External knowledge search paths in open innovation processes of small and medium enterprises

External knowledge search paths in open innovation processes of small and medium enterprises

By:

Preecha Chaochotechuang Institute for Knowledge and Innovation, Southeast Asia (IKI-SEA), Bangkok University, Bangkok, Thailand

Farhad Daneshgar College of Engineering and Science, Victoria University, Sydney, Australia,

Stefania Mariano School of Business Administration, American University of Sharjah, Sharjah, United Arab Emirates

Abstract

Purpose -- This paper aims to advance knowledge about how small and medium enterprises (SMEs) search for external knowledge in their open innovation processes.

Design/methodology/approach – The research approach is a qualitative multiple case study design. The study is built on a literature review of open innovation in small and medium enterprises (SMEs) and external knowledge search. The empirical study is based on semi-structured interviews with eight SMEs.

Findings -- This study revealed that SMEs adopted a combination of cognitive and experiential search heuristics where cognitive search was practiced during the innovation research process when searching for external knowledge, whilst experiential search was practiced during the innovation development process. Concerning the search space, this study found that SMEs mainly explored local knowledge, and occasionally pursued distant knowledge when confronted with complex problems. The reason for the above behaviour was explained to be related to the reduction of costs and risks associated with innovation activities.

Originality/value – External knowledge plays a pivotal role in open innovation. Although extant studies have shed some light on how large firms search for external knowledge, however, it is not clear how SMEs search for external knowledge. Moreover, this study focuses on both the search space and the search heuristics at both the research and the development stages of the innovation process.

Keywords -- Organisational knowledge, external knowledge, open innovation, cognitive search, experiential search, SMEs

Type – Research paper

1. Introduction

External knowledge is knowledge that is located outside an organisation's boundaries (Ferreras-Mendez et al., 2015: 86). A key component for the success of open innovation is the management of external knowledge (Ferreras-Mendez et al., 2015; Martini et al., 2015; Lee et al., 2016). External knowledge plays a key role in reducing the costs of research and development (R&D) activities as well as in spreading the risks associated with innovation development activities (Laursen, 2012; Leiponen, 2012). Prior research on external knowledge points out the role of search in open innovation processes of large high-tech organisations such as biotech, telecom, electronics, software and pharma (Chesbrough and Crowther, 2006; Gassman et al., 2010; Saguy and Sirotinskaya, 2014). A large stream of literature also investigates this role in more mature and traditional industries including organisations dedicated to the production of fast-moving consumer goods, machinery, architecture, turbines, logistics, and medical tools (Chesbrough and Crowther, 2006; Gassmann et al., 2010; Saguy and Sirotinskaya, 2014). These traditional and mature industries face numerous challenges including fast changing consumer demand, the competitive time-to-market race, shortened product life cycles, cluttered retail shelf space, retailers' private bands (Bellairs, 2010) and increasing difficulty in meeting the requirements of key stakeholders including suppliers, legislators, and customers (Sarkar and Costa, 2008). These challenges are often addressed by adopting open innovation (Saguy and Sirotinskaya, 2014), although some of these industries are going through transition phases in which they have just more recently started opening up their innovation processes (Pellegrini et al, 2014). Similar to larger organisations, SMEs would also benefit from the adoption of open innovation processes, especially due to increasing competition on the one side, and increasing demand of customers on the other side.

Although relevant, current research has however largely understudied open innovation processes in SMEs (Lee et al., 2010; Pellegrini et al., 2014). Understanding how SMEs search for external knowledge in their open innovation processes is relevant for several reasons. First, research has pointed out how the use of networks as preferred sources of external knowledge for SMEs is a complex and multi-faced issues that significantly differ from larger organisations (Brunswicker and Vanhaverbeke, 2015). SMEs often rely on personal and professional ties to create innovation (Ceci and Iubatti, 2012) and it is not possible to adopt findings from research on larger organisations to the SMEs domain (Colombo et al., 2012). Second, understanding both search space and search

heuristics practiced by SMEs becomes crucial since external knowledge is important for SMEs performance levels (Chesbrough et al., 2014; Brunswicker and Vanhaverbeke, 2015). However, the search for such a knowledge is difficult and complex (Martini et al., 2015). Existing literature on search mainly focuses on search space, with little attention being paid to search heuristics (Garriga et al., 2013; Felin and Zenger, 2014: Piezunka and Dahlander, 2015). A better understanding of both search space and search heuristic processes can potentially increase the search performance of SMEs who play a growing role in innovation (Chesbrough et al., 2006). By focusing on both search space and search heuristics, the current study provides a means to those SMEs seeking external knowledge to support their innovation processes. More specifically, the current study attempts to provide answer to the following research question: How do SMEs search for external knowledge during their open innovation processes?

To answer the above research question, we adopted a qualitative case research methodology using multiple case study organisations as the context for both data collection and analysis. Findings revealed that SMEs adopted a combination of cognitive and experiential search heuristics where cognitive search was practiced during the innovation research process, whilst experiential search was practiced during the innovation development process. This allowed SMEs to reduce costs and mitigate risks associated with innovation activities. With regards to the search space, this study found that SMEs mainly explored local knowledge, or knowledge in the vicinity of current knowledge base (Lopez-Vega et al., 2016: 126), and occasionally pursued distant knowledge, or knowledge that is unrelated to an organisation's current knowledge base (Lopez-Vega et al., 2016: 126) when confronted with complex problems.

The paper is structured as follows. A review of relevant literature is conducted in order to synthesise a theoretical framework to guide our data collection and analysis. The research methodology of the study is discussed next, followed by a description of the eight case study organisations. The following section reports empirical findings, followed by analysis and discussions of these findings. The paper concludes with a discussion on the contribution of the study and future research directions.

Background literature and theoretical lens

This section discusses the two streams of literature relevant to this study, namely open innovation in SMEs and external knowledge search, and presents the theoretical lens used to analyse collected data.

Open innovation in SMEs

Innovation is prevalent in several sectors including biotech, telecom, electronics, fast moving consumer goods, machinery and medical tools (Chesbrough and Crowther, 2006; Gassmann et al., 2010; Saguy and Sirotinskaya, 2014). Innovation is crucial to organisations' competitiveness and survival (Padilla-Melendez et al., 2015; De Massis et al., 2016; Vanhaverbeke, 2017); market performance (Lee et al., 2016); and growth and long-term success (Kammerlander et al., 2015). For organisations, the need for innovation is driven by rising e-commerce initiatives and globalised competition, increasingly demanding regulations, potentially disrupting technologies, emerging business models, rising customer demands, greater product diversity, and increasingly changing and challenging environments (Crossan and Apaydin, 2010; Vanhaverbeke, 2017).

SMEs are key actors in innovation (Maula et al., 2006; Brunswicker and Vanhaverbeke, 2015) and major forces in the development of the world's economy (Renton et al., 2015). Compared to larger organisations, SMEs face certain disadvantages in managing innovation. SMEs normally do not have sufficient complementary resources such as marketing competence, manufacturing capabilities, financial resources, and distribution network (Colombo et al., 2012; Sag et al., 2016). Additionally, SMEs possess fewer human resources at their disposal to search for useful knowledge in the external environment, the latter being a key factor in the development of innovative products (Dahlander and Gann, 2010; Chesbrough, 2011). However, SMEs do have some advantages in managing innovation, such as, flexibility, adaptability, motivation, proximity to the markets, and entrepreneurial orientation (Hewitt-Dundas, 2006; Madrid-Guijarro et al., 2009) that favour open innovation processes.

Open innovation is "a distributed innovation process based on purposively managed knowledge flows across organisational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organisation's business model" (West et al., 2014: 806). Open innovation consists of two categories, namely, 'inbound' and 'outbound' open innovation (Parida et al., 2012; Sisodiya et al., 2013). Inbound open innovation involves acquiring knowledge from external parties such as customers, suppliers, universities, and other

organisations for the development of innovation, whilst outbound open innovation involves commercialising firm's knowledge or technological capabilities to external parties such as that practiced by Roche and Sygnis Pharma drug companies (Sisodiya et al., 2013; Michelino et al., 2014). This paper focuses on inbound open innovation in SMEs.

Open innovation enables organisations to achieve better innovation outcome (Chesbrough, 2012), and is also linked to organisational sustainability (Lopes et al., 2017) and to new business development (Vanhaverbeke et al., 2017). However, much of the research on open innovation is aimed at the management of large high-tech organisations where the concept of open innovation was first initiated (Lee et al., 2010; Brunswicker and Vanhaverbeke, 2015).

More recently, the attention to open innovation in SMEs has increased. SMEs face certain challenges in adopting open innovation related to absorptive capacity (Brunswicker and Vanhaverbeke, 2015), R&D capability, small size, and resources constraints (Gassmann et al., 2010). SMEs manage and organise open innovation differently from large organisations, and those lessons drawn from the studies on large organisations cannot be easily transferred to SMEs (Vanhaverbeke et al., 2017; Usman et al., 2018). Whilst large organisations are looking for measurable benefits when switching from closed to open innovation, SMEs are driven by their desire to capture new business opportunities and increase profitability (Vanhaverbeke et al., 2017). The scarcity of human and financial resources necessary for innovation activities forces SMEs to seek external resources and knowledge through the management of a network of innovation partners (Vanhaverbeke et al., 2017). Network-level resources contribute more to firms' innovation performance than do firm-level resources (Demirkan, 2018). SMEs with strong network collaboration are found to be more innovative than those with weak network collaboration (Makimattila et al., 2015; Reidolf, 2016).

Some researchers argue that there is a strong relationship between external knowledge sourcing and product innovation performance (e.g. Garriga et al., 2013; Brunswicker and Vanhaverbeke, 2015; Lee et al., 2016). Other researchers (e.g., Lasagni, 2012) argue that the use of external relationships is positively related to innovation performance because through these relationships organisations can have easier access to new ideas, and can manage the transfer of knowledge from external research units. SMEs can also improve their innovation performance by searching for knowledge from their

customers, and maintaining absorptive capacity through in-house innovation activities (Radicic and Pugh, 2017).

Organisations engaged in open innovation need to continuously scan the external environment in search of new information, knowledge, technologies, and ideas (Sag et al., 2016; Lee et al., 2016). In the context of SMEs, technology scanning is found to be more important for incremental innovation, whilst technology sourcing is more important for radical innovation (Parida et al., 2012). Furthermore, SMEs rely on the commitment and cooperation between organisational members, and provide the most conducive environment for innovation that are not necessarily sustained by the know-how and resources characteristic of large organisations (Sahut and Peris-Ortiz, 2014).

External knowledge search

In inbound open innovation, how organisations manage their search for external knowledge and ideas is important to the success of their innovation and market performance (Ferreras-Mendez et al., 2015; Lee et al., 2016). Organisations mainly conduct local search for external knowledge (Laursen, 2012), and innovation is often the outcome of local search (Corradini and De Propris, 2017). Local search in this context refers to the vicinity of the firm's current knowledge base (Lopez-Vega et al., 2016: 126). However, recent literature argues that a firm's competitive advantage is dependent on its ability to go beyond local search to acquire external knowledge (Cross et al., 2015; Cammarano et al., 2017). The relationship between search depth and innovation performance is mediated by the firm's absorptive capacity (Ferreras-Mendez et al., 2015; Mariano and Al-Arrayed, 2018). Absorptive capacity is "the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal, 1990: 128). The combination of absorptive capacity enhancing innovation inputs including technology, human capital development and R&D is vital for improving technical efficiency in manufacturing companies (Barasa et al., 2019).

Theoretical lens

The theoretical lens for this study adopts the view of open innovation that combines search space and search heuristics as per the study of Lopez-Vega et al. (2016) on knowledge

search. This study combines two knowledge search dimensions, namely *search space* (Levinthal and March, 1993; Knudsen and Srikanth, 2014) and *search heuristics* (Nickerson and Zenger, 2004; Gavetti, 2012; Grandori, 2013) and identifies four search types including *situated paths, analogical paths, sophisticated paths,* and *scientific paths* as shown in Figure 1. This study also examines the objectives and characteristics of each search path, and how the mechanisms of problem framing and boundary spanning operate within each search path to find solutions in idea and technology markets. The mechanisms of problem framing and boundary spanning fall beyond the scope of the current study but the four categories are used in the current study for the analysis of empirical results.

<insert Figure 1>

Search space distinguishes two search types spanning a spectrum from local to distant. When a firm addresses a problem by seeking knowledge that is related to its existing knowledge base, it is considered a local search (Cross et al., 2015; Cammarano et al., 2017) and is also associated with the single-loop learning (Kantamara and Ractham, 2014). Though when a firm seeks knowledge that is remote from its existing knowledge base, it is considered a distant, or non-local search and may be associated with double- or multiple-loop learning (Laursen, 2012; Kanthamara and Ractham, 2014; Piezunka and Dahlander 2015; Cammarano et al., 2017). Local search allows organisations to find solutions that extend from their existing knowledge. Distant search, on the other hand, is characterised by knowledge recombination (Rosenkopf and Nerkar, 2001; Fleming and Sorenson, 2004), and will increase the chances of finding novel solutions and strengthening competitive advantage (Lopes et al., 2017).

Organisations normally tend to favour evaluating local search's solutions, and discard solutions from distant search because they are unrelated to the organisations' existing knowledge base (Piezunka and Dahlander 2015). Organisations' performance can be negatively impacted when the newly acquired knowledge is not compatible with their existing knowledge (Mariano and Casey, 2015). Such incompatibility may lead to organisational dysfunction or knowledge loss (Mariano and Casey, 2015). When a satisfactory solution cannot be found through local search, organisations are forced to carry out distant search for new knowledge and technologies (Carnabuci and Operti, 2013).

The second dimension of the framework for external search is referred to as *search heuristics* that defines how to search. It distinguishes two search types: experiential (Nickerson and Zenger, 2004; Grandori 2013), and cognitive (Gavetti, 2012; Grandori, 2013). In experiential search, the actors undertake several trials, each with a unique combination of knowledge or a set of design choices to arrive at a solution, with each trial guided by experience from earlier trials or feedback (Nickerson and Zenger, 2004). A key component of experiential search is an on-line evaluation of alternatives and action on feedback (Gavetti and Levinthal, 2000; Zollo and Winter, 2002). The development of routines, or learning by doing is an example of the experiential search process (Pisano 1994; Karamanos, 2016; Tabak and Lebron, 2017).

Cognitive search on the other hand constitutes a wide range of alternatives that are considered and evaluated simultaneously using abstractions and representations in the search for solutions (Gavetti and Levinthal, 2000). A key component of cognitive search is the off-line evaluation of alternatives (Gavetti and Levinthal, 2000), or learning-before-doing (Pisano 1994). Trials are chosen based on a cognitive map of how specific design choices and relevant knowledge sets interact to determine solution performance (Nickerson and Zenger, 2004). These heuristics are cognitive representations of the solution landscapes (Gavetti and Levinthal, 2000) which are subsequently selected to conduct trials that maximise the probability of finding a solution (Nickerson and Zenger, 2004). Most extant studies focus on the "where to search", and little attention is paid to the "how to search" (Jeppesen and Lakhani, 2010; Felin and Zenger, 2014).

By combining search heuristics and search space, Lopez-Vega et al. (2016) define four search paths for external knowledge.

A *situated search path focuses* on the development of routines through trial-and-error refinements and was initially proposed by Cyert and March (1963). It is based on testing the proximity of past solutions to gain new feedback on present actions, and substantiation of established convictions based on repeated observations. The studies carried out by Martin and Mitchell (1998), and Stuart and Podolny (1996) in the US and Japan respectively, demonstrated that American magnetic resonance imaging device organisations and Japanese semiconductor producers adopted situated search paths as a component of the firm's innovative activity. More recent examples include the development of natural-based sunscreen for Natura Cosmetics in Brazil and new membrane technologies for Goodyear Tires in the U.S. (Lopez-Vega et al., 2016).

An *analogical search path* capitalises on knowledge from distant domains to guide present actions through the application of analogical reasoning. Analogical reasoning is a practice where a structural comparison is made between a base and a target domain (Gentner, 2002). New insights can be gained to solve problems by applying the characteristics of a solution from distant and unrelated domains. Examples of innovation developed with analogical search path include water-based emulsions for Sherwin Williams and packaging material for Kraft Foods (Lopez-Vega et al., 2016).

The third search path, known as *sophisticated search path*, is implemented through deductive reasoning which generates hypotheses and predictions that stem from general propositions to specific applications of a more general set of knowledge (Gavetti and Rivkin, 2007). In sophisticated search paths, explicit general theories feed forward into representations that make precise assertions about probable states of affairs (Johnson-Laird, 2001). Sophisticated search paths have a key feature which is how they function to produce "path-deepening" search (Ahuja and Katila, 2004). Path-deepening search is driven by organisations' momentum and inertia along with other paths that lead to the creation of resource endowments (Amburgey and Miner, 1992; Karim and Mitchell, 2000). Examples of innovation developed with sophisticated search path include foam component for Philips shaving machines and roofing granulates for 3M (Lopez-Vega et al., 2016).

Lastly, the *scientific search path* consists of knowledge acquisition through innovative search (Levinthal and March, 1981) or exploratory search (March, 1991). Exploratory search consists of basic research, building new capabilities, invention, and risk taking aimed at creating new knowledge or competencies which can be utilised to create value (Ferreras-Mendez et al., 2016). Scientific search enables the discovery of models and theories, which lead to the predictions that subsequently feed forward into representations, and can extend the search space by adding new theoretical building blocks and hypotheses when the search space for solutions is exhausted (Ahuja and Katila, 2004). Examples of innovation developed with scientific search path include potato chips for PepiCo and substitutes for formaldehyde for L'Oreal (Lopez-Vega et al., 2016).

Research methodology and case study organisations

Research methodology

This study adopts a qualitative case study methodology that enables researchers to study complex phenomena within their contexts (Yin, 2009). Case study research facilitates the use of multiple data sources to ensure that the topic is explored through a variety of lenses so that the phenomenon can be revealed and understood from multiple facets (Baxter and Jack, 2008). The current study adopted a multiple-case study design because this approach could produce more compelling evidence whilst making the study more robust and enabling the researcher to replicate findings between cases (Yin, 2009), particularly when evidence is limited (Eisenhardt et al., 2016).

Two sampling techniques were used in the selection of the cases including purposeful sampling (Patton, 2002) to identify and select samples that meet the predetermined criteria; and theoretical sampling which emphasises the selection of samples based on their suitability for "illuminating and extending relationships and logic among constructs" (Eisenhardt and Graebner, 2007: 27). Additionally, the following two criteria were used to select the eight cases: (a) the SMEs must have launched innovative product(s) in the past 12 months and, (b) they must have relied on external knowledge in their innovation activities.

Eight cases were selected for this study. This is in line with several experts' suggestions, for example, Eisenhardt (1989: 545) suggests between four and ten cases; Crabtree and Miller (1992) suggest between six and eight cases; and Curran and Blackburn (2001) suggest fewer than ten.

Case study organisations

The participants were key executives such as Managing Directors, Marketing Managers, R&D Managers, Production Managers and Sales Managers, all of whom were directly involved with the organisations' innovation projects. They were presented with the research ethical procedures when consenting to be interviewed. A summary of the profiles of the eight case study organisations is provided in Appendix A.

Data collection method

Data were collected through face-to-face semi-structured, open-ended interviews (Patton, 2002), reviews of documents such as websites and advertising materials, relevant trade periodicals, attendance at several trade and state-sponsored conferences, and observations of the research sites. Each interview lasted 60 minutes on average. The semi-structured interview protocol allowed probe questions to let relevant issues emerge during the interview conversation.

There were 18 open-ended questions inquiring about demographic and context; external knowledge search; search process; and lessons learned, all listed in Appendix B. The interviews started with the discussion about the business and competitive landscape with particular emphasis on the degree of innovation intensity. Each participant was then asked about the role and the acquisition of external knowledge in their innovation projects. We also asked them to talk about their search strategies. The final part of the interview explored the key lessons learned from their search activities. All interviews were conducted at the sites of the participants, audio recorded and subsequently transcribed. The interviews generated detailed and rich accounts of the interviewees' experience. Data collection was conducted over a three-month period with several follow-up telephone calls made to selected participants to seek further clarifications. The unit of analysis was the 'innovation experience' of the participants. In all cases, this meant either the creation of a radical or an incremental innovation (Parida et al., 2012).

In addition to the interviews, the first author spent one week observing the innovation activities at the operating level at each SMEs location. Notes were taken during these observation sessions.

Data analysis method

Data analysis was conducted through a holistic and unstructured approach that allowed themes to emerge from reading the interview transcriptions, and organising them into abstract units of information to allow themes, categories and patterns to emerge (Creswell 2014). Individual case histories including observational interview, and archival data were written (Eisenhardt, 1989; Yin, 2009). The case histories, including quotes, were about 50 pages in legnth. Data triangulation, which involved analysing data from various sources, was performed to capture different dimensions of the same phenomenon and gain better understanding from different perspectives (Bryman, 2012). Themes that emerged from various sources and discussed by several participants were emphasised. In addition, we

obtained feedback on our analysis from several participants, and organised peer debriefing with colleagues (Lincoln and Guba, 1985).

We conducted two types of coding: initial and focused (Charmas, 2014). In the initial coding, we studied the data closely, and coded line-by-line and began to conceptualise our ideas. We named segments of data with a label that categorised each piece of data. This was the first step in making an analytic accounting of the collected data. When the initial coding was completed, we proceeded to focused coding in which the most significant earlier codes were used to sift through large amounts of data. This made the codes more selective, direct, and conceptual.

A cross-case analysis (Yin, 2009) was conducted that led to the development of a summary report. The report indicates the extent of the replication logic that is central to building theory (Eisenhardt and Graebner, 2007). The cross-case analysis was made by comparing cases in a spread sheet programme. Comparisons among case pairs were made to identify and sharpen differences and similarities. Subsequently, tentative relationships between constructs were formed, and refined through replica logic (Yin, 2009). This was an iterating process that involved revisiting the cases and verifying constructs and relationships. This process helped sharpen the construct definitions, and relationships between constructs. Finally, we compared the emerging theory with the literature to identify differences and similarities from earlier studies. The multiple cases methodology helped us extent emerging theories (Yin, 2007).

The steps taken to analyse the data are shown in Figure 2.

<insert Figure 2 >

Findings

SMEs knowledge search practices

All participants recognised the importance of external knowledge to the success of innovation processes. External knowledge complemented and, at times, blended with existing knowledge, and provided a means to better respond to environmental opportunities or threats, and to enable innovation processes, as participants of this study pointed out:

> *Knowledge outside our firm is very important….There may be new methods that we can adopt for a factory, or new ideas that we can get to modify our*

products…External knowledge helps us make new product that is certified and gains market share (*R1*).

From my experience, past knowledge, or the knowledge that is currently available, does not guarantee future success. We review the knowledge that we get, and determine how we need to make any adjustments or changes (*R2*).

External knowledge has a major role in our product innovation projects. It gives us the direction (*R6*).

Two additional findings emerged: The first finding referred to search heuristics, with SMEs adopting a combination of cognitive and experiential search in their open innovation processes. The second finding regarded the search space, with SMEs pursuing local or distant knowledge depending on complexity of problems faced.

Search heuristics: cognitive versus experiential search

With respect to search heuristics, all participants stated that they used a combination of cognitive followed by experiential search for their innovation processes. Specifically, cognitive search was used during the initial research process, whilst experiential search was used in the development process. The main reasons behind the use of such an approach were to reduce costs and mitigate risks. From the perspective of those SMEs participating in this study, experiential search involved evaluating alternatives and taking actions upon feedback received from the external environment. This practice reseambled learning-by-doing and carried higher costs compared to cognitive search, or learning-before-doing, which involved conceptualisation, abstractions and representations in the search for solutions. Therefore, the use of cognitive search was considered economical and sufficient in the research part of the innovation process, whilst experiential search was considered more appropriate in the development part of the innovation process. This was done in order to manage the risks involved, as experiential search, or learning by doing, provided the opportunity for trial-and-error refinements.

Search space: local versus distant knowledge

With respect to search space and the question of local versus distant knowledge, most participants felt that distant knowledge was not relevant to their innovation activities (R1, R5, R6, R7, R8). Furthermore, some participants claimed that searching for distant knowledge normally required greater effort because the knowledge seekers did not always have a clear idea of what they were looking for. Participants generally searched for external

knowledge within the local knowledge domain (R6, R7). However, they searched for distant knowledge when faced with complex problems that could not be solved by local knowledge (R4). Distant knowledge was also found though serendipity (R2, R3). These findings were explained as follows:

> *We normally seek knowledge that is related to our business or products* (*R1*)
>
> *You talked earlier about acquiring knowledge from other industries. This happened to me by accident. My product is beverage. One day, I was looking at the data from automotive industry (which is vastly different from the respondent's industry). I was looking at data from Ford Company. Ford executives said that the market segment in the auto market that had the highest growth rate in which the company would further invest was the SUV* (*sport utility vehicle*) *segment. How can the knowledge about the SUV market segment be applied to my product?* (*R2*)
>
> *We do not just look at new products in our industry, but we also look at related industries, such as packaging…. We have milk in a tube, or milk in tablet form. Milk in tablet form comes from the technology in the pharmaceutical industry* (*R3*)
>
> *Recently, we had some problems that we could not solve. We could not get rid of the alpha toxin found in our chili. However, in the environmental protection sector, they have the solution to get rid of heavy metal which can be applied to our situation…. So, we can use the know-how from a different industry to solve our alpha toxin problem* (*R4*)
>
> *No, we have not* (*searched for distant knowledge). Water (their product) is water. There is not much we can do other than changing the flavour, aroma, and color. So, we only search for knowledge that is close to our existing knowledge base.* (*R6)*

The distant knowledge acquired by SMEs was originated from a wide range of industries and provided a means to solve complex technical problems.

Integration of external knowledge search paths adopted by SMEs to open innovation model

Our findings reveal that SMEs acquire external knowledge from both local and distant space, and that cognitive search is adopted at the research stage, whilst experiential search is adopted at the development stage of the innovation process. By applying the Chesbrough's (2012) open innovation model to our empirical data we propose how local and distant knowledge is acquired through cognitive and experiential search, and how these search practices deliver the acquired knowledge to the research and development stages of the open innovation process. The integration of our findings to the open innovation model is illustrated in Figure 3. A summary of our findings is illustrated in Appendix C.

<insert Figure 3>

Although SMEs generally start their search efforts in the knowledge domain close to their existing knowledge base, they do not discriminate between local and distant knowledge. So, they may search simultaneously for local and distant knowledge in order to obtain a solution for a particular product innovation project. This is different from the practices found in large enterprises as reported in the Lopez-Vega et al., (2016) study where local knowledge is mainly acquired for the situated and sophisticated search paths, whilst distant knowledge is acquired for the analogical and scientific search paths.

Discussion and implications for theory and practice

From a theoretical perspective, this study aimed to understand how SMEs searched for external knowledge in their open innovation processes. Organisations need to allocate financial and non-financial resources to carry out innovation projects, and there is always a risk that the innovation will not be successful (Lakemond et al., 2016). We were inspired by some of the recent studies such as Chesbrough (2012), Lopaz-Vega et al., (2016), Vanhaverbeke (2017), and Usman and Vanhaverbeke (2017) that provided multiple lenses which featured various search paths adopted by organisations when searching for external knowledge in open innovation processes. Based on the data collected from eight SMEs, we found that SMEs combine key elements of the search paths applied to the large organisations in their search processes. SMEs mainly search in the local space, and only search in the distant space when confronted with complex technical problems. The search heuristics adopted by SMEs involve conducting cognitive search during the research stage, and experiential search during the development stage of the innovation process. Of the two search heuristics, SMEs find that cognitive search, or learning-before-doing, is less costly than experiential search, or learning-by-doing. They consider cognitive search to be adequate for the research stage of the innovation process, whilst experiential search is needed for the development stage of the innovation process. The combination of cognitive and experiential search in an innovation project enables SMEs to acquire external knowledge to support their open innovation activities, whilst reducing the costs and mitigating the risks associated with innovation projects. We further deducted that this process is quite different from those adopted by innovation intermediaries working for large organisations. Based on our findings, this study makes several contributions to existing literature.

First, it contributes to open innovation literature where scholars have argued that external knowledge search is important to the success of the organisations' innovation and market performance (Ferreras-Mendez et al., 2015; Martini et al., 2015; Lee et al., 2016). Prior research on factors contributing to the search performance highlighted several search practices, search types and organisations' capabilities including searching in local space and distant space (Cross et al., 2015; Lopez-Vega et al., 2016; Corradini and De Propris, 2017; Cammarano et al., 2017), searching broadly and setting up multiple objectives (Leiponen and Helfat (2010), cognitive search and experiential search (Gavetti 2012; Grandori 2013; Lopez-Vega et al., 2016), organisations' absorptive capacity (Ferreras-Mendez et al., 2015; Mariano and Al-Arrayed 2017), and external relationships and bridging capabilities (Lowik et al., 2012). The literature has broadened our understanding of how organisations can improve their search performance for their innovation initiatives by adopting the above search practices or acquiring certain capabilities. We advance this literature on search by showing how SMEs can reduce the costs and mitigate the risks associated with innovation by adopting a search process that combines both cognitive and experiential search. Through our focus on open innovation in SMEs, our research also contributes to the emerging stream of literature highlighting the importance of external knowledge search to the success of innovation in SMEs (Saguy and Sirotinskaya 2014; Long et al., 2018). In addition, this study provides a better understanding of what characterises the SMEs' search practices for accessing external knowledge.

Second, given that context for SMEs is different from that of large organisations where most of the studies on knowledge search have focused, this study addresses a gap in knowledge search practices for innovation projects in the context of SMEs. We conclude that SMEs' knowledge search process is characterised by having a mix of four search paths being present in a single innovation project, as opposed to distinct paths practiced by large organisations in a single project.

Third, external knowledge sourcing is regarded as vital to the success of innovation not only by scholars but also by managers in the industry (Martinez et al., 2014; Brunswicker and Vanhaverbeke 2015; Long, Looijen and Blok 2018). What is less understood, however, is what managers in small organisations, due to their smallness, normally face with resource constraints, possess lower level of research capacity and cannot handle all the innovation activities (Lee et al., 2010; Brunswicker and Vanhaverbeke 2015;

Minarelli et al., 2015) can do to enhance their external knowledge sourcing performance. Our findings shed light on this key area. By analyzing the external knowledge sourcing activities conducted by SMEs throughout the whole innovation process, this study suggests that the four search paths identified by Lopez-Vega et al., (2016) as situated, analogical, sophisticated, and scientific search paths, may not be appropriate for SMEs. Rather, SME managers should combine both cognitive and experiential search in their search activities for an innovation project. Cognitive search should be adopted during the research phase, whilst experiential search should be adopted during the development phase of an innovation project. This practice has been found to help reduce costs and mitigate risks associated with innovation.

Finally, in terms of search heuristics, we propose that both experiential search and cognitive search are adopted alternatively by SMEs in any one particular product innovation processes. Cognitive search is adopted in the research stage of the product innovation process, whilst experiential search is adopted in the development stage of the product innovation process. The rationale given by the participants is that they find this approach reduces costs and mitigates the risks associated with the management of product innovation. This finding is different from that reported in the Lopez-Vega et al., (2016) study among large enterprises where experiential search is mainly adopted for situated and analogical search paths, whilst cognitive search is adopted for aophisticated and scientific search paths. The Lopez-Vega et al., (2016) study shows no incidence where both experiential search and cognitive search are adopted in the same product innovation process.

In summary, we propose that SMEs' external knowledge search is characterised by the acquisition of both local and distant knowledge, adopting cognitive search for the research stage, and experiential search for the development stage within the new product innovation process.

This study also contributed to practice. Managers can make use of the model presented in Figure 3 when working on their innovation projects. The model can serve as a framework that helps them to manage the search for external knowledge for their innovation. This should enable managers to improve the efficientcy of their search efforts in terms of costs and risk management.

Limitations and future research

We acknowledge some limitations of our study. First, the generalisability of the findings is limited. The current exploratory research is of a qualitative nature based on eight cases of SMEs. We may not have identified all the possible search paths as the sample was limited. We encourage future research to explore other search practices and to determine their value on external knowledge sourcing. Second, the focus of this study is on SMEs seeking external knowledge directly, without the assistance from innovation intermediaries. We suggest that future research can examine how SMEs seek external knowledge through the use of innovation intermediaries. It will be interesting to investigate if the combination of cognitive and experiential search evidenced from this study is also practiced.

Funding

This research did not receive any specific grant from funding agency in the public, commercial, or not-for-profit sectors.

References

Ahuja, G. and Katila, R. (2004), "Where do resources come from? The role of idiosyncratic situations", *Strategic Management Journal*, Vol. 25 No. 8-9, pp. 887-907.

Amburgey, T. and Miner, A. (1992), "Strategy momentum: The effects of repetitive, positional, and contextual momentum on merger activity", *Strategic Management Journal*, Vol. 13 No. 5, pp. 335-348.

Barasa. L., Vermeulen, P., Knoben, J., Kinyanjui, B. and Kimuyu, P. (2019), "Innovation inputs and efficiency: manufacturing firms in Sub-Saharan Africa", *European Journal of Innovation Management*, Vol. 22 No. 1, pp. 59-83.

Baxter, P. and Jack, S. (2008), "Qualitative case study methodology: Study design and implementation for novice researchers", *The Qualitative Report*, Vol. 13 No. 4, pp. 544-559.

Bellairs, J. (2010), "Open innovation gaining momentum in the food industry", *Cereal Foods World*, Vol. 55 No. 1, pp. 4-6.

Brunswicker, S. and Vanhaverbeke, W. (2015), "Open innovation in small and medium-sized enterprises (SMEs): External knowledge sourcing strategies and internal

organizational facilitators", *Journal of Small Business Management,* Vol. 53 No. 4, pp. 1241-1263.

Bryman, A. (2012), *Social Research Methods,* Oxford University Press, Oxford.

Cammarano, A., Michelino, F., Lamberti, E. and Caputo, M. (2017), "Accumulated stock of knowledge and current search practices: The impact on patent quality", *Technological Forecasting & Social Change,* Vol. 120, pp. 204-222.

Carnabuci, G. and Operti, E. (2013), "Where do firms' recombinant capabilities come from? Intraorganizational networks, knowledge, and firms' ability to innovate through technological recombination", *Strategic Management Journal,* Vol. 34, pp. 1591-1613.

Ceci, F. and Iubatti, D. (2012), "Personal relationships and innovation diffusion in SME networks: A content analysis approach", *Research Policy,* Vol. 41 No. 3, pp. 565-579.

Charmaz, K. (2014), *Constructing Grounded Theory.* Sage Publications, London.

Chesbrough, H. (2011), *Open Services Innovation: Rethinking Your Business to Grow and Compete in a New Era,* Jossey-Bass, San Francisco.

Chesbrough, H. (2012), "Open innovation: Where we've been and where we're going", *Research-Technology Management,* July-August 2012, pp. 20-27.

Chesbrough, H. and Crowther, A. (2006), "Beyond high tech: Early adopters of open innovation in other industries", *R&D Management,* Vol. 36 No. 3, pp. 229-236.

Chesbrough, H., Vanhaverbeke, W. and West, J. (2006), *Open Innovation: Researching a New Paradigm,* Oxford University Press, Oxford.

Chesbrough, H., Vanhaverbeke, W. and West, J. (2014), *New Frontiers in Open Innovation,* Oxford University Press, Oxford.

Cohen, W. and Levinthal, D. (1990), "Absorptive capacity: A new perspective on learning and innovation", *Administrative Science Quarterly,* Vol. 35 No. 1, pp. 128-152.

Colombo, M., Laursen, K., Magnusson, M. and Rossi-Lamastra, C. (2012), "Introduction: small business and networked innovation: Organizational and managerial challenges", *Journal of Small Business Management,* Vol. 50 No. 2, pp. 181-190.

Corradini, C. and De Propris, L. (2017), "Beyond local search: Bridging platforms and inter-sectoral technological integration", *Research Policy*, Vol. 46, pp. 196-206.

Crabtree, F. and Miller, L. (1992), *Doing Qualitative Research*, Sage Publications, Beverly Hills, CA.

Creswell, J. (2014), *Research Design*: *Qualitative, Quantitative, and Mixed Methods Approaches*, 4th Edition, Sage Publications, Thousand Oaks, CA.

Cross, R., Ernst, C., Assimakopoulos, D. and Ranta, D. (2015), "Investing in boundary-spanning collaboration to drive efficiency and innovation", *Organizational Dynamics* Vol. 44, pp. 204-216.

Crossan, M. and Apaydin, M. (2010), "A multi-dimensional framework of organizational innovation: A systematic review of the literature", *Journal of Management Studies*, Vol. 47 No. 6, pp. 1154-1191.

Curran, J. and Blackburn, R. (2001), *Researching the Small Enterprise*, Sage Publications, London.

Cyert, R. and March, J. (1963), *A Behavioral Theory of the Firm*, Blackwell, Oxford.

Dahlander, L. and Gann, D. (2010), "How open is innovation?" *Research Policy*, Vol. 39, pp. 699-709.

De Massis, A., Frattini, F., Kotlar, J., Petruzzelli, A. and Wright, M. (2016), "Innovation through tradition: Lessons from innovative family businesses and directions for future research", *Academy of Management Perspectives*, Vol. 30 No. 1, pp. 93-116.

Demirkan, I. (2018), "The impact of firm resources on innovation", *European Journal of Innovation Management*, Vol. 21 No. 4, pp. 672-694.

Eisenhardt, K. (1989), "Building theories from case study research", *Academy of Management Review*, Vol. 14 No. 4, pp. 532-550.

Eisenhardt, K. and Graebner, M. (2007), "Theory building from case studies: Opportunities and challengers", *Academy of Management Journal*, Vol. 50 No. 1, pp. 25-32.

Eisenhardt, K., Graebner M, and Sonenshein, S. (2016),"Grand challenges and inductive methods: Rigor without rigor mortis", *Academy of Management Journal*, Vol. 59 No. 4, pp. 1113-1123.

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

Ferreras-Mendez, J., Fernandez-Mesa, A. and Alegre, J. (2016), "The relationship between knowledge search strategies and absorptive capacity: A deeper look", *Technovation* Vol. 54, pp. 48-61.

Ferreras-Mendez, J., Newell, S., Fernandez-Mesa, A. and Alegre, J. (2015), "Depth and breadth of external knowledge search and performance: The mediating role of absorptive capacity", *Industrial Marketing Management*, Vol. 47 pp. 86-97.

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

Garriga, H., Von Grogh, G. and Spaeth, S. (2013), "How constraints and knowledge impact open innovation", *Strategic Management Journal*, Vol. 34, pp. 1134-1144.

Gassmann, O., Enkel, E. and Chesbrough, H. (2010), "The future of open innovation", *R&D Management*, Vol. 40 No. 3, pp. 213-221.

Gavetti, G. (2012), "Perspective – Toward a behavioral theory of strategy", *Organization Science*, Vol. 23 No. 1, pp. 267-285.

Gavetti, G. and Levinthal, D. (2000), "Looking forward and looking backward: Cognitive and experiential search", *Administrative Science Quarterly*, Vol. 45, pp. 113-137.

Gavetti, G. and Rivkin, J. (2007), "On the origin of strategy: Action and cognition over time", *Organization Science*, Vol. 18 No. 3, pp. 420-439.

Gentner, D. (2002), "Analogy in scientific discovery: The case of Johannes Kepler", in Magnani, L. and Nersessian, N. (Eds), *Model-Based Reasoning: Science, Technology, Values*, Kluwer Academic/Plenum Publisher, New York, pp. 21-39.

Grandori, A. (2013), *Espistemic Economics and Organization*: *Forms of Rationality and Governance for a Discovery Oriented Economy,* Routledge, London.

Hewitt-Dundas, N. (2006), "Resource and capability constraints to innovation in small and large plants", *Small Business Economics*, Vol. 26 No. 3, pp. 257-277.

Jeppesen, L. and Lakhani, K. (2010). "Marginality and problem-solving effectiveness in broadcast search", *Organization Science*, Vol. 21 No. 5, pp. 1016-1033.

Johnson-Laird, N. (2001), "Mental models and deduction", *Trends in Cognitive Sciences,* Vol. 5 No. 10, pp. 434-442.

Kammerlander, N., Dessi, C., Bird, M., Floris, M. and Murru, A. (2015), "The impact of shared stories on family firm innovation: A multicase study", *Family Business Review,* Vol. 28 No. 4, pp. 332-354.

Kantamara, P. and Ractham, V. (2014), "Single-loop vs. double-loop learning: An obstacle or a success factor for organizational learning", *International Journal of Education and Research,* Vol. 2 No. 7, pp. 55-62.

Karamanos, A. (2016), "Effects of a firm's and their partners' alliance ego-network structure on its innovation output in an era of ferment", *R&D Management*, Vol. 46 No. S1, pp. 261-267.

Karim, S. and Mitchell, W. (2000), "Path-dependent and path-breaking change: Reconfiguring business resources following acquisitions in the U.S. medical sector, 1978-1995", *Strategic Management Journal,* Special Issue Vol. 21, pp. 1061-1081.

Knudsen, T. and Srikanth, K. (2014), "Coordinated exploration: organizing joint search by multiple specialists to overcome mutual confusion and joint myopia", *Administrative Science Quarterly,* Vol. 59 No. 3, pp. 409-441.

Lakemond, N., Bengtsson, L., Laursen, K. and Tell, F. (2016), "Match and manage: The use of knowledge matching and project management to integrate knowledge in collaborative inbound open innovation", *Industrial and Corporate Change,* Vol. 25 No. 2, pp. 333-352.

Lasagni, A. (2012), "How can external relationships enhance innovation in SMEs? New evidence for Europe", *Journal of Small Business Management*, Vol. 50 No. 2, pp. 310-339.

Laursen, K. (2012), "Keep searching and you'll find: What do we know about variety creation through firms' search activities for innovation?", *Industrial and Corporate Change*, Vol. 21 No. 5, pp. 1181-1220.

Lee, K., Yoo, J., Choi, M., Zo, H. and Ciganek, A. (2016), "Does external knowledge sourcing enhance market performance? Evidence from the Korean manufacturing industry", *PLoS ONE*, Vol. 11 No. 12, e01688676. Doi: 10.1371/journal.pone.0168676.

Lee, S., Prak, G., Yoon, B. and Part, J. (2010), "Open innovation in SMEs—An intermediated network model", *Research Policy*, Vol. 39, pp. 290-300.

Leiponen, A. (2012), "The benefits of R&D and breadth in innovation strategies: A comparison of Finnish service and manufacturing firms", *Industrial and Corporate Change*, Vol. *2*1 No. 5, pp. 1255-1281.

Leiponen, A. and Helfat, C. (2010), "Research notes and commentaries—Innovation objectives, knowledge sources, and the benefits of breadth", *Strategic Management Journal*, Vol. 31 No. 2, pp. 224-236.

Levinthal, D. and March, J. (1981), "A model of adaptive organizational search. *Journal of Economic Behavior & Organization*, Vol. 2 No. 4, pp. 307-333.

Levinthal, D. and March, J. (1993), "The myopia of lLearning", *Strategy Management Journal*, Vol. 14, pp. 95-112.

Lincoln, S. and Guab, E. (1985), *Naturalistic Inquiry*, Sage Publications, Atlanta, GA.

Long, T., Looijen, A. and Blok, V. (2018), "Critical success factors for the transition to business models for sustainability in the food and beverage industry in the Netherlands", *Journal of Cleaner Production*, Vol. 175, pp. 82-95.

Lopes, C., Scavarda, A., Hofmeister, L., Thome, A. and Vaccaro, G. (2017), "An analysis of the interplay between organizational sustainability, knowledge management, and open innovation", *Journal of Cleaner Production,* Vol. 142, pp. 476-488.

Lopez-Vega, H., Tell, F., and Vanhaverbeke, W. (2016), *"*Where and how to search? Search paths in open innovation", *Research Policy,* Vol. 45, pp. 125-136.

Lowik, S., Von Rossum, D., Kraaijenbrink, J. and Groen, A. (2012), "Strong ties as sources of new knowledge: How small firms innovate through briding capabilities", *Journal of Small Business Management*, Vol. 50 No. 2, pp. 239-256.

Madrid-Guijarro, A., Garcia, D. and Van Auken, H. (2009), "Barriers to innovation among Spanish manufacturing SMEs", *Journal of Small Business Management,* Vol. 47 No. 4, pp. 465-488.

Mäkimattila, M., Junell, T. and Rantala, T. (2015), "Developing collaboration structures for university-industry interaction and innovations", *European Journal of Innovation Management*, Vol. 18 No. 4, pp.451-470, https://doi.org/10.1108/EJIM-05-2013-0044.

March, J. (1991), "Exploration and exploitation in organizational learning", *Organization Science*, Vol. 2 No. 1, pp. 71-87.

Mariano, S. and Casey, A. (2015), "Is organizational innovation always a good thing?", *Management Learning*, Vol. 46 No. 5, pp. 530-545.

Mariano, S. and Al-Arrayed, S. (2018), "Combinations of absorptive capacity metaroutines: The role of organizational disruptions and time constraints", *European Management Journal*, Vol. 36 No. 2, pp. 171-182.

Martin, X. and Mitchell, W. (1998), "The influence of local search and performance heuristics on new design introduction in a new product market", *Research Policy*, Vol. 26, pp. 753-771.

Martinez, M., Lazzarotti, V., Manzini, R. and Garcia, M. (2014), "Open innovation strategies in the food and drink industry: Determinants and impact on innovation performance", *International Journal of Technology Management*, Vol. 66 No. 2/3, pp. 212-242.

Martini, A., Neirotti, P. and Appio, F. (2015), "Knowledge searching, integrating and performing: Always a tuned trio for innovation?", *Long Range Planning*, http://dx.doi.org/10.1016/j.lrp.2015.12.020.

Maula, M., Keil, T. and Salmenkaita, J. (2006), "Open innovation in systemic innovation context", in Chesbrough, H., Vanhaverbeke, W. and West, J. (Eds), *Open Innovation*: *Researching a New Paradigm*, Oxford University Press, New York, pp. 241-257.

Michelino, F., Caputo, M., Cammarano, A. and Lamberti, E. (2014), "Inbound and outbound open innovation: Organization and performances", *Journal of Technology Management & Innovation*, Vol. 9 No. 3, pp. 65-82.

Minarelli, F., Raggi, M. and Viaggi, D. (2015), "Innovation in European food SMEs: Determinants and links between types", *Bio-based and Applied Economics*, Vol. 4 No. 1, pp. 33-53..

Nickerson, J. and Zenger, T. (2004), "A knowledge-based theory of the firm – The problem-solving perspective", *Organization Science*, Vol. 15 No. 6, pp. 617-632.

Padilla-Melendez, A., Dieguez-Soto, J. and Garrido-Moreno, A. (2015), "Empirical research on innovation in family business: Literature review and proposal of an integrative framework", *Review of Business Management*, Vol. 17 No. 56, pp. 1064-1089.

Parida, V., Westerberg, M. and Frishammar, J. (2012), "Inbound open innovation activities in high-tech SMEs: The impact on innovation performance", *Journal of Small Business Management*, Vol. 50 No. 2, pp. 283-309.

Patton, M. (2002), *Qualitative Research and Evaluation Methods*, 3rd ed., Sage Publications, Thousand Oaks, CA.

Pellegrini, L., Lassarotti, V. and Manzini, R. (2014), "Open innovation in the food and drink industry", *Journal of Agricultural & Food Industrial Organization*, Vol. 12 No. 1, pp. 75-94.

Piezunka, H. and Dahlander, L. (2015), "Distant search, narrow attention: How crowding alters organizations' filtering of suggestions in crowdsourcing", *Academy of Management Journal*, Vol. 58, pp. 856-880.

Pisano, G. (1994), “Knowledge integration and the locus of learning: An empirical analysis of process development”, *Strategic Management Journal*, Vol. 15, pp. 85-100.

Radicic, D. and Pugh, G. (2017), “Performance effects of external search strategies in European small and medium-sized enterprises”, *Journal of Small Business Management*, doi: 10.1111/jsbm.12328.

Reidolf, M. (2016), "Knowledge networks and the nature of knowledge relationships of innovative rural SMEs", *European Journal of Innovation Management*, Vol. 19 No. 3, pp.317-336, https://doi.org/10.1108/EJIM-06-2015-0043.

Renton, M., Daellenbach, U., Davenport, S. and Richard, J. (2015), “Small but sophisticated: Entrepreneurial marketing and SME approaches to brand management”, *Journal of Research in Marketing and Entrepreneurship*, Vol. 17 No. 2, pp. 149-164.

Rosenkopf, L. and Nerkar, A. (2001), “Beyond local search: Boundary-spanning, exploration, and iimpact in the optical disk industry”, *Strategic Management Journal*, Vol. 22, pp. 287-306.

Sag, S., Sezen, B. and Guzel, M. (2016), “Factors that motivate or prevent adoption of open innovation by SMEs in developing countries and policy suggestions”, *Procedia – Social and Behavioral Sciences*, Vol. 235, pp. 756-763.

Saguy, S. and Sirotinskaya, V. (2014), “Challenges in exploiting open innovation’s full potential in the food industry with a focus on small and medium enterprises (SMEs)”, *Trends in Food Science & Technology*, Vol. 38, pp. 136-148.

Sahut, J-M, and Peris-Ortiz, M. (2014), “Small business, innovation, and entrepreneurship, *Small Business Economics.* Vol. 42, pp. 663-668.

Sarkar, S. and Costa, A. (2008), “Dynamics of open innovation in the food industry”, *Trends in Food Science & Technology*, Vol. 19 No. 11, pp. 574-580.

Sisodiya, S., Johnson, J. and Gregoire, Y. (2013), “Inbound open innovation for enhanced performance: Enablers and opportunities”, *Industrial Marketing Management*, Vol. 42, pp. 836-849.

Stuart, T. and Podolny, J. (1996), "Local search and the evolution of technological capabilities", *Strategic Management Journal*, Vol. 17, pp. 21-38.

Tabak, F. and Lebron, M. (2017), "Learning by doing in leadership education: Experiencing followership and effective leadership communication through role-play", *Journal of Leadership Education*, Vol. 16 No. 2, pp. 199-212.

Usman, M. and Vanhaverbeke, W. (2017), "How start-ups successfully organize and manage open innovation with large companies", *European Journal of Innovation Management*, Vol. 20 No. 1, pp. 171-186.

Usman, M., Roijakkers, N., Vanhaverbeke, W. and Frattini, F. (2018), "A systematic review of the literature on open innovation in SMEs", in Vanhaverbeke, W., Frattini, F., Roijakkers, N. and Usman, M. (Eds), *Researching Open Innovation in SMEs*, World Scientific Press, Singapore, pp. 3-35.

Vanhaverbeke, W. (2017), *Managing Open Innovation in SMEs*, Cambridge University Press, Cambridge.

Vanhaverbeke, W., Roijakkers, N., Lorenz, A. and Chesbrough, H. (2017), "The importance of connecting open innovation to strategy", in Pfeffermann, N. and Gould, J. (Eds), *Strategy and Communication for Innovation: Integrative Perspectives on Innovation in the Digital Economy*. Springer, pp. 1-22.

West, J., Salter, A., Vanhaverbeke, W. and Chesbrough, H. (2014), "Open innovation: The next decade", *Research Policy*, Vol. 43, pp. 305-811.

Yin, R. (2009), *Case Study Research: Design and Methods*. 4th ed., Sage Publications, Thousand Oaks, CA

Zollo, M. and Winter, S. (2002), "Deliberate learning and the evolution of dynamic capabilities", *Organization Science*, Vol. 13 No. 3, pp. 339-351.

.

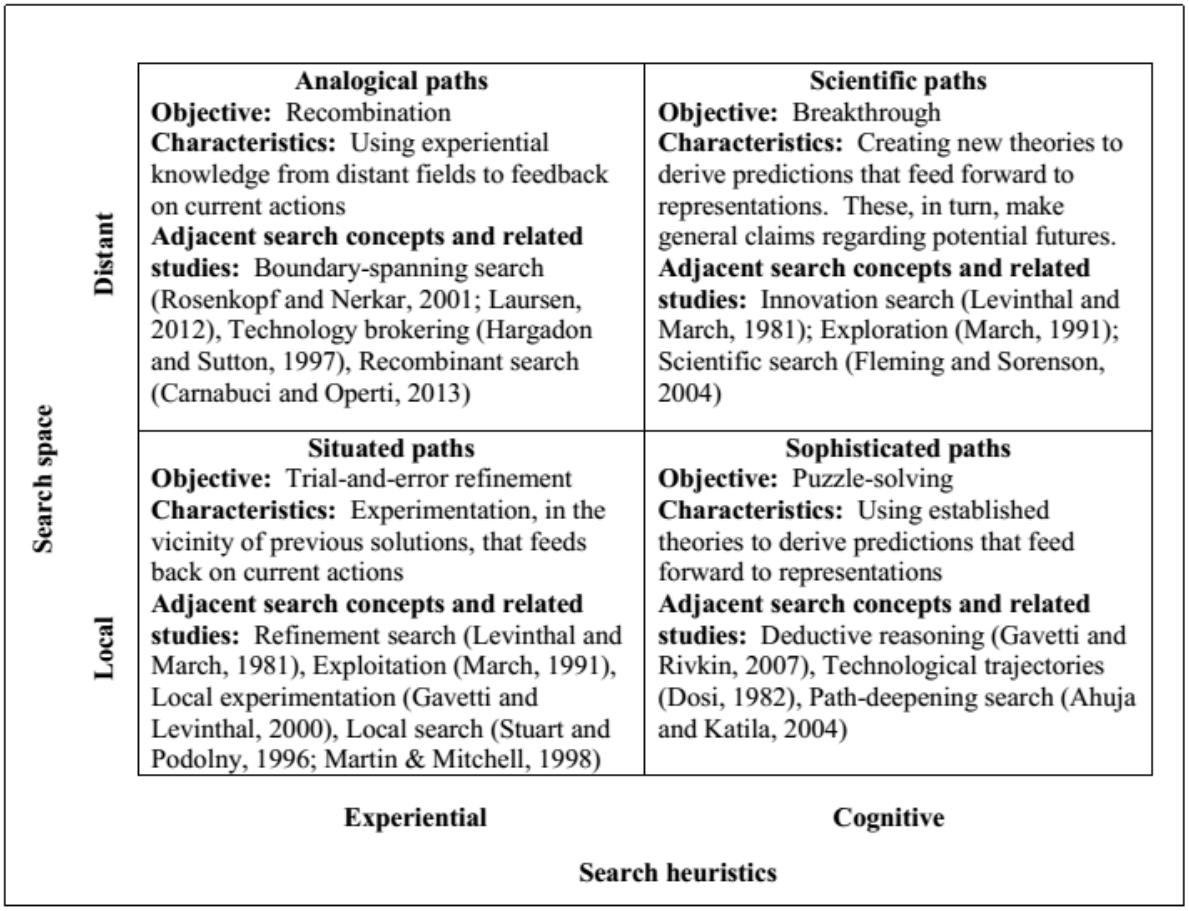

Figure 1. A Knowledge search framework synthesised from Levinthal and March (1993); Nickerson and Zenger (2004); Gavetti (2012); Grandori (2013); Knudsen and Srikanth (2014); and Lopez-Vega et al., (2016);

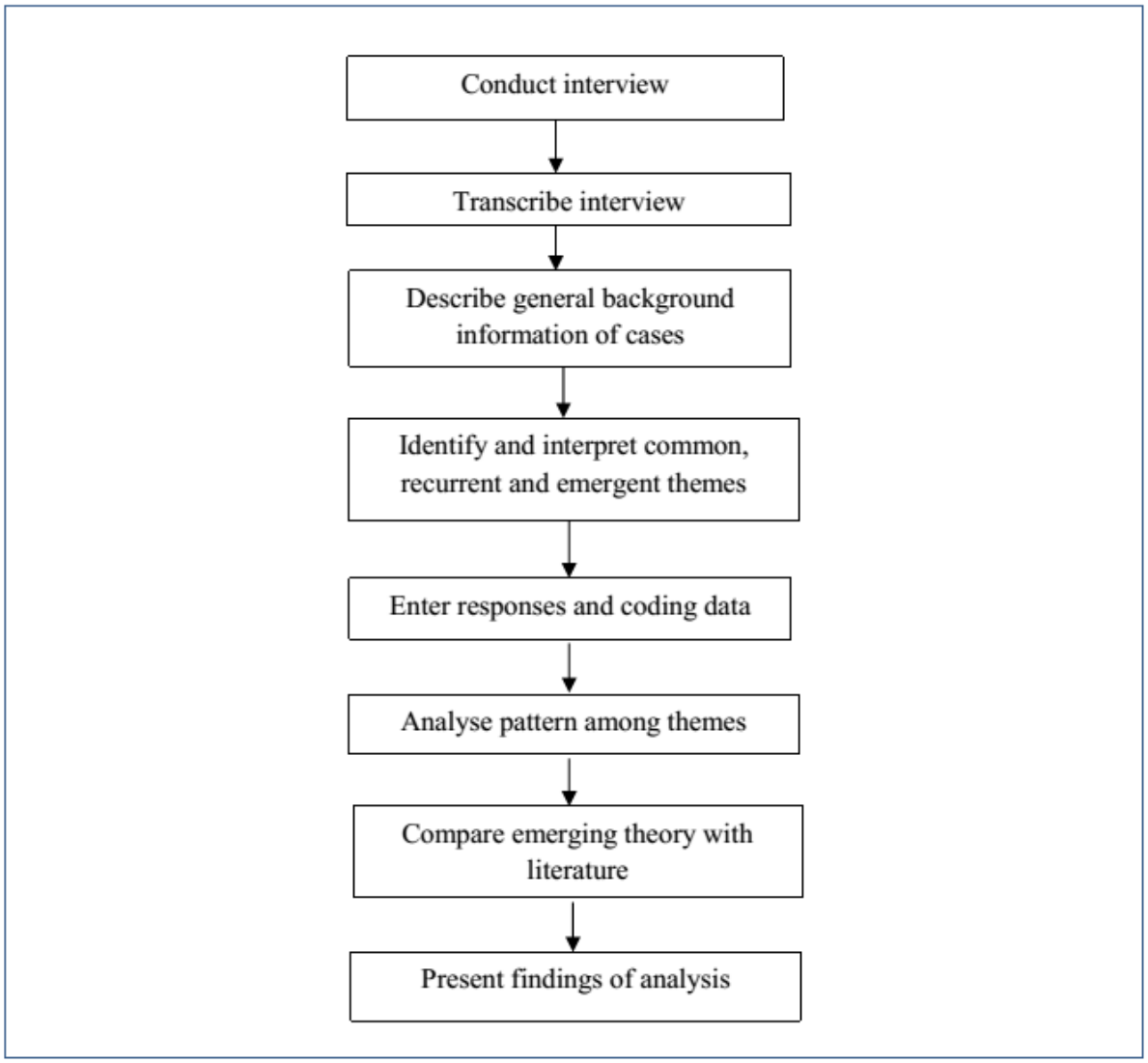

Figure 2. Steps in data analysis of the interviews

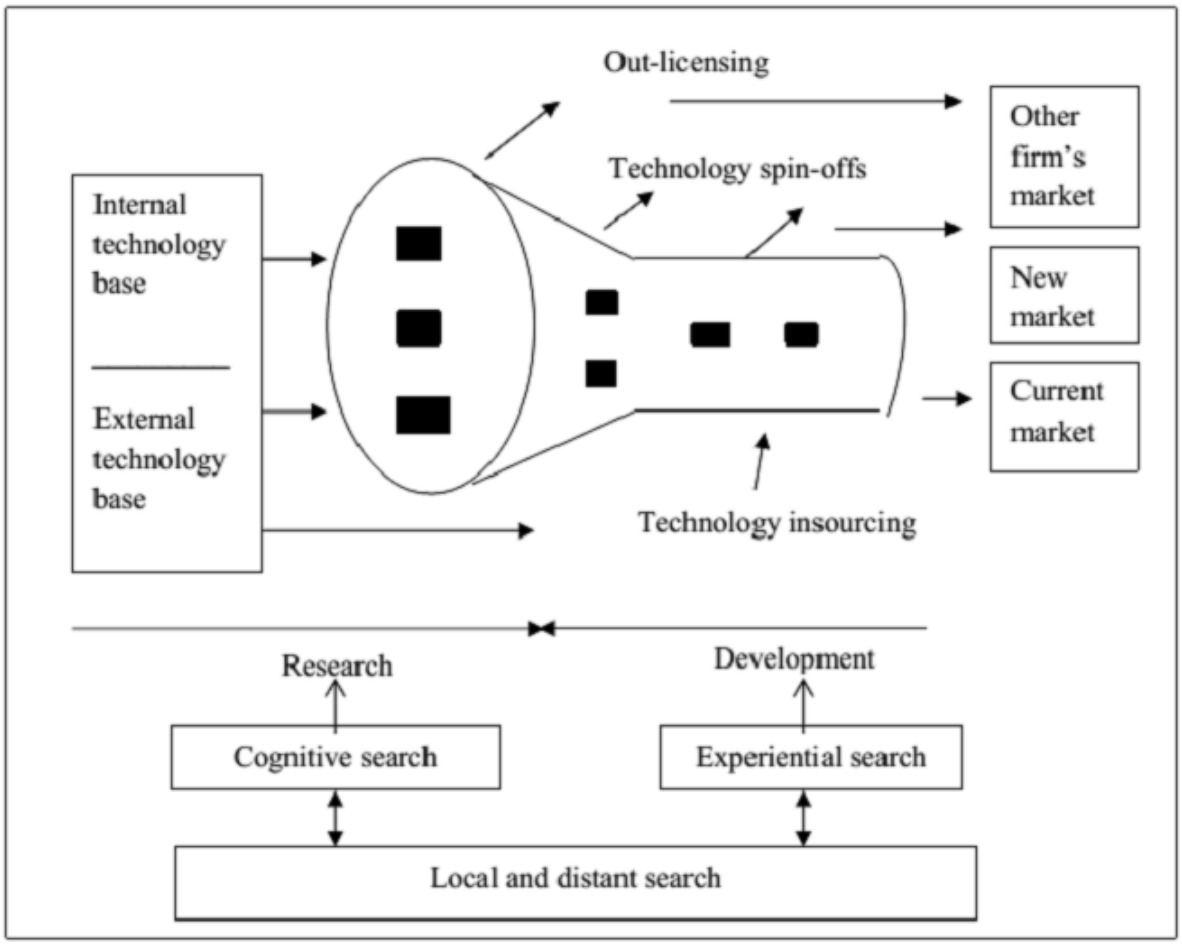

Figure 3. Integration of external knowledge search paths adopted by SMEs to open innovation model by combining Chesbrough's (2012: 23) model with findings from the current study.

Appendix A. General information on participants

Case	Job title	Description of business
R1	General Manager & R&D Manager	This is a manufacturer of chicken and pork sausages with 250 employees. The firm's owner is a doctorate in food science with over 30 years of experience. The firm produces low-priced sausages for low income consumers. This is a market that is so price sensitive. The firm is very active in product and process innovations because it believes that product innovation allows it to decommoditise its products and charge a higher price, whilst process innovation enables it to lower its production costs. The firm works closely with machinery suppliers to develop product innovation.
R2	CEO	This firm markets functional beverages. It is a new firm that has only been in business for three years. The firm does not have an R&D department and relies on external sources, primarily universities to develop its new products. It sources its products from original equipment manufacturers. The main functions that the firm performs are marketing and sales. Its products are mainly distributed through modern trade outlets in major cities. The firm employs 25 people.
R3	Director	This organisation produces canned fruits and vegetables such as baby corns for export. It has 180 employees including an R&D team. However, the firm also works extensively with its overseas customers to develop new products. The firm frequently participates in international trade fairs in order to gain new knowledge about market trends and production technologies, in addition to generating new sales leads.
R4	R&D Manager	This is a food seasoning manufacturer with 150 employees. It has been in business for almost 20 years. The firm has an R&D department and works closely with its machinery suppliers to develop new products. The firm's primary target market is middle income housewives, although it also sells some products to the food service sector. Because of the fast-changing consumer preferences, the firm is very active in its product innovation programmess to ensure that its products are relevant to the changing needs.
R5	Managing Director	This organisation produces glucose for its business-to-business customers. Its customers are manufacturers of food

		and beverage products that use glucose as an ingredient. As glucose is essentially an unbranded merchandise, customers can switch supplirs relatively easily. Hence, there is always a market pressure for lower price and the margin is razor thin. In order to gain better margin, the firm collaborates with its key customers to develop new and differentiated products with propriatory technologies. These product innovations allow the firm to charge higher price for its products. The firm employs 150 people.
R6	Managing Director	This firm produces fruit-flavoured beverages for the middle and low income consumers. The firm employs 280 people. As the market for fruit-flavoured beverages is quite mature, the management believes that it needs to diversify its product lines to include snacks. The firm collaborates with a number of machinery suppliers to develop new products. In addition, t the firm also participates in local and international trade fairs to explore new possibilities for innovation.
R7	General Manager	This firm produces ready meals for both the business-to-business and the business-to-consumer markets. It supplies to both domestic and international markets. The firm employs 60 people, four of whom work in the R&D department. It collaborates with public research agencies and universities to develop new products and new recipes. Recently, the firm developed a new baby food product with one of its customers. The product became a real success within a relatively short period. This has motivated the firm to develop its next product, a ready meal for seniors.
R8	CEO and Marketing Manager	This firm produces functional beverages and coffee creamer for both the business-to-business and the business-to-consumer markets. It employs 30 people, 5 of whom work in R&D department. The firm sources its products from several original equipment manufacturers who are instrumental in developing new products with the firm's R&D team. The firm's coffee creamer is well-received by its customers who are coffee shop operators. The creamer offers superior quality in terms of consistency, long shelf-life, ease of use and versatile applications.

Appendix B. Interview questions

Interview protocol

---

1. Interview protocol

- Name of the research: External knowledge search paths in open innovation processes of small and medium entereprises.

- Explain the purpose of the study: I am studying the way SMEs search for external knowledge in their product innovation initiatives.
- Research start and finish time/date:
- Explain the interview length: 60 minutes
- Explain the format and review process
- Explain the confidentiality and ethics
- Any questions they have before starting?

2. Demographic and context

1. Interview's job title, department.
2. Level of involvement and role in product innovation projects
3. Industry the organisation is operating in.
4. Size of the organisation.
5. Number of product innovation in the last 12 months.
6. Who are the customers?

3. External knowledge search

7. What is the role of external knowledge in your innovation activities?
8. Is the external knowledge related to the existing knowledge that you already possess? Please explain**.**
9. How do you go about searching for external knowledge?
10. What is the practice of the search for knowledge that you use, for example**:**

- Trial-and-error (learning by doing), or

- Simultaneously consider and evaluate a wide array of alternatives (learning-before-doing)?

4. Search process

11. Please describe the processes of your firm's search for external knowledge.
12. Are there any principles/values/policy that guide your search activities? If there are, what are they?
13. What are the key elements of your search processes?
14. What are the strategies employed to access external knowledge?
15. What are the impediments?

5. Lessons learned

16. Please describe your most successful knowledge search activities.
17. Why do you think they are successful?
18. What makes them successful?

Sections 4 & 5 (Questions 7-15) were aimed at investigating the search space and search heuristics adopted by the SMEs.

Appendix C. Summary of responses related to search heuristics

Participants	Responses
R1	For the research stage, they acquire external knowledge by analysing various alternatives that are available outside of the firm. Once the winning alternative is identified, they put it into test in the product development stage. Recently, they analysed several ready-to-eat food items from outside of the firm to see which ones have the longest shelf-life in room temperature. From this exercise, they identified the winning products and put them into test. The results of the test enabled them to develop sausages that do not need refrigeration for six weeks. It was a real product innovation in this category.
R2	They take the learning-before-doing approach in acquiring external knowledge to determine how to change their products. When it is determined that changes are needed, they will find out what the costs are. They will start experimenting the changes on a small scale in order to keep the costs low. After launching its first product three years ago, an essence of chicken beverage, the firm realised that it needed to change the product to make it more relevant to the need of the consumers who are primarily students. It collaborated with a university to develop a new product. Subsequently, the university developed a soy-based beverage designed to nourish the brain. The firm then commissioned a contract manufacturer to produce the new product on a small scale. This allowed the firm to test the new product without incurring substantial costs.
R3	They adopt both approaches: learning before doing and learning by doing, depending on the prevailing situation. When the firm started developing a new product which is canned coconut water, it decided to do cognitive search for external knowledge. The firm contacted its overseas customers and sought their assessment of the market potential for this product. When the firm received positive feedback from its customers about the market potential for this product, it decided to do experiential search by producing several variants of canned coconut water and had them tested by its customers. Finally, it launched canned coconut water based on the combination of cognitive and experiential search during the research and development stages of the innovation process.
R5	They acquire external knowledge during the research stage by talking to machinery suppliers and key clients. Once this is completed, they take it to the next stage by using a pilot plant to develop new products. This enables them to control costs and collect all the necessary data at the product development stage. When the market price for glucose was soaring due to the

shortage of its main raw material, cassava, the firm collaborated with its key clients and machinery suppliers to find a solution. This led to the development of a new product, called complex glucose. The new product was developed in the firm's pilot plant that can run small batches of production. This enabled the firm to collect all the relevant data without incurring excessive costs. Finally, a new product was launched as a substitute for glucose at a fraction of its original cost.

R7 They start the new product development process by seeking knowledge from their machinery suppliers. They ask the suppliers to provide them with a proposal and allow them to inspect the production process in order to assess its merits and constraints. Recently, the firm plan to launch ready meals product for seniors. They asked their machinery suppliers to provide proposals for the development and production of such products. One of the requirements for the proposal was that the participating machinery suppliers must allow the firm's technical and R&D personnel to inspect the production process of the proposed machinery prior to awarding the purchase contracts.

R8 They adopt the trial-and-error approach to gain external knowledge after launching new products to the market. They talk to consumers and the trade regarding the performance of their products. The firm launched a new functional beverage last year on a limited scale. After the launch, the marketing and R&D personnel asked for feedback from their customers. Based on the feedback received, a new improved product was developed and launched on a full scale.

Author biographies

Dr. Preecha Chaochotechuang received his PhD degree from Bangkok University. His research areas include innovation management, small and medium enterprises, and new product development.

Dr. Farhad Daneshgar received his PhD in Information Systems from the University of Technology, Sydney, Australia. He is currently affiliated with the College of Engineering and Science, Victoria University, Sydney, Australia, and has published extensively in the areas of Knowledge Management, Cloud Computing, and Enterprise Systems in the Basket of Eight and other high-rank journals.

Dr. Stefania Mariano is an Associate Professor of Management in the School of Business Administration at the American University of Sharjah (UAE). She earned her PhD degree from University of Molise (Italy). She lived and conducted research in Canada, USA, Europe, the Middle East and South-East Asia. Her current research interests focus on knowledge dynamics, organizational learning and forgetting processes.

……..

Reviewer: 1

Recommendation: Reject & Resubmit

Comments:
build a "conceptual framework" for the study.
Methodology is the weakest part.
Which questions do you want to answer and why?
You have provided some 100+ sources; yet only some 25% can be considered current
Do not attempt to answer questions for all SMEs - concentrate on a selected sector, describe the context where this sector operates, attempt to provide some useful tips for them.
Otherwise it is jet another literature review without any focus. But, good lick and keep going.

Additional Questions:
Q1 - Originality: Does the paper contain new and significant information adequate to justify publication?: I see no significant points that would justify publication at this point. It is a good initial study/review to start a sound research.

Q 2 - Relationship to Literature: Does the paper demonstrate an adequate understanding of the relevant literature in the field and cite an appropriate range of literature sources? Is any significant work ignored?: A very extensive literature review - there are 9 pages of references – have all these sources been used in the text? – have not checked, but I doubt. The understanding of the concept of open innovation is not clearly explained – the definition adopted by authors – page 3, 3rd paragraph by West et.al may be regarded controversial. Even if the leading one it should be put at the beginning of the section.

Q 3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the methods employed appropriate?: The paper is well referenced – in most parts it is in fact a literature review: introduction pp.1-9; Discussion … pp. 14-17; Limitations p.17; References pp.17-25. I have not checked it – seems like no all referenced positions are used in the text.

What is the research question? ◊ Understanding how SME search for external knowledge ….. page 2, 2nd paragraph – well, it is quite question, unless I have missed something authors wanted to address

Methodology (in fact if any) is a very weak point in the report. The sample is insufficient to provide any generalizations. The argument that four to ten cases are enough (p. 9 at the bottom) cannot be accepted here. It seems that all companies are from some food and beverages industry. The market (geographically) is not indicated. It will be worthwhile to indicate how many companies are in this industry. Expanding this concern: size – 15 to 280 employees, indicated that the sample is not homogenous. Therefore, any generalizations to " … how SME search for external knowledge …." cannot be supported. Authors confirm it on page 15, the first sentence of the part – limitations – but it is not reflected in the text.

Open questions – Appendix B – are very general – not prone for any "quantification".

Questions in the Interview protocol – part 1-4 – not reflected in Appendix A – general information on participants.

Appendix C – eg. (or as a part of point 6 comments)
R1 – the first sentence ◊ and so what? What are these alternatives?
R2 – They take …… and so what
Etc.
I found it difficult to relate responses to the text.

4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: Results ?? – Findings (p.11 the bottom of the page and 12-13 are weakly linked to what the authors might have found (what have they found that can be generalized based on the sample used?)

5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between theory and practice? How can the research be used in practice (economic and commercial impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: I cannot find any real implications to the theory or practice. It is an abbreviated literature review that highlights the key findings / opinions of the host of authors with a very weak link to the empirical part of the paper.

6. Quality of Communication: Does the paper clearly express its case, measured against the technical language of the fields and the expected knowledge of the journal's readership? Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: - Adequate, yet from my perspective too descriptive – nice sentences that do not bring clarity.

- Page 2 2nd paragraph ◊ the statement “Although relevant, current research has however largely understudied open innovation processes in SME’s …. “ calls for explanation
- Page 15, last paragraph – “Second, given …”what message do you want provide – all SMEs
- The word “heuristics” seems to serve a role of the “key” word.

Reviewer: 2

Recommendation: Major Revision

Comments:
Exploring the cognitive and experiential search heuristics practiced by SMEs in the open innovation process is the objective of the paper. The authors engaged in an exhaustive literature review of the subject matter but its relevant can be questioned. The key concern that I have about this paper is the disconnection that exists between its data and contributions. It appears to embrace uncritically ideas that have been published elsewhere (e.g. Lope-Vega et al., 2016) instead of looking hard to find undiscovered connections and new patterns in the study's data. The implications for practice are also poorly developed and this is an indication of a wider lack of engagement with the qualitative data. I would suggest that the authors need to do two things that are interconnected: 1) more qualitative data need to be included (quotes) that support the model advocated in the study 2) deconstruct Appendix C (summary of responses to search heuristics) in a manner that makes it into primary evidence that create the necessary connections between the data and the study's contributions to the literature.

Overall, I think there is potential in the paper which requires however significant work on a scale that is much greater than a simple revision.

Additional Questions:
1. Originality: Does the paper contain new and significant information adequate to justify publication?: The paper draws heavily on existing literature but its originality is not clearly presented. Even though this is a qualitative study, it appears that the authors used a deductive logic looking to see if ideas published in the literature are replicated in this study. This has somehow undermined the whole study even though the authors have worked hard to put together a good literature review.

2. Relationship to Literature: Does the paper demonstrate an adequate understanding of the relevant literature in the field and cite an appropriate range of literature sources? Is any significant work ignored?: There is a good literature review that covers all the relevant constructs used in the study.

3. Methodology: Is the paper's argument built on an appropriate base of theory, concepts or other ideas? Has the research or equivalent intellectual work on which the paper is based been well designed? Are the methods employed appropriate?: The study employed purposive sampling on the basis of two criteria: 1) SMEs that launched an innovative product in the past year 2) use of external knowledge in the innovation process. However, these criteria are not narrowing sufficiently the context of the study, in a way are not purposive enough and we get to know little about the geographical location of the chosen cases. Does this imply that the selected eight cases could have been nowhere and anywhere and their context does not really matter?

4. Results: Are results presented clearly and analysed appropriately? Do the conclusions adequately tie together the other elements of the paper?: The key problem with this study is the presentation of the findings. Primary data is either not presented but rather described (e.g. search heuristics) or quotes with very little added value are included. We get to know very little about what is different about these eight cases under investigation here. This is an SME study but R6 firm employs 280 people (Appendix A). Does this mean that this is not a European study? We almost have to take the researcher's word as evidence for the conclusions of the paper. The distinctions between the cognitive and experiential search are not well supported in the qualitative findings.

5. Implications for research, practice and/or society: Does the paper identify clearly any implications for research, practice and/or society? Does the paper bridge the gap between theory and practice? How can the research be used in practice (economic and commercial impact), in teaching, to influence public policy, in research (contributing to the body of knowledge)? What is the impact upon society (influencing public attitudes, affecting quality of life)? Are these implications consistent with the findings and conclusions of the paper?: The author(s) simply suggest that managers should look at the model to gain insights about how the open innovation process works in practice rather than explain in detail to the reader how these insights can be applied in a real situation.

6. Quality of Communication: Does the paper clearly express its case, measured against the technical language of the fields and the expected knowledge of the journal's readership? Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: The paper is well written and there are no language issues.

DEADLINE: 10-May-2019