 2012; Dong and Pourmohamadi, 2014). In open innovation for a, they can also selectively reveal information as trusted parties (Henkel, 2006; Alexy et al., 2013; Henkel et al., 2014) and therefore help in supporting collaboration innovation in a non-partisan way.

After going through some or all of these initial stages, firms more actively undertake a search process which will involve information searches and personal contacts of the in-house staff. Search is often not about a single partner or solution on a one-to-one basis, but rather involves more complex partner search arrangements, forming both vertical and horizontal relationships in increasingly distributed innovation networks (Howells, 2006). The three key search dimensions have been highlighted: (1) breadth versus depth of search (Laursen and Salter, 2004; Chiang and Hung, 2010; Leiponen and Helfat, 2010; Classen et al., 2012); (2) distant (far) versus local (near) search (Katila and Ahuja, 2002; 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 depends on the accepted risk, costs, speed and expected number of solutions.

Once the searching has been completed, firms need to filter out possible options and to select and make decisions of what is the best solution or innovation. A technology buyer will also need to have sufficient absorptive capacity (Cohen and Levinthal, 1990; Zahra and George, 2002) to be able to understand, evaluate, adapt and implement new external solutions, and this involves the ability *and* willingness to take such actions (Kotlar et al., 2020). As Stieglitz (2002) noted in partner selection, screening involves identifying and selecting the best within the set of possible partners. Screening can also be seen as 'learning by doing' (Arrow, 1971) to improve search routines and screening processes in future, although this is not well covered in the existing literature (McCarthy et al., 2006). Figure 1 illustrates the sequence of search activities performed by firms, according to previous literature covering innovation search stages.

Besides having described search mechanism and search paths, Lopez-Vega et al. (2016) point towards the need for further examination of their use, rate and direction, including models used by innovation intermediaries or third-party platforms. Although some search processes are reported by previous literature, as mentioned above, McKelvey (2016) points to gaps to be addressed in the description of firm search and problem-solving when looking at how firms span the industry and regional and national context for innovation solutions and partners. Our study seeks to enlighten these issues, by conceptualising 'innovation search' and differentiating its processes as well as understanding the role of intermediaries on different stages and methods of innovation search.

3. Research methods

3.1. Methodological framework

In order to answer the research questions 'What is the nature of the innovation search process when it involves innovation intermediaries and how should it be conceptualised?' and 'What role

do intermediaries or surrogates play in different stages and methods of innovation search process?' the research takes a qualitative approach through descriptive multiple case studies that were used to analyse real-life contexts in which the phenomena occurred (Yin, 1994). It enabled a more in-depth understanding of the phenomenon of innovation search and the role of intermediaries in such search processes.

3.2. Data sources

The selection of case studies is regarded as a crucial element in the case study method (Eisenhardt, 1989). Fourteen case studies (Table 1) involved innovation intermediaries from Norway and the United Kingdom (UK) and their clients over the period 2013–2018. The unit of observation for the analysis in terms of the 'case study' was an 'innovation search', defined here as a search activity by an individual, group or organisation seeking to find a partner for an innovation ranging from a novel idea or new knowledge right through to a final 'off the shelf' solution in the form of a new product, service or process. Innovation search is associated with active search mechanisms described above, but can be linked to the growth of more passive forms of search (Wilson, 1997), such as crowdsourcing, whereby the idea or innovation is delivered by the solution provider without the seeker actively undertaking a search process (Dong and Pourmohamadi, 2014; Madrid and Hout, 2019). Innovation search may therefore be highly focused, short term and targeted based on clear, existing strategic objectives and search fields, or it may be a broad based, longer term iterative process (Magistretti et al., 2020) exploring and seeking solutions to, as yet, less well defined or articulated innovation objectives. Using the 'theoretical sampling' technique (Suddaby, 2006), we sought case studies that were *diverse* in nature to achieve maximum variance (Seawright and Gerring, 2008). As such, the set of *collective instrumental* cases provide insights on an issue and is used to refine theory (Stake, 1995).

3.3. Data collection and analysis

Data was collected by the authors with intermediaries and clients to gather a diversity of innovation search cases. The combination of multiple data (from interviews, secondary data and direct observation) was aimed at improving the research validity (Siggelkow, 2007). Twenty-seven people were interviewed covering managers, directors, project leaders and companies' researchers directly involved in innovation activities, especially on the search processes (Table 2). The number of interviews varied according to the case study and it was not predetermined when defining the cases to be studied. The researchers considered it to be sufficient when they fully understood the innovation search and the role of intermediaries in each case. The data collection followed a research protocol, which included an interview guide, developed from previous literature in order to increase reliability of the case study research method. The questions in the interview guide covered intermediaries' activities and firms' activities in search processes. Semi-structured interviews took an average 45 min each, following the interview guide. Whenever authorised by interviewees, the meetings were recorded and transcribed for researchers' consultation.

Another data collection technique was direct observations, which were useful for additional information on the cases (Yin, 1994). Observations took place at intermediaries and clients' places in 10 different situations (such as internal meetings, meetings between intermediaries and clients, and wider networking events). Examples of observation situations are: during the Union, an event run by 100% Open with companies from diverse sectors of the industry wanting to meet possible partners to innovate (case 5); at RIS from the University of Southampton, on meetings between faculty-focused teams with thematic-focused teams, between the Director and the Head of Faculty Support with collaboration managers from different faculties, and direct communication among external partners and faculties' researchers (case 7); at 100%Open headquarters concerning relationships among members of the staff when discussing clients' needs and possible solutions at OSCR case; meetings between the intermediary from the Centre for Entrepreneurship at the University of Stavanger and the students developing co-creation projects with local firms (case 9).

Documents and information about innovation projects were also collected, as of people involved, activities, funds, institutional context, roles and responsibilities in the project, and previous relationships among the firms. Data was then analysed using a directed approach to content analysis technique (Stemler, 2000; Hsieh and Shannon, 2005) to conceptually develop the search model framework. A six-stage search model was therefore developed to explain and illustrate when and how innovation intermediaries intervene in the search process for their clients. To ensure research reliability and validity on the basis of 'intersubjectivity' (Kvale, 1995)

Table 1. Case studies

ID	'Search' case study	Intermediary	Scope	Country
1	Online platform I	InnoCentive	The website posts innovation needs from clients, which can be openly accessed by any external organisation or individuals interested in offering a solution. They include financial award for the solver	UK
2	Online platform II	AstraZeneca's platform	AstraZeneca posts key focus areas for innovation in their own website to attract target proposals from researchers or firms interested in offering a solution. Through the website, AstraZeneca also gets requests for technology licencing and new partners for new research	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	UK
4	Jam	100%Open	This physical event consists of activities involving unconnected organisations to find possibilities for new partnerships. The method joins a group that could work well together, without previous specific innovation needs to be solved	UK
5	The Union	100%Open	The Union is an event with the presence of organisations (senior innovation and venturing professionals) wanting to meet possible partners to innovate. The gatherings include 10 × 5 min presentations when members outline their needs and their offers. There is also an online community to join the network between meetings	UK
6	StarStream	Research and Innovation Services (RIS) – University of Southampton	StarStream was a research project that led to an invention patented by the university. The researched involved many partners from different industries and funding agencies, such as DSTL, Philips, Ultrawave and Sellafield. RIS was responsible for searching for commercial partners and negotiating their partnerships' contracts	UK
7	Research partner search	Research and Innovation Services (RIS) – University of Southampton	Collaboration managers from RIS scan and search different industries to introduce the University's innovation possibilities and to find partners.	UK
8	Broad partnership scan and signalling	Research and Innovation Department (RID) from the University of Stavanger	Representatives of the university frequently participate in several forums that join regional public administration and private organisations. As there are not previous specific innovation needs to be solved, the discussions generate briefs for partnerships	Norway
9	Demola – InGenious	Research and Innovation Department (RID) and the Center for Entrepreneurship	In 2017, the University of Stavanger ran Demola (Finland) program, where the university acts as an intermediary between students and companies for the development of co-creation innovation projects. In 2018, it was replaced by InGenious, a more flexible method in the establishment of contracts facilitating more local partnerships	Norway
10	Scale-up partnership search	Validé	Validé is an organisation that combines technology transfer, incubation and investment functions. It searched and recommended a partner in London for the incubated firm, Huddlestock, established by students from the University of Stavanger	Norway

(Continues)

Table 1. (Continued)

ID	'Search' case study	Intermediary	Scope	Country
11	Partnerships for start-ups	ITSA/Validé	Ipark Tech Startup Accelerator (ITSA), a program run by Validé, organises an event where the participant start-ups pitch their products to several investors (pre-seed and angels) invited by Validé	Norway
12	Innovation Dialogue	VRI (Programme for Regional R&D and Innovation)	VRI organises various activities to promote cooperation between companies, industry sectors and R&D institutions. One of them is a workshop, Innovation Dialogue, run in a structured way. Organisations present innovation problems and the workshop should be concluded with a document of possible ways to solve them. This document could be the foundation for joint-research projects	Norway
13	Articulation, scan and search	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
14	Applied research partnership search	VRI (Programme for Regional R&D and Innovation)	The broker 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, that later got a partnership with a German manufacturer and with the California Institute of Technology	Norway

and to better trust the findings (Eisenhardt, 1989), interviewees' feedbacks were used and relied upon. Follow-up questions were discussed over phone calls and emails to confirm information and to ask specific details when the authors were writing up the research.

4. Findings: intermediaries in innovation search processes

The research explored innovation search practices and strategies with varying levels of support from innovation intermediaries, ranging from being an online platform 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. In addition to the three stages already identified by previous literature (scanning, searching and screening), three other stages were found on the research case studies (Articulation, two ways of Signalling and the Post-Selection/Feedback).

4.1. Search articulation

In the study, it was found that innovation intermediaries spend a lot of time with their clients to help them articulate what they want out of the search process. 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). On Innovation Dialogue (case 12), the articulation was based on the intermediary's earlier learning experiences of where to and who to partner with. Another search articulation happened when RIS (case 6) started being involved in the StarStream project in the early stages of the development process over six years before the project delivered a commercially viable outcome. A Collaboration Manager explained that:

> It is very important, at the initial stage of assessing an invention, to meet the academics and get a thorough understanding of the technology and its applications (…) so we can search for commercial partners.

Indeed, in the case of RID (case 8), a key role of the intermediary was to identify problems and articulate future scenarios to develop a set of innovation strategies and pathways for partnerships with organisations in the region, including industry associations, firms and public sector organisations. As such, this articulation stage helps define the 'search field'.

4.2. Scanning

Scanning activity was found to be more specific and targeted on identifying a particular technology or market condition. When scanning, the intermediary directs its attention to problems and innovation possibilities for the client. At RIS (case 7), the

Table 2. Record of fieldwork

Case	Evidence	Year of data collection	Recorded	Usage of data
1	Interview with senior business development director, email exchanges, secondary data	2016, 2017	No	Gathering data regarding intermediaries using online platforms
2	Interview with director of innovation partnerships and collaboration managers, email exchanges, secondary data	2015–2018	No	Gathering data regarding online platform for innovation search without the use of a third party
3	Interviews with the co-founder of 100%Open, networks manager of 100%Open, project director of Interactive Scotland, founder of the winning proposal, secondary data, email exchanges	2013, 2014	Some	Gathering data regarding an active innovation intermediary in different search stages. Triangulating facts and observations provided by firm informants
4	Interviews with the co-founder of 100%Open, secondary data	2013	Yes	Gathering data regarding an active innovation intermediary when the client-firms do not have specific problem or need
5	Observation, interviews with the co-founder of 100%Open	2013	Yes	Gathering data regarding an active innovation intermediary in community brainstorming without a specific innovation project
6	Interviews with collaboration manager for the Faculties of Humanities, Business and Law, Social and Human Sciences, Physical and Applied Sciences, Research Support Officer, SETsquared Centre Director, Researcher, Technical Specialist from Sellafield, Senior Business Development Manager and former project leader at Philips, director of Ultrawave, secondary data, observations	2013, 2014	Some	Gathering data regarding an active innovation intermediary in technology commercialization processes. Triangulating information with other interviews
7	Interview with collaboration managers from Faculty of Natural and Environmental Sciences & Institute for Life Sciences, Southampton Marine and Maritime Institute	2013	Some	Gathering data regarding an active innovation intermediary searching for partners, without specific innovation projects
8	Interview with innovation director, observation, secondary data	2017, 2018	No	Gathering data regarding a university acting as an active innovation intermediary searching for partners, without specific innovation projects. Triangulating information with other cases
9	Interview with the innovation director, facilitator, email exchanges, secondary data	2017	Yes	Gathering data regarding a university acting as an active innovation intermediary searching for partners, for a specific innovation projects
10	Interviews with the CEO, business development manager, business development employee, secondary data	2017, 2018	Yes	Gathering data regarding an active innovation intermediary searching for partners for a client-firm, with specific innovation projects. Triangulating information with other cases.
11	Interviews with the business development manager, business development employee, secondary data, observation	2017, 2018	Yes	Gathering data regarding an active innovation intermediary putting together actors who are searching for partners specifically around financial needs for innovation. Triangulating information with other cases

(Continues)

Table 2. (Continued)

Case	Evidence	Year of data collection	Recorded	Usage of data
12	Interview with a VRI innovation broker, email exchanges, secondary data	2018	Yes	Gathering data regarding an active innovation intermediary in community brainstorming when the client-firms do not have specific problems or needs
13	Interviews with director of innovation and knowledge exchange, email exchanges and secondary data	2016, 2017	No	Gathering data regarding an active innovation intermediary. Discussion of search function in relation to partners for a client-firm, with specific innovation projects. Triangulating information with other cases
14	Interview with a VRI innovation broker, a professor, email exchanges, secondary data	2018	Yes	Triangulating information with another case regarding an active innovation intermediary searching for partners for a client-firm, for a specific innovation projects

collaboration managers keep track of companies where alumni are working so that the University of Southampton has an easier way to get in contact with those companies. RIS also registers previous supported partnerships and builds a list of companies that narrows down the scope of scanning activity.

As a further example, the intermediary of VRI (case 12) scans for potential new partners to be involved in the cooperative programme. This has resulted on the establishment of a formalised cluster of firms, public agencies and the university. Scanning the environment by intermediaries and their clients was often a precursor for then going out searching and selecting possible partners through comparing and matchmaking complementary assets, such as knowledge, materials and funding.

4.3. Signalling

The case study analysis revealed two related types of signalling activities: broadcast or passive signalling and active or targeted signalling. There were significant differences in terms of the degree of proactivity and specificity of what the firm is signalling.

In b*roadcast or passive signalling* (3A), organisations do not go out actively searching for partners with a problem or issue to be solved. The firm does little more than describing what it does, listing in general terms scientific, technical or market areas it works. 100%Open (case 4) calls it 'Jam' when a client has no specific problem or need. Within this category, there can be activities described as general networking events as, for example, 'The Union' (case 5). The co-founder of 100%Open says that a lot of relationships come from hosting these events. For a number of firms such as AstraZeneca (case 1), online platforms represent a process of wide-ranging 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.

By contrast, *active or targeted signalling* (3B) is a problem-solving approach where firms identify a specific solution, opportunity space or problem they are seeking to resolve or find. This can be on a general online platform, which invites crowdsourced solutions to a problem, such as InnoCentive (case 2). Specifications are outlined in detail as well as desired outcomes, financial rewards and a closing date. OSCR (case 3) was an innovation competition aimed at establishing a long-term relationship 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 service high-tech start-up that could benefit from (and benefit) Orange through collaborating with it.

4.4. Core searching

Here, seeking is about searching for a *partner(s)* that has the *capability* and track record to deliver the innovation output at some stage in future (cases 7, 10, 13 and 14). In the case of raw ideas, the search process often has to be re-set several times and new partners brought in. The *iterative* staged nature of the wider search process was therefore not uncommon (cases 7, 11, 12 and 13). Linked to this, the case studies suggest that rarely do firms seek bi-polar solutions, i.e.

breadth versus depth, or local versus distant. In terms of the case studies (cases 7, 9, 10 and 14), 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 (and where local knowledge remains important; Howells, 2012; Mabey et al., 2015). Thus, on the VRI programme (case 14), when a start-up needed partners to test a prototype, the intermediary brought an applied research institute, Sintef, 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.

Innovation searching does not necessarily lead to identification of a single partner, but often can lead to and involve a *network search*. Thus, in the StarStream project, the search began for a single partner, but resulted with Philips and Ultrawave and then Sellafield Ltd and two further firms (case 6). Even with standard formats and tools, personal contacts of both intermediary and client staff were crucial and often short-circuited more formal procedures. Thus, although search tools and models enabled more objective search processes, the individuals or small teams leading the search still injected subjective elements into the search process, 'hunches', or more especially past experiences in the search process.

4.5. Screening and selecting

This function was exhibited when representatives of the University of Stavanger approached several companies from their personal network and industry fora to present the program Demola in 2017 and inGenious in 2019 (case 9). Two major Norwegian companies (Statoil and Kolumbus) were partners of the programme in 2017 and eight firms in 2019. 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 (Orange) demands. An executive in the intermediary explained:

there were business criteria that we used from our own perspective: *if it was a scalable platform; the business trading history; if the company could cope with working with a big corporation, etc.*

On the next stage of OSCR competition, short-listed proposals got help from the intermediary to improve and tailor their technologies according to the needs of the client and to protect it (case 3). Technical information provided by the candidates to the 'Trusted Agent' was held under a confidentiality agreement and was not disclosed to the client.

4.6. Post-selection and feedback

As in any feedback and 'learning by doing' model, the selection and use of the knowledge or solution will shape further innovation search processes for the organisation. This may be about where to search, how to search (including efficiency practices) and what to search for. Post-selection and feedback stage can also lead to the development of longer-term arrangements once trust, successful relationship building and past successful outcomes have been established. 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. 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 to Philips, initiating another partnership with the company (case 6). ITSA (case 11) 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.

A framework of the results is illustrated at Figure 2, where the three stages previously identified by the literature (scanning, searching and screening) on innovation search are related to the three new stages identified by this research. Each stage is iterative between the client firm and the intermediary. In addition, the Feedback stage generates a new or modified process that can re-start from the Articulation, Scanning or Core Search stages.

The six search stages, their operationalization by innovation intermediaries and a list of cases where each of the stages were identified are summarised in Table 3. In addition, in Table 3, previous literature on existing stages (scanning, searching and screening) was cited and where literature relating to the newly identified stages regarding innovation search was added.

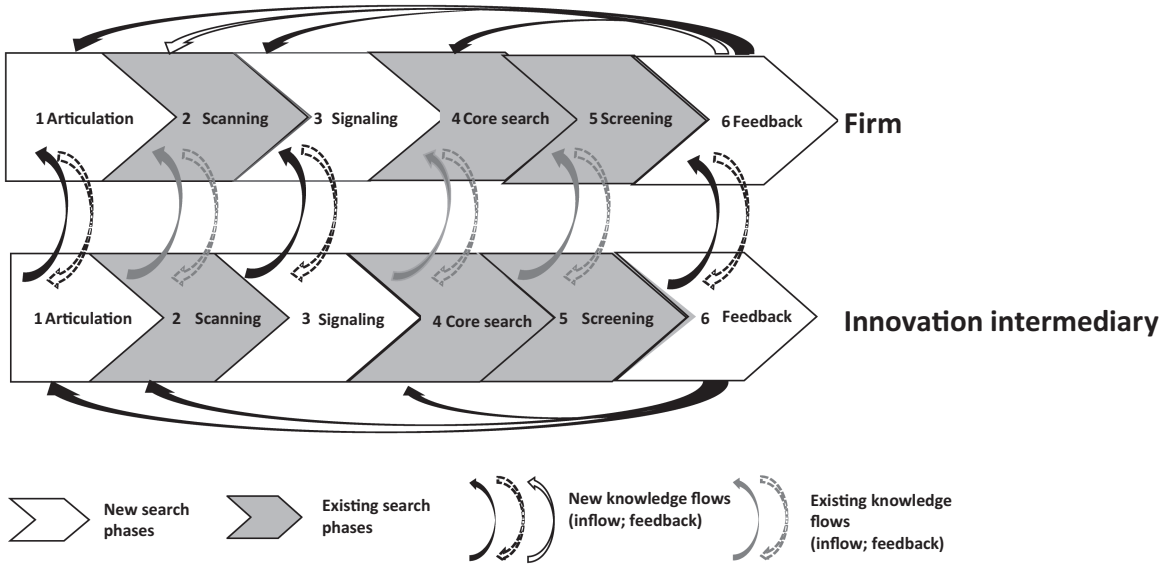

Figure 2. Innovation search phases and innovation intermediary support.

5. Discussion

The research has implications for theory regarding how we conceptualise innovation search in a number of ways. Firstly, *new forms and complexity of the innovation search* process have been observed, with activities emerging around the new innovation search space, especially because of the specialised activity of innovation intermediaries. Thus, intermediaries have been key in developing new forms of search, through, for example, innovation contests and prizes and open innovation facilitation (cases 4 and 5), in addition to those firms that still 'go it alone' (Piazza et al., 2019). Intermediaries have also emerged in other roles associated with the design, implementation and 'after-contest' provision of services to both winners and losers. Among new roles, the study revealed intermediaries as being trusted, third party 'revealers', expanding previous knowledge as noted earlier on how firms 'selectively reveal' information in open innovation (Henkel, 2006; Alexy et al., 2013; Henkel et al., 2014), although in a wider intermediary context such neutrality may be altered by regulatory or institutional changes (De Beer and Clemmer, 2009).

The research has therefore helped to integrate and expand the conceptualisation of innovation search, whose complexity and granularity have often been under-emphasised (as in, for example, the duality approached by breadth versus depth of search (Laursen and Salter, 2004 ; Chiang and Hung, 2010; Leiponen and Helfat, 2010; Classen et al., 2012); distant versus local search (Katila and Ahuja, 2002; Wang, 2015; Lopez-Vega et al., 2016); and search for ideas versus market-ready products (Nambisan and Sawhney, 2007). The case studies indicate that the search process is a much longer process than normally conceived, which tends to foreshorten the actual search activity. Thus, one illustration of the new-found stage in the sequential decision-making search process, which this analysis has highlighted, is the Articulation stage. This takes place at the fuzzy front-end of searching (Khurana and Rosenthal, 1997; Koen et al., 2001; Kim and Wilemon, 2002; Takey and Carvalho, 2016), and organises it to become 'less fuzzy', where the intermediary helps the firms to specify what their innovation window is, their collection of themes and areas the firm wants to explore.

Besides, the case studies show that rarely innovation search involves simple, one-off search activity evident in more traditional, normalised search models (as in Feller et al., 2012; Garcia Martinez, 2015; Piazza et al., 2019). Instead it involves a more dynamic, iterative and loosely coupled feedback search process covering a more extended series of search stages (Figure 2). Thus, the case studies indicate that firms seldom use binary alternatives (e.g. breadth versus depth, as stated by Laursen and Salter, 2004), but rather undertake a more sequential search (breadth followed by depth, distant ones followed by more targeted, localised searches) confirming some of the earlier findings of Garriga et al. (2013). The research has also sought to highlight the iterative nature of the search process, which can also involve recombining 'old' solutions, something that Petruzzelli and Savino (2014) and Savino et al. (2017) have sought to articulate further. The iterative nature of finding the right technological

Table 3. Typology of innovation search and innovation intermediaries' support

Search stage	Description	Literature	Intermediaries' operationalization	Cases where they appear
1. Articulation	Search for themes or areas a firm or organisation 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	Nambisan and Sawhney (2007); Khurana and Rosenthal (1997); Koen et al. (2001); Kim and Wilemon (2002); Brunswicker and Hutschek (2010); Takey and Carvalho (2016)	Participation in several forums with firm and public agencies from the region	2, 6, 8, 9, 12, 13
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	Aguilar (1967); Van Wyk (1997); Ansoff (1975); Jain (1984); Haeckel (1999)	Portfolio of previous partnerships and of firms with former students. Attendance to several conferences and trade fairs of different industries	1, 2, 3, 5, 7, 11, 12, 13
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	Verona et al. (2006); Fontana et al. (2006); Dong and Pourmohamadi (2014); Ye et al. (2012); Spence (2002); Penin (2005)	Crowdsourcing; online platform; untargeted meetings among several organisations seeking innovation	1, 3, 4, 5
	3B. Targeted signalling: Identifying a specific solution, opportunity space or problem. Posing an issue and waiting for organisations coming to them with a solution or partnership idea	Lakhani (2006); Pisano and Verganti (2008)	Online platform; innovation tournaments	2, 3, 4, 5, 11, 12
4. Core Searching	Active search process	Katila and Ahuja (2002); Laursen and Salter (2004); Fontana et al. (2006); Howells (2006); Nambisan and Sawhney (2007)	May include personal contacts. It can be a formal, staged process	6, 7, 9, 10, 11, 12, 13, 14
5. Screening and Selecting	Identifying the best within the set of possible solution providers. It may lead to non-selection	Stieglitz (2002); Fontana et al. (2006)	Comparing and matchmaking complementary assets (as knowledge and funding) and absorptive capacity	3, 6, 9, 11, 14
6. Post Selection and Feedback	After selection and use of the knowledge or solution. Shaping further innovation search processes in regard to where to search, how to search and what to search for	Arrow (1971); McCarthy et al. (2006); Easterby-Smith and Prieto (2008)	Evaluation of positive and negative outcomes from search activities and from relationships	3, 6, 7, 11

applications for firms has also been stressed in a recent review by Magistretti et al. (2020).

Additionally, the research identified a stage after the collaboration has taken place or the technology or knowledge has been negotiated and traded, which is a part of the broad search process. We named it post-selection and feedback stage, where the firms involved in innovation, either the seeker or the solver, evaluate past partnerships and negotiations and decide if the partner, technology or search method are worth repeating. The post-selection and feedback can also combine longer term experiences of once partners have been selected in terms implementation and outcomes arising from the search (Bengtsson et al., 2015).

Secondly, this study of innovation intermediaries in the search process has highlighted the role of search *surrogacy*. The analysis has shown that, using an external expert in the search process is not uncommon in a range of different search environments (see Black and Tagg, 2007). Innovation intermediaries increasingly follow complex search strategies in order to provide the best solution for their clients. Innovation search is often not undertaken by firms alone, but guided and framed by an expert agent, the intermediary, who already has built up considerable prior knowledge, routines and capability in the search process. This role of surrogacy involves complex interactions between the client(s) and the intermediary or surrogate throughout the innovation search chain, although a client may select support for only certain specific parts or stages of the search process. The importance of trust is crucial here as clients are in a state of dependency whilst a solution is found by the surrogate for that stage of the search process or for all of it.

Thus, in the context of the case studies, innovation intermediaries not only searched for potential partners and solutions, but went further by tailoring and supporting the applications and selecting partners (cases 3, 6, 10, 12 and 15). Within the signalling stage, the case study showed that there were two different methods intermediaries used, different from firms signalling their competencies by patenting, as the case of SMEs (Fontana et al., 2006). The first signalling strategy places the intermediary in a role of conducting *passive search* forms, which is linked back to cognitive search research where there is a stress between background (passive) and foreground (active) searching (Wilson, 1997). This involved passive (or broadcast) and more targeted signalling associated with the development of open innovation platforms that have moved from 'go it alone' strategies to ones of 'supported openness' (cases 2, 3, 6, 10, 11 and 13). Passive searching allows more wide-ranging potential options and solutions to 'pop out' to the searcher (Madrid and Hout, 2019).

6. Conclusions

At the start of this paper, it was argued from a theoretical standpoint that innovation search processes have changed with the emergence and growth of innovation intermediaries. The case study analysis sought to explore more of the roles of these third parties or surrogates in this process that have been under-explored in terms of their contribution to different methods and stages of innovation search. This research aimed at answering two issues related to firms' process of searching for partners and solutions: first, to conceptualise the 'innovation search' and differentiate its processes, and, second, to understand the role of intermediaries during the different stages and methods of the innovation search process.

Related to this first question, concerning the nature and conceptualisation of innovation search associated with intermediaries, the research has identified a number of findings. Firstly, it has sought to show that there is a much wider spectrum of search activity by firms or organisations than has been previously acknowledged. Previous research on innovation search has lacked granularity, with search processes not being as targeted or as specific as formerly suggested. Secondly, the research found that search activity was not concentrated in the core search stage, but spread much more widely across several and loosely coupled stages in an iterative process; one which is far from being linear in nature. The study has sought to show these inter-linked and iterative processes and their important feedback loops, which have been acknowledged as key in wider contexts surrounding organisational learning (Akbar et al., 2018). Lastly, it was found that not all search stages may be necessary or complete as part of the search process, although the case studies revealed that these stages were distinct and apparent across the range of cases. Thus, intermediaries may often only be involved in one or two search stages or roles, depending on what and when the research manager within the client organisation requires.

In terms of the second question, innovation intermediaries have been shown more widely to play an important role across the innovation search process having built up considerable search experience through the surrogacy process. Intermediaries involved in these search activities build upon prior search strategies that have been honed over a set of previous client relationships (De Silva et al., 2018). For many research managers in firms, especially

small- and medium-sized enterprises (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. Intermediary's aggregate and can 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 organisations. Intermediaries also became involved in mediation and conflict resolution in collaborations post-selection (see also Lauritzen, 2017). However, using surrogates and 'going it alone' in the innovation search process should not been be seen as mutually exclusive activity (as evident in other surrogacy activities; see Ford et al., 2001 in relation to information search or Franklin et al., 2001 in terms of entrepreneurship), with firms often taking a blended approach to search activity.

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'* (non-targeted search). Online platforms and crowdsourcing have therefore allowed in one way a much less deep *a priori* concept of what is being sought. Is simply informing other organisations that one is open to novel and innovative suggestions and then making ex post decisions about them really a search process? Incorporating signalling and passive broadcast search or netting into our wider conceptualisation of the innovation search process is important in developing our understanding of how firms and intermediaries are undertaking innovation search, but also highlights of how we conceptualise innovation search.

Equally, more research needs to be undertaken in terms of search behaviours and who is doing the searching within organisations. Thus, although key factors such as costs, resource and time availability are important in influencing the search process, actual search *behaviours* by individuals, teams and organisations appear much less rational in their predicted outcomes. Although this research has highlighted the role of intermediaries, few studies have considered the size, membership and character of those making searches and choices (see, for example, Pellegrini and Lazzarotti, 2019). This links, in turn, with search and the *decision-making* underlying it and the iterative way that search is coupled with decision-making (Moat et al., 2016). Such work also confirms the move away from assumptions of simple, single search processes (paralleling critiques of 'one shot' versus sequential decision-making; Jeffrey, 1965, 1974).

Increasingly, open innovation strategies involve both complex partner relationships, but also ones which can involve disparate types of actors and roles within such links. 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 is important to understand to what extent the intermediary acts as a *system coordinator* of collaborative projects apart from just searching for partners. The case study work in this paper therefore highlights a newer, more significant role for boundary spanning organisations, such as innovation intermediaries.

Acknowledgements

Thanks go to the financial support of Santander Bank plc, the Brazilian National Council for the Improvement of Higher Education (CAPES) and Kellogg College, University of Oxford. The authors would also like to thank all the useful comments and feedback from seminar and conference presentations, including from the 2019 British Academy of Management Conference held at Aston University.

Data availability statement

The authors are happy to share data from the case study survey the analysis is based upon, in line with the policy of our research funders, and will be lodged with the UK ESRC Data Archive at the University of Essex.

REFERENCES

Aguilar, F.J. (1967) *Scanning the Business Environment*. New York: Macmillan.

Akbar, H., Baruch, Y., and Tzokas, N. (2018) Feedback loops as dynamic processes of organizational knowledge creation in the context of the innovations' front-end. *British Journal of Management*, **29**, 445–463.

Alexy, O., George, G., and Salter, A.J. (2013) Cui bono? The selective revealing of knowledge and its implications for innovative activity. *Academy of Management Review*, **38**, 270–291.

Ansoff, H.I. (1975) Managing strategic surprise by response to weak signals. *California Management Review*, **18**, 21–33.

Appleyard, M.M., Enders, A.H., and Velazquez, H. (2020) Regaining R&D leadership: the role of design thinking and creative forbearance. *California Management Review*, **62**(2), 12–29.

Arrow, K.J. (1971) The economic implications of learning by doing. In: *Readings in the theory of growth*. London: Palgrave Macmillan, pp. 131–149.

Arthur, B. (2007) The structure of invention. *Research Policy*, **36**, 274–287.

Bengtsson, L., Lakemond, N., Lazzarotti, V., Manzini, R., Pellegrini, L., and Tell, F. (2015) Open to a select few? Matching partners and knowledge content for open innovation performance. *Creativity and Innovation Management*, **24**, 72–86.

Bessant, J. and Rush, H. (1995) Building bridges for innovation: the role of consultants in technology transfer. *Research Policy*, **24**(1), 97–114.

Black, I. and Tagg, S. (2007) A grounded theory of doctors' information search behaviour. Implications for information provision, pharmaceutical market entry and development. *Journal of Marketing Management*, **23**, 347–366.

Brunswicker, S. and Hutschek, U. (2010) Crossing horizons: leveraging cross-industry innovation search in the front-end of the innovation process. *International Journal of Innovation Management*, **14**, 683–702.

Chiang, Y.H. and Hung, K.P. (2010) Exploring open search strategies and perceived innovation performance from the perspective of inter-organizational knowledge flows. *R&D Management*, **40**, 292–299.

Classen, N., Van Gils, A., Bammens, Y., and Carree, M. (2012) Accessing resources from innovation partners: the search breadth of family SMEs. *Journal of Small Business Management*, **50**, 191–215.

Cohen, W.M. and Levinthal, D.A. (1990) Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly*, **35**, 128–152.

De Beer, J. and Clemmer, C.D. (2009) Global trends in online copyright enforcement: a non-neutral role for network intermediaries? *Jurimetrics*, **49**, 375–409.

De Silva, M., Howells, J., and Meyer, M. (2018) Innovation intermediaries and collaboration: knowledge–based practices and internal value creation. *Research Policy*, **47**, 70–87.

Dell'Era, C., Magistretti, S., Cautela, C., Verganti, R., and Zurlo, F. (2020) Four kinds of design thinking: from ideating to making, engaging and criticizing. *Creativity and Innovation Management*, **29**, 324–344.

Dodgson, M., Gann, D., and Salter, A. (2006) The role of technology in the shift towards open innovation: the case of Procter & Gamble. *R&D Management*, **36**, 333–346.

Dong, A. and Pourmohamadi, M. (2014) Knowledge matching in the technology outsourcing context of online innovation intermediaries. *Technology Analysis & Strategic Management*, **26**, 655–668.

Easterby-Smith, M., and Prieto, I.M. (2008) Dynamic capabilities and knowledge management: an integrative role for learning? *British Journal of Management*, **19**, 235–249.

Eisenhardt, K.M. (1989) Building theories from case study research. *Academy of Management Review*, **14**, 532–550.

Fabrizio, K.R. (2009) Absorptive capacity and the search for innovation. *Research Policy*, **38**, 255–267.

Felin, T. and Zenger, T.R. (2014) Closed or open innovation? Problem solving and the governance choice. *Research Policy*, **43**, 914–925.

Feller, J., Finnegan, P., Hayes, J., and O'Reilly, P. (2012) Orchestrating 'sustainable crowdsourcing: a characterisation of solver brokerages. *The Journal of Strategic Information Systems*, **21**, 216–232.

Fleming, L. (2001) Recombinant uncertainty in technological search. *Management Science*, **47**, 117–132.

Fleming, L. and Sorenson, O. (2004) Science as a map in technological search. *Strategic Management Journal*, **25**, 909–928.

Fontana, R., Geuna, A., and Matt, M. (2006) Factors affecting university-industry R&D projects: the importance of searching, screening and signalling. *Research Policy*, **35**, 309–323.

Ford, N., Wilson, T.D., Foster, A., Ellis, D., and Spink, A. (2001) Information seeking and mediated searching. *Journal of the American Society for Information Science and Technology*, **53**, 728–735.

Franklin, S.J., Wright, M., and Lockett, A. (2001) Academic and surrogate entrepreneurs in university spin-out companies. *The Journal of Technology Transfer*, **26**, 127–141.

Garcia Martinez, M. (2015) Solver engagement in knowledge sharing in crowdsourcing communities: exploring the link to creativity. *Research Policy*, **44**, 1419–1430.

Garriga, H., Von Krogh, G., and Spaeth, S. (2013) How constraints and knowledge impact open innovation. *Strategic Management Journal*, **34**, 1134–1144.

Giudici, A., Reinmoeller, P., and Ravasi, A. (2018) Open-system orchestration as a relational source of sensing capabilities: evidence from a venture association. *Academy of Management Journal*, **61**, 1369–1402.

Grant, A.M. and Pollock, T.G. (2011) From the editors: Publishing in AMJ – Part 3: setting the hook. *Academy of Management Journal*, **54**, 873–879.

Haeckel, S.H. (1999) *Adaptive Enterprise: Creating and Leading Sense-and-Respond Organizations*. Harvard, MA: Harvard Business Press.

Henkel, J. (2006) Selective revealing in open innovation processes: the case of embedded Linux. *Research Policy*, **35**, 953–969.

Henkel, J., Schöberl, S., and Alexy, O. (2014) The emergence of openness: how and why firms adopt selective revealing in open innovation. *Research Policy*, **43**, 879–890.

Howells, J. (2006) Intermediation and the role of intermediaries in innovation. *Research Policy*, **35**, 715–728.

Howells, J. (2012) The geography of knowledge: never so close but never so far apart. *Journal of Economic Geography*, **12**, 1003–1020.

Howells, J., Ramlogan, R., and Chong, S.L. (2012) Innovation and university collaboration: paradox and complexity within the knowledge economy. *Cambridge Journal of Economics*, **36**, 703–721.

Hsieh, H.F. and Shannon, S.E. (2005) Three approaches to qualitative content analysis. *Qualitative Health Research*, **15**, 1277–1288.

Jain, S.C. (1984) Environmental scanning in US corporations. *Long Range Planning*, **17**, 117–128.
Jeffrey, R.C. (1965) *The Logic of Decision*. New York: McGraw Hill.
Jeffrey, R.C. (1974) Preferences among preferences. *The Journal of Philosophy*, **71**, 377–391.
Katila, R. and Ahuja, G. (2002) Something old, something new: a longitudinal study of search behavior and new product introduction. *Academy Management Journal*, **45**, 1183–1194.
Khurana, A. and Rosenthal, S.R. (1997) Integrating the fuzzy front end of new product development. *IEEE Engineering Management Review*, **25**, 35–49.
Kim, D.J. and Kogut, B. (1996) Technological platforms and diversification. *Organization Science*, **7**, 283–301.
Kim, J. and Wilemon, D. (2002) Focusing the fuzzy front–end in new product development. *R&D Management*, **32**, 269–279.
Koen, P., Ajamian, G., Burkart, R., Clamen, A., Davidson, J., D'Amore, R., and Johnson, A. (2001) Providing clarity and a common language to the "fuzzy front end". *Research-Technology Management*, **44**, 46–55.
Kotlar, J., De Massis, A., Frattini, F., and Kammerlander, N. (2020) Motivation gaps and implementation traps: the paradoxical and time-varying effects of family ownership on firm absorptive capacity. *Journal of Product Innovation Management*, **37**, 2–25.
Kvale, S. (1995) The social construction of validity. *Qualitative Inquiry*, **1**, 19–40.
Lakhani, K.R. (2006) Broadcast search in problem solving: attracting solutions from the periphery. In: *Technology Management for the Global Future. PICMET 2006*, Vol. 6, pp. 2450–2468.
Lauritzen, G.D. (2017) The role of innovation intermediaries in the firm-innovation community collaboration: navigating the membership paradox. *Journal of Product Innovation Management*, **34**, 289–314.
Laursen, K. and Salter, A. (2004) Searching low and high: what types of firms use universities as a source of innovation? *Research Policy*, **33**, 1201–1215.
Leiponen, A. and Helfat, C.E. (2010) Innovation objectives, knowledge sources, and the benefits of breadth. *Strategic Management Journal*, **31**, 224–236.
Li, X., Gagliardi, D., and Miles, I. (2020) Variety in the innovation process of UK research and development service firms. *R&D Management*, **50**, 173–187.
Lopez-Vega, H., Tell, F., and Vanhaverbeke, W. (2016) Where and how to search? Search paths in open innovation. *Research Policy*, **45**, 125–136.
Mabey, C., Wong, A.L., and Hsieh, L. (2015) Knowledge exchange in networked organizations: Does place matter? *R&D Management*, **45**, 487–500.
Madrid, J. and Hout, M.C. (2019) Examining the effects of passive and active strategies on behaviour during hybrid visual memory search: evidence from eye tracking. *Cognitive Research: Principles and Implications*, **4**, 39.
Magistretti, S., Dell'Era, C., and Verganti, R. (2020) Searching for the right application: a technology development review and research agenda. *Technological Forecasting and Social Change*, **151**, 119879. https://doi.org/10.1016/j.techfore.2019.119879.
Martín-de Castro, G. (2015) Knowledge management and innovation in knowledge-based and high-tech industrial markets: The role of openness and absorptive capacity. *Industrial Marketing Management*, **47**, 143–146.
McCarthy, I.P., Tsinopoulos, C., Allen, P., and Anderssen, C.R. (2006) New product development as a complex adaptive system of decisions. *Journal of Product Innovation Management*, **23**, 437–456.
McKelvey, M. (2016) Firms navigating through innovation spaces: a conceptualisation of how firms search and perceive technological, market and productive opportunities globally. *Journal of Evolutionary Economics*, **26**, 785–802.
Mina, A., Bascavusoglu-Moreau, E., and Hughes, A. (2014) Open service innovation and the firm's search for external knowledge. *Research Policy*, **43**, 853–866.
Moat, H.S., Olivola, C.Y., Chater, N., and Preis, T. (2016) Searching choices: quantifying decision-making processes using search engine data. *Topics in Cognitive Science*, **8**, 683–696.
Mokyr, J. (2002) *The Gifts of Athena: Historical Origins of the Knowledge Economy*. Princeton, NJ: Princeton University Press.
Montoya-Weiss, M.M. and O'Driscoll, T.M. (2000) From experience: applying performance support technology in the fuzzy front end. *Journal of Product Innovation Management*, **17**, 143–161.
Nambisan, S. and Sawhney, M. (2007) A buyer's guide to the innovation bazaar. *Harvard Business Review*, **85**, 109–118.
Natalicchio, A., Petruzzelli, A.M., and Garavelli, A.C. (2014) A literature review on markets for ideas: emerging characteristics and unanswered questions. *Technovation*, **34**, 65–76.
Pellegrini, L. and Lazzarotti, V. (2019) How governance mechanisms in family firms impact open innovation choices: a fuzzy logic approach. *Creativity and Innovation Management*, **28**, 486–500.
Penin, J. (2005) Patents versus ex post rewards: A new look. *Research Policy*, **34**, 641–656.
Petruzzelli, P.M. and Savino, T. (2014) Search, recombination, and innovation: lessons from haute cuisine. *Long Range Planning*, **47**, 224–238.
Piazza, M., Mazzola, E., Acur, N., and Perrone, G. (2019) Governance considerations for seeker–solver relationships: a knowledge-based perspective in crowdsourcing for innovation contests. *British Journal of Management*, **30**, 810–828.
Pisano, G.P. and Verganti, R. (2008) Which kind of collaboration is right for you? The new leaders in innovation will be those who figure out the best way to leverage a network of outsiders. *Harvard Business Review*, **86**, 78–86.
Randhawa, K., Wilden, R., and West, J. (2019) Crowdsourcing without profit: the role of the seeker in open social innovation. *R&D Management*, **49**, 298–317.
Savino, T., Messeni Petruzzelli, A., and Albino, V. (2017) Search and recombination process to innovate: a review of the empirical evidence and a research agenda.

International Journal of Management Reviews, **19**, 54–75.

Schemmann, B., Herrmann, A.M., Chappin, M.M., and Heimeriks, G.J. (2016) Crowdsourcing ideas: involving ordinary users in the ideation phase of new product development. *Research Policy*, **45**, 1145–1154.

Seawright, J. and Gerring, J. (2008) Case selection techniques in case study research: a menu of qualitative and quantitative options. *Political Research Quarterly*, **61**, 294–308.

Siggelkow, N. (2007) Persuasion with case studies. *Academy of Management Journal*, **50**, 20–24.

Spanjol, J., Tam, L., Qualls, W.J., and Bohlmann, J.D. (2011) New product team decision making: regulatory focus effects on number, type, and timing decisions. *Journal of Product Innovation Management*, **28**, 623–640.

Spence, M. (2002) Signaling in retrospect and the informational structure of markets. *American Economic Review*, **92**, 434–459.

Spithoven, A., Clarysse, B., and Knockaert, M. (2010) Building absorptive capacity to organise inbound open innovation in traditional industries. *Technovation*, **30**, 130–141.

Stake, R.E. (1995) *The Art of Case Study Research*. Thousand Oaks, CA: Sage.

Stemler, S. (2000) An overview of content analysis. *Practical Assessment, Research, and Evaluation*, **7**, 17.

Stieglitz, N. (2002) Industry dynamics and types of market convergence. Proceedings of. *DRUID summer conference on industrial dynamics of the new and old economy: Who is embracing whom?* Copenhagen, Denmark. 6–8 June.

Stockstrom, C.S., Goduscheit, R.C., Lüthje, C., and Jørgensen, J.H. (2016) Identifying valuable users as informants for innovation processes: comparing the search efficiency of pyramiding and screening. *Research Policy*, **45**, 507–516.

Strike, V.M. and Rerup, C. (2016) Mediated sensemaking. *Academy of Management Journal*, **59**, 880–905.

Suddaby, R. (2006) From the editors: what grounded theory is not. *Academy of Management Journal.*, **49**, 4.

Takey, S.M. and Carvalho, M.M. (2016) Fuzzy front end of systemic innovations: a conceptual framework based on a systematic literature review. *Technological Forecasting & Social Change*, **111**, 97–109.

Thomas, E., Vieira, L.M., and Balestrin, A. (2017) Mind the gap: lessons from the UK to Brazil about the roles of TTOs throughout collaborative R&D projects. *BAR-Brazilian Administration Review*, **14**, 4.

Van Wyk, R.J. (1997) Strategic technology scanning. *Technological Forecasting and Social Change*, **55**, 21–38.

Verona, G., Prandelli, E., and Sawhney, M. (2006) Innovation and virtual environments: towards virtual knowledge brokers. *Organization Studies*, **27**, 755–788.

Wang, C. (2015) Geography of knowledge sourcing, search breadth and depth patterns, and innovative performance: a firm heterogeneity perspective. *Environment and Planning A*, **47**, 744–761.

West, J. and Bogers, M. (2014) Leveraging external sources of innovation: a review of research on open innovation. *Journal of Product Innovation Management*, **31**, 814–831.

Wilson, T.D. (1997) Information behaviour: an interdisciplinary perspective. *Information Processing & Management*, **33**, 551–572.

Ye, H., Kankanhalli, A., and Yang, Z. (2012) Knowledge brokering for open innovation: a case study of innovation intermediaries. In: *Proceedings of the 33rd International Conference on Information Systems*. Orlando, United States. 16–19 December.

Yin, R. (1994) *Case Study Research: Design and Methods*. Beverly Hills, CA: Sage.

Zahra, S.A. and George, G. (2002) Absorptive capacity: a review, reconceptualization, and extension. *Academy of Management Review*, **27**, 185–203.

Zobel, A.-K. (2017) Benefiting from open innovation: a multidimensional model of absorptive capacity. *Journal of Product Innovation Management*, **34**, 269–288.

Professor Jeremy Howells is Executive Dean of the Faculty of Business and Law at the University of Portsmouth and Professor of Innovation. His research focuses on innovation and research and development (R&D) management, knowledge exchange and the role of innovation intermediaries in national and regional innovation systems.

Dr Elisa Thomas is an Associate Professor at Nord University Business School and an Adjunct Associate Professor at the University of Stavanger Business School, Norway. Her research focuses on innovation intermediaries, innovation and entrepreneurship ecosystems, and the role of universities to foster innovation and entrepreneurship.

