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A review of literature on open innovation in small and medium-sized enterprises

Mokter Hossain

Correspondence: mokter.hossain@aalto.fi
Department of Industrial Engineering and Management, Institute of Strategy and Venturing, Aalto University, Otaniementie 17, 02150 Espoo, Finland

Abstract

Studies on open innovation in small and medium-sized enterprises (SMEs) have experienced a rapid growth over the last several years. Yet, there is no comprehensive review on this field of research. The objective of this study is to examine current research on open innovation in SMEs to integrate empirical findings and to point out future research agenda. Findings suggest that studies are mostly performed based on panel data and only several studies include sophisticated statistical analysis. Studies are mostly conducted in the European context along with some studies in China and Korea while studies in the context of North America are scant. Open innovation improves the overall innovation performance of SMEs. However, relevant theories and models for managers are not well-established in the literature.

Keywords: Open innovation; SMEs; Network; Strategy; Literature review

Introduction

Studies on open innovation have surged significantly ever since the open innovation concept was introduced by Chesbrough (2003). He defines open innovation as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation" (Chesbrough et al. 2006, p.1). Until recent time, studies on open innovation had mainly focused on large firms (van de Vrande et al. 2009; Bianchi et al. 2010). Many large firms such as IBM, Philips, and Procter & Gamble are successfully using open innovation in their strategies (Chesbrough 2003). Some studies on open innovation in the context of small and medium-sized enterprises (SMEs) are conducted in the early stage. However, these studies are mainly based on secondary data, conceptual, or managerial.

In general, SMEs lack both managerial and technical skills for their effectiveness (Rahman and Ramos 2010). They are less active than large firms in open innovation because of their particular characteristics such as organization, culture and strategy. A study by the OECD found that only 5-20% of SMEs are actively using open innovation approach. Studies on open innovation in SMEs are fragmented (Bianchi et al. 2010; Colombo et al. 2014). Some scholars argue that SMEs can achieve greater benefits from the open innovation than larger firms because of their less bureaucracy, increased willingness to take risks, and faster ability to react to changing environments (Parida et al. 2012). In addition, studies also show that open innovation is a promising means for SMEs to overcome their challenges and increase their profitability (Gassmann et al.

2010). Methods that can help SMEs to overcome barriers to the successful implementation of open innovation are necessary to explore. Consequently, integration of fragmented state of the literature is essential. The objective of this study is to examine current research on open innovation in SMEs to integrate empirical findings and to point out future research agenda.

Research methodology

The selected articles for this study are firstly collected from the ISI Web of Science database. This database includes quality articles. Recently, scholars have widely considered the ISI Web of Science as a rich source of significant research articles (Dahlander and Gann 2010). The data extraction took place at end of December 2014. Searching was limited within peer-review journal articles written in English for the period of 2003–2014 in the business discipline. From the ISI Web of Science database, the search results retrieved 37 articles using "open innovation" and "SMEs" as the keywords. However, the number of articles on open innovation in SMEs which are published in the journals listed in the ISI Web of Science is low. Hence, using the same searching criteria, to include more articles, a second attempt is made in the Scopus database. Altogether 56 articles were retrieved from the Scopus database.

Thereafter double entries of articles were removed. After careful reading abstracts and sometimes the main bodies of the articles, the irrelevant articles were left out from both the ISI and Scopus databases. Consequently, 68 articles were found relevant. A third attempt is made to find more articles and searching was performed in the Google Scholar and five more articles were found. Altogether 73 articles were found for this study purpose.

After carefully reading the main body of each article, 12 articles were excluded as these articles are beyond the scope of this study. The final dataset consists of 61 articles (see Figure 1). NVivo program is used to compare abstract of each article with others to generate broad themes of the studies (Macpherson and Holt 2007). Based on the thematic categories, necessary information from each article is tabulated in spreadsheet. Finally, thematic analysis is performed to identify empirical evidences from the studies.

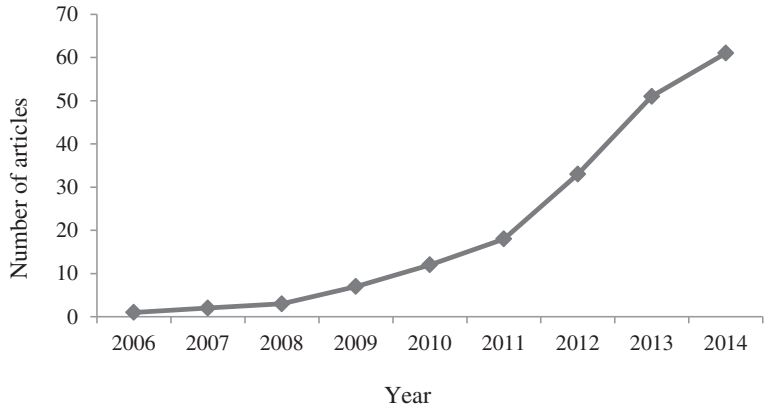

Figure 1 Number of articles published on open innovation in SMEs overtime.

Reviews

Searching strategy

Developing an appropriate searching strategy is an important step for SMEs to pursue open innovation. Acquisition and exploitation are crucial for searching strategy. Acquisition refers to the absorption of external technologies whereas exploitation refers to technology commercialization. Brunswicker and Vanhaverbeke (2014) identified five strategies that SMEs adopt for searching: (1) minimal searchers, (2) supply-chain searchers, (3) technology-oriented searchers, (4) application-oriented searchers, and (5) full-scope searchers. They also identified that each strategy entails a mix of interactions with external sources of innovation such as (1) customers, (2) suppliers, (3) universities/research organizations, (4) IPR experts, and (5) network partners. Going beyond technology road mapping methods (TRMs) to adopt the market pull strategy of technology-product integration, Caetano and Amaral (2011) proposed a method for the organizations such as SMEs and research centers. The collaborations of SMEs with their open innovation partners enable them to attain strategic moves which are not feasible for the closed innovation SMEs (Colombo et al. 2014).

Comacchio et al. (2012) suggest that the endowment of human capital at individual level and social capital at individual and organizational levels are the main determinants for SMEs in the task coordination activities implied by a boundary spanning role. SMEs can find very valuable development from external sources through partially revealing their internal development to external environment (Henkel 2006). Regional and national proximities along with external obstacles to innovation are the major drivers of SMEs to open their innovative activities (Idrissia et al. 2012). However, Lecocq and Demil (2006) found that open systems strategy in an industry creates an entry induction phenomenon and new entrants adopt the open systems more readily than the incumbents. SMEs need to focus significantly on the selection of practices and partners (Theyel 2013). SMEs develop searching strategies for various activities such as new knowledge, innovative ideas, partners, and potential market. However, searching strategies provide less benefit for SMEs than for large firms (Lee et al. 2010; Spithoven et al. 2013).

Challenges for innovation management

SMEs face unique challenges for innovation. Abouzeedan et al. (2013) argue that these challenges include scarcity of resources, complexity of scientific field, coordination of the operative functions of the firm, and access to up-to-date scientific excellence. Even though licensing out the knowledge of SMEs to external parties is beneficial for them, it is not appropriate for short-term benefits (Andries and Faems 2013). Christensen et al. (2005) highlighted that the complexity of interplay between technology entrepreneurs and incumbents. They showed that open innovation sometimes incurs high transaction costs. Using data from the European car industry, Dodourova and Bevis (2014) found that SMEs have weak ties with other organizations and larger incumbents. SMEs practice open innovation activities extensively even though they face a number of barriers while trying to apply open innovation (Pullen et al. 2012).

van de Vrande et al. (2009) argue that most SMEs face challenges that are related with organizational and cultural issues to deal with the increased external contacts.

These challenges include venturing, customer involvement, external networking, research and development (R&D) outsourcing, and external participations. Moreover, SMEs in developing countries face different challenges from the SMEs in developed countries. Vrgovic et al. (2012) suggest that, in developing countries, a government agency using innovation hubs, could help SMEs to connect, communicate and collaborate with independent inventors and other parties to jumpstart innovation practices. However, Wynarczyk (2013) argue that in the international competitiveness, SMEs are highly dependent on two key internal components – R&D capacity, and managerial structure and competencies, and two external factors – open innovation practices and the ability of the firm to attract government grants for R&D and technological development.

Policy for open innovation

Open innovation has appeared as an alternative method for providing SMEs with R&D outsourced services as a strategically focused approach (Albors-Garrigós et al. 2011). A study over UK technology-based SMEs identified that these firms are quite different from policy makers' perceptions (Brown and Mason 2014). Consequently, many public policies are not supportive to them. Csath (2012) argues that embracing open innovation is essential for SMEs to grow internationally and they need an educational system which encourages and appreciates creativity, criticism, self-discipline, self-motivation, desire for knowledge and life-long learning, openness, and cooperation. Hemert et al. (2013) claimed that policy makers may not be aware of the importance of various networks for SMEs. Innovation support schemes from the public actors are useful to sensitize SMEs towards open innovation practices (Kamp and Bevis 2012). Kim et al. (2014) suggested that team size, perceived uncertainty, and fostering outbound openness are pivotal for the success of open innovation policy. They argue that effective medium team size is appropriate to provide public support for the cooperation and collaboration. Eco-innovation is increasingly becoming an integral part even for SMEs. SMEs may embrace informal, systematic, and open innovation approaches for eco-innovation (Bocken et al. (2014).

McAdam et al. (2014) argue that policy should devise to integrate SMEs in network support programs to encourage the initiation and development of such networks. Roper and Hewitt-Dundas (2013) believe that in many countries public funding is provided to university and company R&D centers to act as a catalyst for open innovation whereas public funding should focus towards the needs of SMEs. Suh and Kim (2012) suggested that public policy initiatives differentiating from networking strategy are better to facilitate open innovation in service SMEs. Vega et al. (2012) found that the existing public policy needs to improve significantly to accelerate open innovation in SMEs. Considering Europe's challenges for innovation, Vigier (2007) argue that cluster and open-innovation policies can foster innovation to better respond to individual needs, and national reform programs should foster society-driven innovation considering issues in the regional level. Zeng et al. (2010) found that Chinese SMEs' linkage and cooperation with government agencies do not have significant impact on SMEs' innovation performance. Yan and Yu (2013) suggest that appropriate policy initiatives such as tax incentives may effectively help SMEs to become active participants in technology innovation.

Absorptive and desorptive capacities

Braun et al. (2012) found that both absorptive and desorptive capacities play a significant role in the interaction of potential cooperation partners. However, they also found that in the negotiation process, the importance of these capacities shifts from firm level to personal level. Absorptive capacity means firms' ability to sense, value, assimilate, and apply new knowledge and desorptive capacity means a firm's capability of external knowledge exploitation (Lichtenthaler, 2007). SMEs require new managerial capabilities as part of an integrated managerial system for open innovation (Brunswicker and Ehrenmann 2013). However, Grimaldi et al. (2013) argue that the absorptive capacity consists of different components, and neither the amount of R&D expenditures nor the presence of an R&D unit is sufficient to measures absorptive capacity. According to Spithoven et al. (2011), SMEs lack absorptive capacity and hence technology intermediaries are useful for them. They found that R&D-related activities may share around a half of a budget of a technology intermediary center and consequently these form an important element of absorptive capacity. Teirlinck and Spithoven (2013) argue that research cooperation and R&D outsourcing often offer possibilities to complement the internal research resources but they need absorptive capacity and managerial skills of the internal R&D personnel. However, almost all SMEs are involved with open innovation to some extent (Idrissia et al. 2012). Theyel (2013) found that more than 50% of US SMEs engage in open innovation to some degree during technology and product development and commercialization.

Collaboration

Collaboration of SMEs depends on what they are aiming to achieve. Spithoven et al. (2013) found that SMEs' collaboration with external agencies increases their chances of launching products and services. A study by Parida et al. (2012) pointed out that for SMEs, vertical collaboration is relevant for radical innovation, and horizontal collaboration is appropriate for incremental innovation. However, under an industry's open system, vertical specialization may result in a decrease in the size of SMEs (Lecocq and Demil 2006). Collaboration of SMEs goes beyond science and technology and includes value chain partnerships that bring new knowledge bases which they can absorb easily (Spithoven et al. 2013). Wynarczyk (2013) believes that open innovation SMEs tend to collaborate for product introductions whereas closed innovation SMEs tend to collaborate for incremental changes of their existing products. Studies have repeatedly confirmed that collaboration for SMEs is more important in the commercialization stage than in the early stages of innovation (van de Vrande et al. 2009; Hemert et al. 2013). The size of the firm is related with the degree of collaboration. For example, studies found that smaller the size of an SME less the degree of collaboration (van de Vrande et al. 2009; Teirlinck and Spithoven 2013).

Dynamic capabilities

Dodourova and Bevis (2014) revealed that SMEs benefits greatly from dynamic, knowledge-based, labor-intensive industries but they have limited options in mature capital-intensive asset-based industries. Grimaldi et al. (2013) explored the critical dynamic capabilities of SMEs in the innovation process. They found that SMEs with

strong sensing, seizing and configuring capabilities are more inclined to develop open innovation approaches. Zeng et al. (2010) found that the vertical and horizontal cooperations with customers, suppliers, and other agencies plays more distinct role in the innovation process of SMEs than horizontal cooperation with research institutions, academic institute and state agencies. Guräu and Lasch (2011) identified some factors that accelerate the capacity of SMEs to develop and manage open innovation systems. These factors include the size of the firm, its organizational stage, its capability to develop partnerships and its capacity to identify partner organizations with complementary resources and its capacity of implementing and managing open innovation systems. A broad knowledge base of SMEs helps them to appropriate from the dynamic capabilities approach (Heger and Boman 2014).

Patenting

Like large firms, SMEs also benefit from patenting. Andries and Faems (2013) found that patenting activities significantly help SMEs to license out their knowledge to external parties. Timely recognition of opportunities for out-licensing a firm's technologies outside its core business is challenging. SMEs possess focused business portfolio, specialized knowledge base, and limited financial resources for innovation activities. Bianchi et al. (2010) developed a methodology to demonstrate how SMEs can identify viable out-licensing opportunity. Jeon et al. (2011) demonstrated an approach for finding external partners through patent information. They argued that firms can find partners by undertaking three consecutive steps: data collection and preprocessing, transforming patent documents into co-occurrence vectors, and deriving potential technology partners based on similarity indicators. When dealing with SMEs, Universities and state organizations need to consider diverse and adaptable IP-management strategies (Saguy and Sirotinskaya 2014). Spithoven et al. (2013) found that the turnover of SMEs from new products is mainly driven by patent protection whereas large firms benefits predominantly from their searching strategies. In service SMEs, Suh and Kim (2012) found that technology acquisition is positively related to patenting activity. SMEs may consider patenting as an important strategy to fully benefits from their innovation activities (Andries and Faems 2013).

Networking

Networking is an effective way to facilitate open innovation among SMEs (Lee et al., 2010). However, Heger and Boman (2014) found that network partnership is primarily used for activities such as data collection and limitedly used for fundamental activities such as strategy and decision-making. They also found that SMEs may benefit substantially from network approaches to foresight opportunities. Innovative SMEs are more inclined to network with other SMEs and institutions (Hemert et al. 2013). McAdam et al. (2014) demonstrated that knowledge-based open innovation and social network constructs support the concept of horizontal collaborative networks. SMEs need to give attention to both formal and informal relationships with various stakeholders in terms of open innovation (Padilla-Meléndez et al. (2013). However, Pullen et al. (2012) found that a relatively closed, focused, and consistent networking approach results in high innovation performance. They argue that a successful network profile includes high level of goal complementarity, resource complementarity, trust and low network

position strength. Networking may not be an efficient activity for service SMEs (Suh and Kim 2012). Among Hungarian SMEs, Török and Tóth (2013) found that the personal networks still play an important role in the success of SMEs. Managing multiple networks are challenging for SMEs. Consequently, SMEs need to trade-off between intensive and extensive networks, and they are very cautious regarding with whom they should build network (Hughes 2009). In general, SMEs prefer networking with customers over suppliers (Theyel 2013). However, Hronszky and Kovács (2013) argue that supporting agencies such as Living Labs provide innovation services by integrating SMEs as users in a collaborative working environment that would not be available otherwise.

Open innovation performance

Open innovation is essential for continuous growth of SMEs especially in the high-tech industries (Yun and Mohan 2012). Colombo et al. (2014) argue that SMEs largely depend on the resources of their open innovation partners to implement their strategies. Fu (2012) found that long- and short-term incentives both have significantly positive effects on the innovation efficiency of firms and long-term incentives have a greater effect than short-term incentives. She also found that SMEs' open innovation via external collaboration has a curvilinear (inverted U-shape) relationship with innovative efficiency. Among Chinese SMEs, there are significant relation between inter-firm co-operation, cooperation with intermediaries, cooperation with research organizations, and innovation performance of SMEs (Zeng et al. 2010). However, inter-firm organization has most significant positive impact on innovation performance of SMEs. Huang et al. (2013) showed that open innovation has a significant mediating effect on the relationship between organizational inertia and business model innovation, and the relationship between organizational inertia and firm performance. Kim and Park (2010) found that, among Korean SMEs, external R&D has a positive and significant effect on innovation output, but external ideas have a negative effect and external knowledge has no impact. Thus, not all open innovation activities have positive effect on innovation output.

Kim et al. (2014) argue that in project level openness may be affected by team and task characteristics. These characteristics include team size, learning distance, strategic importance, technology and market uncertainty, and relevance of the task to the main business. Technology sourcing is related with radical innovation performance, whereas technology scouting is with incremental innovation performance (Parida et al. 2012). Exploring SMEs in the UK, Laursen and Salter (2006) found that searching widely and deeply is curvilinearly (taking an inverted U-shape) related to performance. They argue that SMEs that are more open to external sources or channels are more likely to gain higher level of innovation performance. Laursen and Salter (2014) explored a paradox of openness — the creation of innovations often requires openness, but the commercialization of innovations requires protection. They found a concave relationship between firms' breadth of external search and formal collaboration for innovation, and the strength of the firms' appropriability strategies. Moreover, they showed that this concave relationship is stronger for breadth of formal collaboration than for external search. Suh and Kim (2012) explored the R&D performance of service SMEs and found that in-house R&D, technology acquisition, and R&D collaboration are positively related to product/service innovation,

patenting activity, and process innovation, respectively. Whatsoever, Chaston and Scott (2012) found that, although involvement in open innovation may enhance business performance, SMEs operating in emerging economies may not necessarily depends on entrepreneurial behavior for business growth.

Benefits of open innovation in SMEs

Lee et al. (2009) found the open innovation is not an attractive option especially for the the early-stage ventures which may not have adequate capabilities regarding R&D investment and capital. Apparently, open innovation has high potential for SMEs (Lee et al. 2010). However, Oakey (2013) criticizes Chesbrough for exaggerating the applicability of open innovation systems because R&D is often long-term, expensive and always risky and required necessary protection of outcomes. He argues that closed innovation is still an effective way for R&D investment. However, The Internet along with supporting tools such as Web 2.0 is becoming increasingly essential to leverage internal and external capabilities of SMEs (Bell and Loane 2010).

Some scholars argue that SMEs are more effective than large firms in using various open innovation practices in parallel (Spithoven et al. 2013). However, Lichtenthaler (2008) found that most SMEs are still pursuing closed innovation over open innovation. Török and Tóth (2013) argue that firms that provide their ideas to external parties are more product innovative than non-providers. They found that mutual – rather than one-way exchange – relationships significantly raise the probability that SMEs experience a substantial benefit from contributing to other firms' new product development projects. Tranekjer and Søndergaard (2013) explored Danish SMEs to find the cost associated with various sources of innovation. They found that market and science sources are related with decreased costs, collaboration with suppliers of similar knowledge base is related with market performance, and collaboration with customers results in lower project costs. However, they found that degree of novelty in new products is lower for SMEs that are closely embedded with suppliers. Technology scouting is a low cost but an effective option for high-tech SMEs (Parida et al. 2012). As a whole, SMEs are increasingly adopting open innovation as a part of in their business activities (Xiaobao et al. 2013; van de Vrande et al. 2009).

Commercialization

A seminal study by van de Vrande et al. (2009) found that SMEs pursue open innovation mainly for commercial activities such as meeting customer demand and keeping up with competitors. Hemert et al. (2013) demonstrated that SMEs' interaction with sources of innovation is important not only in the recognition phase of the innovation process but also at the end stage of the innovation process for the successful commercialization of a product or a service. In Korea, Kang et al. (2013) found that the firm size and the degree of government support have significant impact on commercialization of SMEs. They also found that appropriability, innovative capabilities and investment in external R&D have highly positive impacts on SMEs' commercialization. Lee et al. (2010) argue that SMEs are good at inventions but lack necessary resources for commercialization. Hence, they suggest that collaboration with other partners including intermediaries at the commercial stage may help them to

overcome their limitations for commercialization. Collaboration for SMEs is more important in the commercialization stage than other stages such ideation, and R&D (van de Vrande et al. 2009; Hemert et al. 2013; Theyel 2013). For SMEs, open innovation is less effective for innovations than for sales (Chaston and Scott 2012; Spithoven et al. 2013). However, cooperation with industry incumbents helps to overcome challenges SMEs encounter (van de Vrande et al. 2009).

Conclusions

This review study has revealed several key issues regarding open innovation in SMEs. There is limited number of studies in the top-notch journals. Scholars from the European Union have played a major role in the literature. Some Asian countries such as China, South Korea, and Taiwan have been explored to a considerable extent. The articles on open innovation in SMEs have appeared in a wide range of journals. Simple statistical analyses are used in most of the studies. Hence, future studies should adopt highly sophisticated analysis techniques. Most of the impactful articles are based on panel data. Studies based on primary data would bring very intuitive results. Longitudinal studies may be useful to get insightful knowledge about the relevance of open innovation for SMEs.

For SMEs, open innovation is more useful for commercialization than early stage activities such as for R&D. Compared to large firms, SMEs need to be more careful in terms of their intellectual property (IP) as they protect very selective technologies. Careful balance between revealing and protecting of IP in collaboration is crucial. SMEs are less inclined to adopt searching strategies than large firms. For them, open innovation is more relevant for new product innovation than for incremental innovation.

New entrants are quicker than the incumbents in adopting open innovation. Open innovation brings some measurable effects along with some indirect benefits. Along with R&D activities, SMEs may consider R&D-related activities such as meeting customer demands and remaining competitive. Collaboration with external parties is costly and lengthy process. Hence, adopting new management paradigm is necessary for SMEs. Studies on open innovation in SMEs largely consider high-tech SMEs. Future studies may give more emphasis on SMEs that are not in high-tech industries.

Studies with broad geographical consideration encompassing Asia, Africa, and South America are necessary to consider for future studies. Several studies discussed policy requirements for SMEs to adopt open innovation, but very superficially. Unlike large firms, support for SMEs from state and other agencies are very essential. Consequently, policy developments to support SMEs for open innovation need high attention in future exploration. Scholars need to develop nexus between innovation and entrepreneurship to advise policy makers. Absorptive and desorptive capacities are limitedly and unsystematically practiced by SMEs. However, open innovation requires SMEs to adjust their strategy for absorptive and desorptive capacities.

Innovation involves various issues such as culture, trust, and litigation. However, these issues remain unexplored in the existing literature. Open innovation is deeply rooted with the culture of a particular location. For open innovation, cultural issues need to be explored in various contexts.

Many activities for open innovation depend on trust building among stakeholders. How trust can be built and what are the main catalysts for that are necessary to identify. Sharing properties such as ideas, technologies, and business models with external parties brings legal issues which are highly relevant.

Due to resource and other limitations, SMEs are not able to maintain numerous networks. Therefore their skills in maintaining few relevant networks are essential for open innovation activities. To boost SMEs' open innovation activities, establishment of some organizations such as Living Labs, and venture capital especially in developing countries are necessary. Role of state, public organization and intermediaries to transform SMEs towards open environment may be useful to explore in the future studies. Despite more use of open innovation in the commercialization stage, studies towards that stage are still relatively low.

Competing interests
The author declares that he has no competing interests.

Authors' information
Mokter Hossain is a researcher at Institute of Strategy and Venturing, Department of Industrial Engineering and Management, School of Science, Aalto University, Finland. He researches on innovation management in general. His research focus includes open innovation, user innovation, crowdsourcing, crowdfunding, frugal innovation, and reverses innovation.

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