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LEVERAGING 'THE CROWD': AN EXPLORATION OF HOW SOLVER BROKERAGES ENHANCE KNOWLEDGE MOBILITY

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Abstract

The concept of open innovation has drawn considerable interest from both researchers and practitioners in recent years. We conceptualize the emerging phenomenon of Open Innovation intermediaries (or 'Solver Brokerages') as intermediaries that facilitate innovation exchanges between organizations and crowds. The study presents a theoretical model based on extant research, which is refined through a field study consisting of elite interviewing, with representatives from four solver brokerages as well as stakeholders from an innovation-seeking organisation and a solution provider. In exploring how Solver Brokerages enhance knowledge mobility, the paper examines the ways in which providing access to a knowledgeable and diverse solution community, facilitating problem decomposition and articulation, and mechanisms for increasing appropriability affect knowledge mobility. In addition, the paper examines the ways in which filters and rewards affect appropriability as well as the roles played by collaborative mechanisms in mediating these effects.

Keywords: Open Innovation, Crowdsourcing, Solver Brokerages, Innovation Intermediaries, Knowledge Mobility, Appropriability

1 INTRODUCTION

In open innovation (cf. Chesbrough, 2003: 2006) firms supplement, or even supplant, internal Research and Development (R&D) efforts by leveraging a variety of sources for knowledge 'inflows' including suppliers, partners, customers, competitors, academic researchers, etc. There have been numerous examples of the successful application of open innovation R&D processes in commercial settings such as consumer electronics (Blau, 2007), pharmaceuticals (Lane and Probert, 2007), as well as automobiles and computer hardware (Gwynne, 2007). Such examples illustrate that organisations seeking to acquire innovation and/or innovation capacity will look to establish cooperative relationships with external parties. While many firms seeking to acquire innovation resources (skills and solutions) outside the firm favour traditional inter-firm licensing agreements, the dispersed nature of knowledge and the relative difficulties in accessing innovations and knowledge from firms with which a firm does not have an existing business relationship is likely to give rise to increased use of intermediaries for open innovation (Feller et al., 2009). Crowdsourcing (cf. Howe, 2008) is seen having a lot of potential in operationalising open innovation strategies (Ahonen et al., 2007). Companies such as Proctor and Gamble have successfully used crowdsourcing using a dedicated web-presence, while third-party open innovation intermediaries such as InnoCentive, NineSigma and YourEncore offer mediated crowdsourcing services to firms. Such intermediaries aggregate both demand for capabilities (firms seeking innovators capable of meeting specific challenges) and supply (a large and diverse population of innovators), and are referred to as 'solver brokerages' (Feller et al., 2009). However, as Lichtenthaler and Ernst (2008) note, little is known about such brokerages.

We argue that a richer understanding of Solver Brokerages, and the processes that they need to support, can be achieved by taking into account the distinct nature of the transactions that they mediate. Specifically, such brokerages do not focus on commodity-for-cash exchanges, such as those found in many markets. Rather, companies like InnoCentive, NineSigma and YourEncore broker collaborative innovation exchanges. Viewed from this perspective, such exchanges are conceptually similar to 'Innovation Networks' (cf. Dhanaraj and Parke, 2006) in that they deal with high levels of transactional uncertainty and the exchange of tacit knowledge (cf. Dhanaraj and Parke 2006, Feller et al., 2009). In exploring how solver brokerages operationalise crowdsourcing, we first begin a process of theory building with an analysis of extant research on innovation networks, crowdsourcing, and traditional marketplace intermediaries; delineating constructs and the relationships between these constructs in the form of theoretical propositions. We then use a field study to explain how solver brokerage can enhance knowledge mobility, and conclude by discussing the implications of our work.

2 THEORETICAL GROUNDING AND CONCEPTUAL MODEL

In this section, we utilize extant research to develop a conceptual model for our study. We conceptualize Solver Brokerages as (a) *intermediaries* that facilitate (b) *innovation exchanges* between (c) *organizations* and *crowds*. Solver Brokerages seek to match innovation problem owners (often referred to as "seekers") with potential solution providers (often referred to as "solvers"), to aggregate dispersed knowledge and to mitigate risks and uncertainties for market participants. Activities include helping firms to identify potential solvers, specify problems, manage legal and logistical issues, and otherwise reduce the costs associated with search, discovery and purchase of capability (Feller et al. 2009). This conceptualisation is in line with the function of indirect markets (e.g. Hayek 1945; Clemons and Weber 1990; Lee and Clarke 1996) and with related research describing the roles played by brokerages in innovation and technological development contexts (Howells, 2006), particularly in terms of diffusion/technology transfer and innovation management (Watkins and Horley, 1986; Hargadon and Sutton, 1997; Howells, 2006).

Although Solver Brokerages exhibit many of the characteristics of indirect markets (c.f. Hayek 1945; Clemons and Weber 1990; Lee and Clarke 1996) in that they facilitate exchanges, we note that Solver

Brokerages support transactions that are different from commodity-for-cash exchanges found in many markets, and are instead closer in character to innovation exchanges (collaborations) such as those found in the "Innovation Networks" (cf. Dhanaraj and Parke, 2006). There are differences between the two phenomena, most notably the fact that Innovation Networks are steered by a hub firm who is an active participant in the network, whereas a Solver Brokerage is an external third-party that facilitates the innovation process. There are however important similarities, as both seek to create environments in which firms can safely seek external knowledge, collaborate on solutions to problems, and capture the value associated with such solutions. Solver Brokerages are furthermore shaped by the nature of the resources aggregated on the supply-side, namely the potential capabilities to be leveraged through the process of "crowdsourcing" (Howe 2008; c.f. Shirky 2008; Sunstein 2006; Surowieki 2004). At its core, innovation is about knowledge and emerges as a result of combining different knowledge sets (Nonaka et al. 2003; Tidd et al, 2005), and such knowledge is frequently to be found outside the organization (Chesbrough, 2003; De Wit et al. 2007). As noted by Feller et al. (2009), a key function of solver brokerages is to lower uncertainty for seekers and solvers by easing knowledge exchange by participants (i.e. the seekers and solvers). In line with Dhanaraj and Parke (2006), we use the term Knowledge Mobility to refer to, and define, this function of solver brokerages and define our first construct: ***Knowledge Mobility*** *- the ease with which knowledge is shared, acquired, and deployed.*

To understand how Solver Brokerages might enhance knowledge mobility, we draw on the literature on innovation networks (cf. Dhanaraj and Parke, 2006) and crowdsourcing (cf. Howe, 2008). Crowdsourcing is the "the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call" (Howe, 2008). In recent years, it has been observed that a key aspect of the design of open innovation brokerages has been providing processes that utilise crowdsourcing techniques (Tapscott and Williams, 2006; Whitla, 2009). Indeed, Whitla (2009) illustrates that an intermediary can vary in its approach to operationalising crowdsourcing, with the simplest form being a specialised crowd in the form of an online community to the more complex process of aggregating a more generalised crowd who then pick and chose which tasks they wish to complete. In the business press on crowdsourcing (cf. Howe, 2008), the term 'the right crowd' is used to refer to our second construct: ***The Solution Community*** *- The optimal group of people that can, individually or collectively, provide or generate the desired innovation solution.* In line with other research (e.g. Tapscott and Williams 2006, Whitla 2009, Howe 2008, Shirky 2008, Sunstein 2006, Surowieki 2004), we characterise open innovation brokerages as essentially service providers that enable firms to leverage crowdsourcing techniques by providing access to an appropriate solution community. We thus present our first proposition: ***Proposition 1*** *- Knowledge mobility is enhanced by access to an appropriate solution community.*

Research on the design of brokerages (e.g. Dai and Kauffman, 2002; Soh et al., 2006) has illustrated that searching and matching are key elements. Indeed, as the search for solutions is an uncertain process, the complexity of a problem influences the optimal method of solution search and the optimal means of organising that search (Nickerson and Zenger, 2004). Popularly referred as 'asking the right question' (cf. Howe, 2008), we use the term ***Challenge Specification*** to refer to our third construct: *The framing of the problem so as it can be solved by potential solvers.* In adopting Nickersons and Zengers' (2004) logic, we purport that providing the correct search path by clearly defining and communicating the problem to be solved is essential for knowledge mobility, and can present our second proposition: ***Proposition 2*** *- Knowledge mobility is enhanced by challenge specification.*

It is evident that Crowdsourcing involves some form of payment (Howe, 2008). Furthermore, in relation to innovation networks, Dhanaraj and Parke (2006) use the work of Teece (1986) to argue that hub firms in an innovation network must engage in activities to maximise members' "ability to capture the profits generated by an innovation" (p. 660, quoting Teece 1986, p. 610). They refer to this ability as 'Knowledge Appropriability' and argue that it is an enabler of knowledge mobility. In adopting the logic of Dhanaraj and Parke (2006), we purport that solver brokerages must enable appropriability and thus present our fourth construct: ***Appropriability*** *- The ability of seekers and solvers to capture value*

from the innovation process; and also our third proposition: ***Proposition 3*** - *Knowledge mobility is enhanced by appropriability*.

The issue of value capture (appropriability) looms large in the traditional marketplace literature as well as in the crowdsourcing literature. In relation to the trading of products, one of the key value adding processes provided by marketplaces is assistance to the buyer in evaluating both the products offered and the service provided. This process is also useful to the product/service provider as it helps them tailor the product / service offering to the needs of the potential buyer (cf. Fairchild et al., 2007). In line with Howe (2008), we use the term 'filtering' to refer to our fifth construct: ***Filtering*** - *The evaluation of potential solutions*. We use the logic inherent in the marketplace literature to present our fourth proposition: ***Proposition 4*** - *Appropriability is enhanced by filtering*.

Rewards to participants in user innovation communities are a key aspect of crowdsourcing. Researchers (Von Krogh, 1998; Von Hippel, 2001; Brabham, 2009) believe that rewards can be provided in a variety of forms including the opportunity to make money, the opportunity to develop one's creative skills, elevate reputations, expected reciprocity and incentives to help build a community. Therefore, when designing their processes, a solver brokerage needs to decide upon which rewards work best and should be offered to participants. We thus present our final construct: ***Rewards*** - *The incentives offered to seekers and solvers for participating in the innovation process and developing potential solutions*; and final proposition: ***Proposition 5*** - *Appropriability is enhanced by rewards*.

3 RESEARCH APPROACH

The study was categorised as exploratory due to the scarcity of empirical work in the area, and the focus on discovery and theory building. In line with Lee and Baskerville (2003) (who document the process of generalising from theory to empirical description), we began with extant theories of innovation networks, crowdsourcing and marketplace intermediaries to frame our conceptual model (section 2). In order to empirically investigate the conceptual model, we took direction from Marshall and Rossman (1989) who propose that either a case study or field study method can be used in exploratory research. We decided that a field study would be most appropriate for this study as it would facilitate the collection of data from a larger number of organisations, and would form the basis for more focused research at a later stage; an approach consistent with the thinking of Galliers (1992). The field study method consists of narrowly focused cross-sectional qualitative case studies (McGrath, 1979) that measure dependant variables without any attempt to control independent variables (Buckley et al., 1976).

The study focused on four solver brokerages: InnoCentive, YourEncore, NineSigma, and InnoCrowding, as well as one seeker (Rockefeller Foundation) and one solver (An independent consultant). InnoCentive, YourEncore and NineSigma have been identified as leading examples of open innovation (cf. Motzek, 2007; Huston & Sakkab, 2006) and we included InnoCrowding, as a representative emerging company addressing the needs of small and medium sized enterprises (SMEs) in the open innovation space. Data was gathered from July 2008 to May 2009, using (1) documents (e.g. white papers) and interviews published by the firm, (2) analysis of the companies' web-based systems for acquiring IP (where applicable), (3) secondary content (e.g. news articles) related to the companies and (4) elite interviews with key personnel (cf. Marshall and Rossman, 1989). The interviews, which lasted approximately 60 minutes each, focused on the knowledge integration aspects of matching IP seekers and providers revealed by the secondary data analysis. See Table 1 for study sites and interviewees.

Interviews were transcribed; yielding 250 pages of notes. Content analysis on the interview transcripts and other documentation was undertaken using open, axial and selective coding (cf. Strauss and Corbin, 1990), as exemplified by Orlikowski (1993) and Urquhart (1997). This approach necessitates the researchers to be immersed in the data (Glaser and Strauss, 1967) and to draw on existing theoretical knowledge without imposing a theory (Corbin and Strauss, 1990; Urquhart, 1997). It thus

encourages the researcher to be flexible and creative (Sarker et al., 2000) while imposing systematic coding procedures (Strauss and Corbin, 1990). The first step (open coding) involved the data being examined 'line by line' to ascertain the main ideas, which were then grouped to reveal categories (informed by constructs developed in section 2) and sub-categories/properties. The next step (axial coding) was the process of determining hypotheses about the relationships between a category and its subcategories. Relational and variational sampling (cf. Strauss and Corbin, 1990) was used to select data to assess the validity of these hypothesized relationships. This process continued in an iterative manner, and resulted in the modification of categories and relationships. Finally, Selective Coding was undertaken to identify the relationships between categories (constructs) using hypothesized conditions, context, strategies and consequences. Discriminate sampling (cf. Strauss and Corbin, 1990) was used to select data to examine strong and weak connections between categories. The results of this analysis are discussed in the next section.

Company	Overview	Interviewees
InnoCentive	Established in 2001, InnoCentive (www.innocentive.com) provide a web site where firms (called 'seekers') can post problems to be solved (called 'challenges') in over 40 industry disciplines in the areas of physical, life and computer sciences, chemistry, engineering and design, business & entrepreneurship. A community of over 125,000 experts (called 'solvers') review the posted challenges, and possibly propose solutions. Seekers evaluate the solutions, and possibly purchase one or more that meet their needs.	Innovation Development Manager
NineSigma	Established in 2000, NineSigma (www.ninesigma.com) work on behalf of clients to source ideas, technologies, products and services from innovators outside the client's organisation. NineSigma possess a multi-national, multi-disciplinary proprietary network of scientists, university researchers and technology incubators (referred to as 'Solution Providers') that have signed up to NineSigma through their website. NineSigma work closely with clients throughout the due diligence, Request for Proposal (RFP), response management and solution evaluation processes.	CEO of NineSigma Europe
YourEncore	Established in 2003, YourEncore (www.yourencore.com) maintain a network of retired/veteran scientists, engineers and other experts, and offer companies (in the U.S. only) the ability to utilise these experts to solve problems on a short-term assignment basis, either remotely or on-site.	Vice President of Market Development and Strategy
InnoCrowding	Established in 2006, InnoCrowding helps SMEs to leverage the prize-based model of open innovation, beginning inside the seeker firm itself and escalating to a global pool of skilled problem solvers through a proprietary platform. The firm also offers a range of value-added services such as IP Portfolio Analysis, access to databases of innovation for sale/licence and requests for e-partners.	Executive Vice President
Rockefeller Foundation (seeker)	Founded in 1913, the Rockefeller Foundation is a prominent not-for-profit organisation with the mission to "to promote the well-being of mankind throughout the world". Renowned for its philanthropic activities and it financial assets, It is widely regarded as being one of the most influential non-governmental organisations in the world. The Rockefeller foundation sponsors innovation challenges on InnoCentive on behalf of non-profit organisations.	Associate Vice President
Solver	An independent consultant with a background in medical devices and commercialization of technology, he has been a challenge winner of one problem on InnoCentive. He has submitted solutions to 5 problems in the past, and currently has 2 solutions pending review.	Independent Consultant

Table 1. Study Sites and Interviewees.

4 FINDINGS OF THE RESEARCH STUDY

In this section, we describe the findings of the research study. The findings show that mobility is affected by the ability of brokerages to enable access to an appropriate solution community, facilitate the specification of challenges, and ensuring that all parties in the innovation exchange are able to appropriate value from the interaction. The findings also show that appropriability is affected by the ability of brokerages to provide filters (mechanisms for evaluating proposed solutions) and rewards (mechanisms for ensuring all parties, successful or not, capture value from participating). Additionally, we highlight the mediating role played by technological systems, formal and informal governance, and other mechanisms. Based on our analysis, we are able to advance our theory development process by refining the propositions presented in section 2.

4.1 Mobility

The findings demonstrated that Solver Brokerages seek to maximise the ease with which "knowledge is shared, acquired, and deployed" by (1) aggregating a sufficient mass of innovation seekers, (2) aggregating a sufficient mass of solution providers, (3) implementing mechanisms and processes to facilitate exchanges between the two populations. Depending on the brokerage, these activities might be focused on providing innovation seekers with access to a large, anonymous solution community (a service provided by InnoCentive, InnoCrowding and NineSigma) or to a specific community (e.g. the community of retirees at YourEncore), or communities of internal employees (a service provided by NineSigma, InnoCentive and InnoCrowding). The level of mobility in these contexts is evident from the levels of activity in the brokerages (number of problems posted/solutions proposed) and more specifically by levels of successful knowledge exchanges (solutions accepted and implemented).

4.1.1 Assembling an appropriate solution community

The brokerages identified the need for problems to be presented to a population of solution providers with relevant knowledge as well as diverse skills and perspectives. The aggregated knowledge and capabilities of such a population form the basis for sharing, acquiring and deploying knowledge. Two operational models for assembling an appropriate solution community were observed:

1) Maximise the size of the solution community.

One approach to assembling an appropriate solution community is to simply maximise the number of participants, relying on large numbers of self-selecting participants to collectively provide a diverse set of relevant skills and perspectives. This strategy is evident in the operating model of established brokerages, such as InnoCentive, who make all innovation challenges visible via the public web. Similarly, reaching the largest crowd possible was seen to be strategically important by emerging brokerages like InnoCrowding, whose Executive VP argued that "We haven't even touched the tip of the iceberg of the amount of people that are available on the planet. And that makes open innovation truly work. But if you start to close the gate you're going to have a problem on your hands." In this model, the aggregation of large crowds with diverse skills affects mobility by increasing the potential number of solutions proposed, thus increasing the volume of knowledge shared in the market.

2) Pre-filter the members of the solution community.

An alternative approach to assembling an appropriate solution community is to target a smaller, more specific group of participants by pre-defining a set of desirable skills and backgrounds. For example, YourEncore focuses on aggregating the capability of expert retirees, whose qualifications and experience has been authenticated by the brokerage. The importance of having a pre-validated community was highlighted by the Vice President at YourEncore, who noted "we've got 48,000 experts and every one of them … has been vetted." Such strategies seek to increase knowledge mobility by ensuring that all participants have a background deemed relevant to the problem space and

represent a diverse set of perspectives, and also by mitigating concerns that firms seeking solutions might have about engaging in a fully "open" process.

Regardless of the model employed, there was wide agreement that diversity of perspective and background in the solution community was critical to mobilizing knowledge within the brokerage. The Executive Vice President at InnoCrowding stated "breakthrough innovation often comes from a person that has a diverse point of view, or from an unrelated discipline. This type of innovator may or may not be a scientist and makes open minded recommendation based on his/her angle view. Organizations embracing a collaborative culture encourage participation at the department level, company-wide, vendors, and clients often harvest breakthrough innovation". Likewise, the Vice President of YourEncore described the value that is created when different disciplinary viewpoints are brought to bear on a problem. For example, in an instance where a firm sought a solution for a bacterial build-up on some processing equipment, "they posted this question out to the innovation community and they got 20 or 30 responses back that were pretty good ideas. Whittled that down to 5 that they thought were pretty good solutions and you know one of them was a chemical process, another was a heat process, another guy suggested totally redesigning the process so you don't have a build-up in the first place". This analysis of the ways in which access to the right crowd affects mobility enables us to refine proposition 1 as follows:

Proposition 1a *- Providing access to a population of solution providers with high levels of relevant knowledge enhances mobility by increasing the quantity and quality of proposed solutions to problems.*

Proposition 1b *- Providing access to a population of solution providers with high levels of diversity in background and perspective enhances mobility by increasing the quantity and quality of proposed solutions to problems.*

4.1.2 Specifying an appropriate challenge

The study showed that simply assembling potential solution providers is not, by itself, sufficient to create high-levels of mobility. Rather, mobility is also dependent on the ability of solution seeking firms to articulate and communicate questions that are of a suitable scope and nature. Specifically, the solver brokerages all defined an appropriately specified challenge as one that is Relevant (the problem behind the challenge has been thoroughly and accurately defined), Solvable (decomposed into unambiguous and independent modular parts), and Safe (framed in such as way as to protect the existing IP and strategic position of the solution seeker).

For example, ensuring the relevance of a task is an important aspect of the challenge creation process for InnoCentive, where the Innovation Development manager remarked; "classically what the InnoCentive client services has done is work with scientists individually to help them identify what their problem is. What are the components of their problem and what are the ways that we could make this into a challenge?" Additionally, decomposing problems into modular knowledge sets are seen to enable the possibility of acquiring an answer. The Innovation Development Manager in InnoCentive commented that "it is all about trying to break down a challenge into its core components at this point then only an individual working alone with a given amount of time and resources can solve it within the allotted period."

Problem decomposition also serves to make challenges safer, as it mitigates the IP risk that may be associated with crowdsourcing. For many organisations, there may be a risk of exposing sensitive information to competitors (e.g. R&D for a new product/service) and there is a need to decompose the problem into a challenge (or a number of challenges) that conceals the innovation being sought, and the purposes that it will be used for, as much as possible. This analysis of the ways in which specifying an appropriate challenge affects mobility enables us to refine proposition 2 as follows:

Proposition 2a *- Clearly defining the problem space enhances mobility by increasing the relevance of the solutions proposed.*

Proposition 2b *- Decomposing problems into unambiguous and independent modular parts enhances mobility by maximising the number (and diversity) of solution providers who can potentially contribute solutions.*

Proposition 2c *- Decomposing problems into unambiguous and independent modular parts enhances mobility by protecting the solution seeking organization while communicating the problem to the community of solution providers.*

4.1.3 Appropriability and mobility

The findings showed that ability of all participants (including (i) firms who find solutions to problems, (ii) firms who fail to find solutions to a problem, (iii) innovation providers who successfully solve problems and (iv) providers of unsuccessful proposed solutions) to realize a return on their investment in the brokerage was important to increasing the mobility of knowledge.

For successful solution seekers, finding the solution represents the acquisition and deployment of knowledge shared in the brokerage, potentially yielding commercial value. For firms who fail to find a solution, value may still be appropriated from the process by developing a better understanding of the open innovation process and a refined understanding of their own problems. In both cases, a positive experience is a prerequisite for repeat participation, and thus affects future mobility.

Likewise, solution providers expect a return for their efforts, whether in the form of payment for an accepted solution, or in other forms such as enhanced reputation, learning and personal satisfaction. When solution providers perceive that it is possible for them to appropriate value from participating in the brokerage, they are more likely to actively engage in the process, thus enhancing mobility.

This analysis of the ways in which appropriability affects mobility enables us to refine proposition 3 as follows: ***Proposition 3*** *- The ability for all parties involved in the innovation process to capture value enhances mobility by increasing the likelihood of future participation.*

4.2 Appropriability

The findings show that Solver Brokerages seek to enhance the ability of participants to capture value from the innovation process in a number of ways. These include the provision of financial rewards for successful solution providers, and support services for enabling solution seeking firms to adopt and implement chosen solutions. Additionally, parties capture value through a number of intangible/non-monetary mechanisms. The specific ways in which appropriability is facilitated by the brokerages, and specifically the ways in which filters and rewards affect appropriability, are described below.

4.2.1 Enabling appropriability by Filtering

The ability to efficiently and effectively evaluate the body of potential solutions, in order to identify one (or more) solutions which can be exploited by the firm, is a key enabler of a firm's ability to capture profits from participating in the innovation process enabled by solver brokerages. To facilitate this, solver brokerages implement a variety of processes and tools designed to help firms filter the proposed solutions. Such filters include:

- Full-service provision (where the brokerage carries out the evaluation on the client's behalf)
- Domain filtering (where clients may choose to view only solutions in certain domains (e.g. only submissions based on chemical solutions to a problem)).
- Quality filtering (where predefined quality criteria are applied to eliminate substandard submissions)
- Provider filtering (where submissions are filtered based on pre-identified "trusted" providers, and/or provider reputation)

- IP filtering (where the brokerage ensures that proposed IP is unfettered, and/or acts as an IP buffer between the client and the solution provider, thus keeping the client anonymous right up to the point of acquisition of IP, and preventing IP contamination.

Based on this analysis, we are able to refine proposition 4 as follows: ***Proposition 4*** *- The availability of filtering mechanisms enhances appropriability by enabling solution seeking firms to more efficiently and effectively identify the most relevant and implementable solution answer amongst those proposed.*

4.2.2 Enabling appropriability with Rewards

Direct, monetary profit emerging from exchanges within the brokerage is limited to (1) providers of winning solutions and (2) the firm who exploits the solution. However, the findings show that appropriability in the broad sense of capturing value from participating manifests in many ways and is affected by the availability of a diverse range of reward mechanisms.

Rewards for successful solution providers include payment, enhanced reputation, enhanced knowledge and skills and better understanding of the brokerage's process. The Innovation Development Manager at InnoCentive described the solution providers as "very creative. They wish to go in, actually challenge themselves, and they are curious to learn more." Additionally, personal satisfaction, based on participating in meaningful and challenging work and satisfying other intrinsic motivations can serve as a reward. As the Vice President of YourEncore commented "we found that what's driving most of our members or experts is the desire to stay connected, to stay involved, keep your skills current and not be playing golf or sitting on the front porch on a rocking chair all the time. Is [payment] relevant? Sure, they are looking for money and supplemental income, but it's the other kinds of intangibles that are the biggest drivers." For unsuccessful solution providers, although many of the intrinsic rewards are the same, the absence of monetary payment and enhanced reputation require that other reward mechanisms be used. For example, even small amounts of meaningful feedback on proposals, indicating that the idea was read and considered creates value for the provider and (as noted in the previous section) makes future participation more likely.

Rewards for successful solution seekers includes exploitation of the solution, improved understanding of both the problem and solution space (learning that takes place within the firm), improved understanding of the brokerage's process, and enhanced branding as an "innovative" firm. For firms that fail to find a solution through the brokerage, the profit associated with exploitation is obviously absent; however organisation learning about the problem space, solution space and open innovation process can still provide rewards for participation. Depending on the costs of participation, such rewards may or may not be adequate to enhance appropriability and justify future use of the brokerage. Based on this analysis, we are able to refine proposition 5 as follows:

Proposition 5a *- The availability of rewards (either monetary or non-monetary) for both successful and unsuccessful solution providers enhances appropriability by ensuring that all solution providers are able to extract value from participation.*

Proposition 5b *- The availability of rewards (either monetary or non-monetary) for both successful and unsuccessful solution seeking firms enhances appropriability by ensuring that all solution seeking firms are able to extract value from participation.*

4.3 Mechanisms for Communication, Coordination and Collaboration

The analysis revealed the key role of tools, processes and other mechanisms for enhancing communication, coordination and collaboration within the brokerages. Such mechanisms serve to mediate the effects that access to an appropriate solution community and challenge specification have on mobility. They also mediate the effects that filters and rewards have on appropriability. These mediating roles are briefly described below.

The effects of accessing the right crowd and asking the right questions on mobility are mediated through a technological infrastructure implemented by the brokerages designed to support a variety of activities (depending on the business model of the particular brokerage). These technologies include tools that support dissemination of problems and solutions (e.g. RSS and other syndication technologies), deliberation (e.g. private virtual workspaces), collaborative authorship mechanisms (e.g. wikis and groupware), among others. Database technologies are also used by some of the brokerages to match potential solution providers with seekers. Non-technological mechanisms can also serve in this regard, such as YourEncore's use of the community of experts not just to solve problems, but also to help firms articulate challenges and to identify potential solution providers. Additionally, brokerages can help to educate firms about the process of seeking innovation through the brokerage, and provide explicit support for the problem definition/articulation activities. Finally, brokerages establish both formal (e.g. terms of service and contracts) and informal (e.g. social norms and accepted practices) mechanisms for governing interaction between the solution seekers and providers.

Similarly, the effects of filters and rewards on appropriability are mediated through a variety of mechanisms. For example, for solution providers, the tangible (monetary) rewards for successful participation can be in a "winner takes all" context. However, some of the brokerages have implemented contractual and operational structures that allow multiple experts to collaborate with each other, contribute a portion of the solution and be rewarded individually in proportion to their contribution. For solution providers, the intangible value captured (such as enhanced reputation) is directly enabled by the visibility created by technologies such as the brokerage web site (e.g. InnoCentive's "I'm a Solver" profiles). Additionally, combinations of technological and non-technological mechanisms can serve to mediate key filtering activities such as provider filtering. For example, YourEncore's Vice President notes that the historic performance of solution providers is "evaluated just like you would on E-Bay and our experts get rated on every interaction. So over a period of time we begin to develop a lot of knowledge about the quality of the responses of that expert". Based on this analysis, we can formulate two additional propositions:

Proposition 6 *- Communication, coordination and collaboration mechanisms (technology, systems and processes) serve to mediate the ways in which access to an appropriate solution community and challenge specification, and appropriability enhance mobility.*

Proposition 7 *- Communication, coordination and collaboration mechanisms (technology, systems and processes) serve to mediate the ways in which filters and rewards enhance appropriability.*

5 CONCLUSIONS

This paper has explored the emerging phenomenon of Solver Brokerages by conceptualizing such entities as mediators for crowdsourcing. The paper makes a contribution to the emerging literature on open innovation, and innovation intermediaries, and in particular offers a re-conceptualisation of the phenomenon of a Solver Brokerage. By viewing this phenomenon through the lens of crowdsourcing, the study was able to describe how knowledge mobility is affected by access to an appropriate solution community, challenge specification and appropriability. In turn, it describes how rewards and filters enhance appropriability. Additionally the study highlights the role of technological infrastructure and other mechanisms that serve to mediate these relationships.

Open innovation – and particularly the use of crowdsourcing as a form of open innovation – is an emerging phenomenon and is consequently under-researched. Thus, this study is exploratory in nature, and the generalizability of the work is limited by the nature of the data gathered. However, the analysis of the data has led to the articulation of a model with implications for researchers.

First, the study has highlighted the importance of (1) aggregating populations of solution providers with high levels of relevant knowledge and diversity of perspectives, (2) helping solution-seeking firms specify the challenge and (3) ensuring that all participating parties are rewarded. We call for future research that more deeply investigates the ideal composition of such populations, challenges,

and rewards, particularly efforts to reveal the relationships between such characteristics and the output of brokerages in terms of problems solved.

Second, the study has described the role of filters and rewards in enhancing appropriability. Here, we call for research investigating the ways in which such mechanisms are implemented. In particular, there is a need to better understand the role of non-monetary rewards and incentives. Also, there is a need to examine emerging forms of solution filtering, particularly those that use collective intelligence (the crowd acting as a filter for the crowd).

Finally, the study has explored the important role played by IT infrastructure and other mechanisms in mediating the various relationships between our constructs. This aspect of the work raises interesting possibilities vis-à-vis the potential for the crowd mediation process to be embedded into a collaboration platform and implemented within firms; indeed this is the idea behind InnoCentive's "InnoCentive@Work" programme.

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