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ENABLING OPEN INNOVATION: PROPOSAL OF A FRAMEWORK SUPPORTING ICT AND KMS IMPLEMENTATION IN WEB-BASED INTERMEDIARIES

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Abstract

Open Innovation is a model used to describe how nowadays companies source and exploit new technologies, new products and services. Web-Based Intermediaries (WBIs) have entered the emerging innovation market and are expected to dramatically increase the number of innovation exchanges. However there are not yet clear theoretical guidelines supporting the design and management of such intermediaries. We use organizational sense-making theory and relative absorptive capacity (RAC) theory to analyze the factors that still hinder Open Innovation. From sense-making theory and RAC theory we draw directions on the services WBIs need to provide in order to effectively support an innovation market. Since information technology is critical to the success of a WBI, we also give directions on how ICT and KMS can be used in order to support these services.

Keywords: Open Innovation, ICT, Intermediaries, Sense-making, Relative Absorptive Capacity.

1 INTRODUCTION

The concept of Open Innovation (OI) was first proposed by Henry Chesbrough (Chesbrough 2003) and has quickly gained the attention of scholars and practitioners. While in the so called *closed innovation paradigm*, research, development and commercial exploitation of a new technology were performed mainly by large companies within their boundaries, today companies increasingly rely on outside innovation for new products and processes and have become more active in licensing and selling results of their own innovation to third parties (OECD 2008).

OI is strongly driven by globalization. The OECD has recently addressed the issue in a research project on "globalization and OI" (OECD 2008). The findings of this project show that increasingly companies link into global innovation networks with people, institutions and other companies in different countries to source and/or exploit innovation. According to some authors a global, secondary market for technology is emerging (e.g. Chesbrough 2003, 2006, Lichtenthaler & Ernst 2008a, 2008b, OECD 2008).

Information Systems play a critical role in coordinating innovation markets. Large companies like Procter & Gamble and IBM have made major investments in proprietary platforms supporting the sourcing (Dodgson et al. 2006) or exploitation (Davis & Harrison 2001) of innovation.

In particular, Web-Based Intermediaries (WBIs) for OI provide virtual milieus to bring together buyers and sellers and to support their transactions. Yet2.com, for example is a technology marketplace where it is possible to exchange patented inventions. Other WBIs, like Ninesigma, Innocentive or Yourencore provide access to broad networks of scientists, researchers and professionals which are potentially able to solve new technological problems proposed by companies (Tapscott & Williams 2007; Chesbrough 2006). These intermediaries are expected to dramatically increase the number of innovation exchanges (Fredberg et al. 2008; Lichtenthaler & Ernst 2008a, 2008b, OECD 2008). In fact, they enable firms to source (as well as exploit) innovation globally with limited investments in proprietary structures. However reducing transaction costs and information asymmetries through a broad availability of information is not sufficient to improve liquidity in the innovation market. Other factors hinder the development of an efficient market. Some of these factors are related to regulatory issues or cultural factors as the NIH syndrome (Laursen & Salter 2006, Lichtenthaler & Ernst 2008b). In this paper we focus on knowledge related factors. That is, we explore what factors hinder the ability of firms to recognize a valuable innovation among the many offered on the market, to find an external application suitable for a technology firms developed or to transfer the innovation form the provider to the recipient.

We argue that the difference between the context in which an innovation is developed and the context in which it is applied is a major cause of the difficulties that hinder OI. We use organizational sense-making theory (Weick, 1995, Weick & Sutcliffe 2001, Taylor & Van Every 2000, Weick et al. 2005) and relative absorptive capacity (RAC) theory (Lane & Lubatkin, 1998; Lichtenthaler, 2008b) to describe and explain the problems that arise when firms which share no substantial previous relation take part in the innovation market. From sense-making theory and RAC theory we draw directions on the services WBIs need to provide in order to effectively support an innovation market. Since information technology is critical to the success of a WBI, we also give directions on how ICT and KMS can be used in order to support these services.

This paper provides a theoretical framework for analyzing the role of WBIs and ICT in a OI context. It is the first paper using sense-making theory and RAC theory together to study OI.

The reminder of this paper is organized as follows: in section two we briefly discuss functions that intermediaries, and WBIs in particular, perform in facilitating OI processes according to the existing literature; in section three we present our theoretical framework; in section four we apply our framework to give directions on the implementation of ICT and KMS by WBIs to support OI processes. Directions for further research and conclusions follow.

2 THE FUNCTIONS PERFORMED BY WEB-BASED INTERMEDIARIES IN THE INNOVATION MARKET

OI comprises all the processes involving the external sourcing or the external exploitation of innovation. Existing research points out that firms are interested in the potentialities of OI and are practicing or are experimenting OI-oriented activities (OECD, 2004; Sheehan et al., 2004; Lichtenthaler & Ernst, 2008b). However, apart from some well known success cases, the application of the OI principles is still limited (OECD, 2004; Lichtenthaler & Ernst 2008b).

In the literature it is often remarked that when the participating firms share a common background the innovation exchange is easier (e.g. Hertzfeld et al. 2006, OECD, 2008, Stock & Tatikonda 2008). On the other hand studies on Absorptive Capacity (Lane & Lubatkin, 1998, Lichtenthaler 2008b) underline that dissimilarities between firms hinder innovation exchange. OI involves by definition the exchange of innovations across different contexts and backgrounds. OI strategies are often driven by the intention to get access to valuable sources of knowledge in other countries bringing together companies and institutions with different cultures (OECD, 2008). The increasing integration of different technologies in many industries increases the need for interdisciplinary research; spin-offs and licensing often lead to the commercialization of innovation in different markets (Fredberg et al. 2008, OECD 2008); innovation is exploited in companies with different business models (Chesbrough 2003, 2006). These differences, then, are expected to be a major challenge to the development of OI.

The emergence of intermediary markets for ideas and technologies may facilitate the exchange of innovation. The number of firms interested in buying or selling innovation on an open market seems to be increasing (Arora et al. 2001; Muthusamy & White, 2005; Cheesbrough, 2007; Lichtenthaler, 2008a; Lichtenthaler & Ernst, 2008b). Intermediaries entered the market which are able to bring together solution seekers and problem solvers or buyers and sellers of intellectual property (Lichtenthaler & Ernst, 2008a; Lichtenthaler & Ernst, 2008b; Fredberg et al. 2008; OECD, 2008).

Firms may draw on the resources and capabilities of intermediaries to improve their proficiency in exchanging innovation (Makadok 2001; Foss & Ishikawa 2007; Lichtenthaler & Ernst, 2008a). Intermediaries can provide resources and capabilities for identifying exchange opportunities (e.g. through their network of resources) and for supporting the innovation transfer (e.g. through their R&D and market experts).

So far, innovation intermediaries have mainly concentrated in marketing and searching for technologies (Morgan & Crowford 1996), but they perform several other functions: identifying partners, helping package technology, selecting suppliers, providing support in deal making, adapt specialized solutions to the needs of user firms (Howells 2006, Lichtenthaler & Ernst 2008a). The functions performed by intermediaries can be seen as related to either of two phases in the innovation process:

1. The *search for innovation* phase comprises functions performed by intermediaries such as indentifying partners, selecting suppliers, evaluating alternative options;
2. The *innovation transfer* phase comprises functions such as supporting deal making, packaging the technology, adapting the innovation to the needs of the user firm, transferring related knowledge.

Several web-based intermediaries operate in the innovation market. Yet2.com, for example, is a marketplaces for IP which also offers intermediary services for the adaptation of technologies to the specific needs of the customer (Lichtenthaler & Ernst, 2008a). Ninesigma, provides access to a broad network of scientists, researchers and professionals which are potentially able to solve new technological problems proposed by companies (Tapscott & Williams, 2007; Chesbrough, 2007). Innocentive works like Ninesigma, but technological problems are more narrowly defined, are posted on the company web-site and can be solved by anyone who registers. Yourencore provides access to a network of retired scientists and engineers.

WBIs were expected to dramatically increase the number of transactions in the innovation market by expanding it to a global scale. They are able to provide wide and ubiquitous access to actors, technologies and information. However, few studies on the performance of these internet platforms have been conducted. The few existing studies suggest that some limits in the way WBIs operate make their services unsatisfying for their users. For example, in their study, Lichtenthaler & Ernst (2008b) on IP commercialization by industrial firms through WBIs, found that even if firms show a keen interest in the potential benefits of web-based technology marketplaces, still their attempts to use them were not satisfactory. The conclusions of the two authors suggest that even if WBIs are able to bring together a large number of potential buyers and sellers of innovation, they offer inadequate support in the selection and integration of innovation.

As a consequence, the research question addressed by this paper is: what kind of services and tools should WBIs provide in order to improve the effectiveness of innovation search and transfer?

This paper focuses on how ICT and KM tools could be used to improve the performance of web-based intermediaries in supporting the global innovation markets. Even if we acknowledge that changes in other areas of WBIs' business models are needed, for example in the value proposition or in the approach to the value network, we focus on technological aspects since we deem that ICT and KM tools can significantly increase the effectiveness of web-based intermediaries if they are used consistently with the needs and structure of global OI processes.

3 A THEORETCAL FRAMEWORK BASED ON SENSE-MAKING AND RELATIVE ABSORPTIVE CAPACITY THEORIES

In this paper we draw on sense-making theory (Weick 1995, 2001, Taylor & Van Every 2000, Weick et al. 2005) and relative absorptive capacity (RAC) theory (Lane & Lubatkin, 1998, Lichtenthaler 2008b) to build a theoretical framework aimed at supporting WBIs in designing and implementing ICT and KMS based solutions. Our hypothesis is that services and tools would be needed to externally complement sense-making and relative absorptive capacity of firms participating in OI processes.

Probably the most common theoretical perspective on innovation exchange is absorptive capacity (AC) theory. Cohen and Levinthal (1990) argue that AC, i.e. a firm's ability to acquire new knowledge, depends on its level of prior related knowledge and in the field. This definition implies that firms already possess substantial knowledge about an innovation. Through AC firms can advance their knowledge, but the theory does not explain how firms can create or exploit knowledge related to a completely new technology or market. OI posits a new challenge to firms: how to gain competitive advantage from knowledge developed in contexts different than the one where it is going to be used.

We argue that AC's shortcomings are due to the fact that it focuses on the exchange of innovation within (more or less) homogeneous contexts. In an OI context it is necessary to understand how two potential, previously unrelated partners can be supported in:

1. Recognizing the opportunity for profitably exchanging innovation;
2. Transferring the innovation and adapting it to its new context of use.

While sense-making theory provides insight on the first problem, RAC theory can be used to address the second one.

When the innovation provider is unfamiliar with the context and/or the recipient is unfamiliar with the innovation, a sense-making effort is needed. Sense-making is a process through which circumstances are turned into a "plausible narrative" which substitutes for a rational decision process in order to take action. In the presence of new and complex problems, in fact, a rational decision process is often not feasible (Uren et al. 2006). As a first step in OI exchanges, the potential provider and recipient of technology need to make sense of the use that can be done of the technology in the new context. Sense-making will lead to a decision whether to undertake the exchange or not. Through the services

they provide WBIs are able to support sense-making. The better WBIs support their customers in making sense of a technology (from the seeker's perspective) or of its potential context of use (from the provider's perspective) the more it is likely that an exchange will effectively take place.

Lane and Lubatkin (1998) coined the term relative absorptive capacity to point out how the ability to acquire new knowledge also depends on the similarity between the source and the recipient of the exchanged knowledge. They suggest that two firms are more likely to effectively exchange new knowledge if they have similar: 1) knowledge bases; 2) knowledge processing systems and norms; 3) organizational structures; 4) dominant logics.

In order to successfully transfer an innovation, it is necessary to create RAC between the firms participating in the exchange. In our view RAC is not only a structural characteristic of the dyad of companies which determines if an exchange can be successful or not, but a "temporary capability" the two firms can build as a part of the exchange process. WBIs can provide tools and services which support RAC creation within the participating firms. But they can also provide tools and services which substitute for the capabilities firms are missing.

The simplest situation is that of a firm dealing with a familiar technology to improve well known business processes. In this case the best line of action is probably to develop and exploit the technology internally (see figure 1, quadrant 1). When considering external innovation sourcing or exploitation a firm can face one of the three situations represented in figure 1, quadrants 2, 3 and 4. The need to support sense-making and RAC formation depends on the asymmetries between the dyads of firms potentially interested in exchanging innovation. These asymmetries depend on two factors: familiarity and similarity.

"Familiarity" is, for a potential recipient, knowledge of the technology of interest which stems from direct experience. For a potential provider, familiarity represents direct knowledge of the recipient context of use. Familiarity provides a common ground for the mutual understanding of the potential buyer and supplier of technology. As the level of familiarity of the recipient with the technology the innovation is based on decreases, there is a greater need for a sense-making effort on the recipient side (quadrant 2). Familiarity with the innovation increases with the past experience a company has in using (and not necessarily developing) the technology. Similarly a greater sense-making effort is needed on the supplier side when she is not familiar with the potential recipient context of use. The level of familiarity increases if the two companies had previous contacts or one has previous experiences working with the business sector of the other, if personal relationships exist or if they are geographically close.

		Level of familiarity with the partner/innovation	
		High	***Low***
Level of similarity between the two firms (RAC)	***High***	1. Closed innovation	2. Sense-making effort
	Low	3. Absorption effort	4. Sense making + Absorption effort

Figure 1. Sense-making, RAC and OI.

As maintained by Lane and Lubatkin (1998) two firms are similar if they have similar: 1) knowledge bases; 2) knowledge processing systems and norms; 3) organizational structures; 4) dominant logics. RAC theory implies that the level of similarity between the participating firms affects the need for support by a WBI when innovation has to be transferred. In particular the lower the similarity the stronger the need for RAC formation support (quadrant 3). If the two firms are familiar with each other, but they are not similar, problems are likely to arise when innovation has to be transferred (Lane & Lubatkin, 1998). Operative procedures and organizational structures need to be coordinated and differences in dominant logics can cause different priorities. The most complex situation, but also the most likely when OI takes place, is the one represented by quadrant 4. In this case, both a sense-making effort and a RAC formation effort are needed. The difficulties in the search and transfer phases sum up making the support of a wide range of intermediary tools and services critical.

In particular our focus is on the adoption and implementation of ICT and KMS to support the services provided by WBIs. In the following section the above described theoretical framework will be further developed and its implications for the choice of ICT an KM tools will be discussed.

4 IMPLICATIONS FOR ICT AND KMS IMPLEMENTATION BY WEB BASED INTERMEDIARIES FOR OI

4.1 ICT and KMS for enhancing sense-making

"Sense-making involves turning circumstances into a situation that is comprehended explicitly in words and that serves as a springboard into action" (Weick et al. 2005). In the absence of a single canonical view of the world, people must construct 'plausible narratives' to fill in the gaps (Uren et al. 2006). Sense making is about explaining phenomena through narratives, given that logical, causal explanations often fail in complex and dynamic contexts. In Weick's words "we expect to find explicit efforts at sense-making whenever the current state of the world is perceived to be different from the expected state of the world". Innovation management, then, is a field in which sense-making should have a prominent role, since by definition innovation changes the "states of the world". Traditional decision support models are based on causal assumptions. For example, effort has been spent in developing quantitative methods for the economic valuation of innovations. The idea is that causal relations can be singled out which link the characteristics of an innovation with the economic value it is able to produce. Accordingly decision-makers will rationally chose the alternative which maximizes the expected returns. In a sense-making perspective the focus is different. It is important to figure out how the technology can be useful and what impact it is likely to have on the business. Sense-making is about the interplay of action and interpretation rather than the influence of evaluation on choice (Weick et al. 2005). According to Bettis and Prahalad (1995) the key problem for an organization is not to accurately assess scarce data, but to interpret an abundance of data into "actionable knowledge".

We argue, then, that much of the effort spent by actors participating in OI processes, above all in early phases of the search for innovations or innovation applications, is a sense-making effort. In traditional innovation exchanges (e.g. R&D alliances, technology transfer projects, spin-offs), the sense-making effort can go unnoticed by an external observer, since sense-making processes are often carried out through informal interactions and only their formalized outcomes are visible (e.g. contracts, projects, agreements). In an OI context and in the presence of WBIs, however, these informal interactions are often limited. The sense-making problem must be explicitly addressed. The lack of tools supporting sense-making is, in our opinion, an explanation of the limited impact WBIs had so far on the growth of the innovation market. These tools must be implemented and managed by WBIs even if, to be effective, the involvement of potential buyers and sellers of innovation. Such an involvement can be thought as a pre-requisite that WBIs need to achieve in the earliest phases of their interaction with seekers and providers.

The model of sense-making process we use in this paper is the one proposed by Weick, Sutcliffe and Obstfeld (2005). According to the authors sense-making starts with chaos. People are immersed in a flux of events and activities. They may or they may not extract cues from this flow. If they do, the first phase of the sense-making process, namely *noticing and bracketing*, takes place. With reference to innovation, decision makers experience both a flux of information from inside their company and from external sources. When decision makers notice a potential match the sense-making process starts. The second phase is *labeling*, that is people use their experience and mental models to give a name to what they noticed and, so, to stabilize the "streaming of experience". One recurrent observation is that ICT is used in OI processes in order to make innovations and innovation needs more visible to the participant actors. For example Tao and Magnotta (2006) describe a web-based system called "Needs Tracker" used within a large chemical company. Through this system employees can post the technological needs they noticed. The Needs Tracker helps to make the needs more visible and to rank them. It is also possible to propose solutions to a need. Similar functions are provided by Procter&Gamble's website InnovationNet, described by Dodgson, Gann and Salter (2006). The company uses the web-site in the context of its Connect&Develop initiative (Huston & Sakkab, 2006) to foster collaboration among its employees and with external sources of knowledge. Artificial intelligence is used for data mining. The system acts in a similar way to Amazon.com, taking into account users' interests and sending back information the user may be interested in. Data mining is also extensively used by a staff of 70 specialists systematically harvesting web pages, scientific literature and databases and global patent databases. "The change of the (technological) interface demands a change in the organizational ability to absorb, or assess the impressions from the outside" (Fredberg et al. 2008). In other words the use of ICT in these cases has changed the sense-making process by supporting the *noticing and bracketing* and the *labeling* phases. In general web-harvesting, i.e. using different, more or less intelligent, tools to search the Internet for relevant information and knowledge (Carlsson, 2003) can be understood as a means to support the *noticing and bracketing* and the *labeling* phases in the sense-making process. Internet-based toolkits for idea competitions (Piller & Walcher, 2006) are also a powerful means to make a technology need visible to potential solvers. They are used by WBIs such as Innocentive. From a sense-making point of view WBIs provide several traditional tools (e.g. newsletters or alerts) to address noticing, bracketing and labeling. However, the effectiveness of these phases can be improved by introducing innovative tools, e.g. Web 2.0 tools such as collaborative tagging (Golder & Huberman, 2006).

The third phase is *thinking retrospectively*. During this phase several cues noticed and labeled before are put together. A plausible narrative is created. Tools such as computer supported argument visualization have proven effective in supporting sense-making about ongoing scientific or professional debates (Shum, 2003). Similarly they can be used to trace debates about innovations or innovation applications. Knowledge mapping or knowledge cartography visually display the conceptual structure of ideas (Okada et al. 2008). By introducing these tools WBIs can support customers in understanding how an innovation could be adapted to a new context from several points of view: it is possible to link a technology to several actual or potential applications, to know about needed complementary competences and resources, to understand who possesses the necessary knowledge and to take into account intellectual property issues. This possibility can be very valuable since one of the problems pointed out by Chesbrough (2006) is the difficulty, for firms, of making sense of the interdependencies among different aspects of OI initiatives (technology, business model, intellectual property rights).

During the following phase, *supposing*, a tentative narrative is created to link the pieces together. Also in OI processes there is a need to build a tentative narrative to make sense of the potential applications of the innovation. Only through confrontation with other people, however, the narrative is rejected or becomes an accepted argumentation. *Socializing*, the fifth phase, explains why sense-making is a collective process: the explanation developed by an isolated individual is influenced by the interpretations of other people she is going to interact with if she is going to put her intentions into action. The subsequent actions will become experiences influencing a person mental models and, as a consequence, her future sense-making. As Web 2.0 tools become more common also in a business

environment (McAfee, 2006; Bardhan et al. 2008) the possibility to support the *socializing* phase of the sense-making process increases. In Web 2.0 tools the *supposing* and *socializing* phases are tightly intertwined, since it is possible to propose opinions, interpretations, points of view which are collaboratively discussed. Some WBIs are already introducing features based on the Web 2.0 approach. For example, Innocentive recently introduced a blog with all the (by now common) Web 2.0 functionalities like tags and feeds. In its "Innovation Community" section, YourEncore provides a full range of Web 2.0 tools like Wikis, forums and other tools to help clients collaborate with experts. These tools can be used independently from the other services, and are aimed at creating an ongoing discourse among the participants. A different way to support the *supposing* phase is through simulation and modelling or virtual prototyping tools (Dodgson et al. 2006). However, in this case a firm has already a good understanding of the innovation and of its applications. As a consequence, in our framework, simulation and modelling tools are better understood as tools for enhancing RAC. Malhotra (2001) suggests that Artificial Intelligence and Expert Systems could be used for supporting the supposing phase if designed to "encourage ongoing and continual re-assessment and modification of practices to ensure dynamic adaptability to the rapidly changing business environment".

In the last phases of the sense-making process, action takes place and, in an organized context, it is likely to require communication with other people. The last phase, then, is called *organizing through communication*. In an OI context both socializing and organizing through communication require interaction with external actors. Both Web 2.0 tools and more traditional e-collaboration tools can be used to support the last phase of the sense-making process, that is *organizing through communication*. In particular e-collaboration tools such as whiteboards, document management systems, collaborative project management systems, file sharing can be used when translating the collaboratively created interpretation of the situation into action (Migliarese & Corvello, 2006; Fink, 2007; Kumar & Becerra-Fernandez, 2007).

4.2 ICT and KMS for enhancing Relative Absorptive Capacity

In Cohen and Levinthal's approach, AC depends only on the previous related knowledge a firm possesses. As a consequence "a firm has an equal capacity to learn from all other organizations". Lane and Lubatkin (1998), instead, argue that AC depends also on the similarity between the two firms exchanging knowledge. So it is better understood as *relative* absorptive capacity. While in Lane and Lubatkin's paper RAC is described as a given attribute of the dyad, other research suggests that RAC can also be created for a specific exchange (Lichtenthaler 2008b).

If the knowledge exchange takes place without the intervention of an intermediary, only the characteristics of the participants (i.e. organizational form, processes and dominant logics) influence RAC. In the presence of an intermediary, however, the services and structures it provides can influence the capacity of the participating firms to exchange innovation. This is consistent with the idea that firms can draw on the resources and capabilities of intermediaries to improve their proficiency in exchanging innovation (Makadok 2001; Foss & Ishikawa 2007; Lichtenthaler & Ernst, 2008a). There are five modes an intermediary can contribute to the development of RAC:

1. Create a common knowledge base: intermediaries can provide firms with knowledge related to interdisciplinary (i.e. issues common to several technological domains) or complementary aspects (e.g. issues related to problems such as intellectual property rights, regulatory issues, electronic infrastructures) useful in more than one exchange;
2. Create field specific knowledge bases: intermediaries can collect, organize and package knowledge related to each specific domain to be provided to the partners once the exchange has been decided in order to speed up the development of a common domain specific knowledge base. This issue probably requires the intermediaries to be specialized in a limited number of domains;
3. Accelerate knowledge transfer: this is the most intuitive function an intermediary can provide for enhancing AC. The sooner knowledge is transferred, the easier is to proceed in the exchange;

4. Develop standard methods: by using standard methods provided by the intermediary (including standard documents, procedures and technologies) the participants can partially overcome the problem of different organizational processes;
5. Act as a temporary structure for innovation transfer: members of the participating firms and of the intermediary can work together as a temporary structure able to limit the problem of different organizational structures.

There is a fairly broad literature on tools supporting the creation of knowledge bases and on knowledge transfer. In fact these two aspects can be considered the central functions of a KMS (e.g. Robey et al. 2000).

With reference to the creation of RAC the first opportunity for intermediaries is to create a common knowledge base even before an innovation exchange is envisioned. Some pieces of knowledge can be useful for several different innovation exchanges. For example complementary knowledge such as knowledge about intellectual property rights or regulatory issues (Somaya et al. 2007). Also complementary technical knowledge can be used in several projects. For example knowledge related to soldering techniques is needed for different applications. Building searchable databases or preparing documents and tutorials related to these topics (in other words "packaging" the related knowledge) can support companies which at the moment of the exchange will be prepared to manage complementary aspects. Collaborative tools as document sharing, forums, blogs and wikis can also be used in order to create a common knowledge base, in particular with respect to more unstructured issues.

Since intermediaries are exposed to diverse knowledge in different exchanges, they gain relevant experience related to several specialist fields. The availability of expert individuals at an intermediary is much appreciated by customers. For example Yet2.com has recently shifted its services from marketing technologies to assisting its customers from a technological point of view (Lichtenthaler & Ernst 2008b). Such services can be made more efficient through the use of KMS. They can be used, in fact, to organize knowledge by specialist domain and make it available to customers. Automation of data retrieval and use (Robey et al. 2000) is complementary to the creation of knowledge bases. Besides capturing knowledge and making it easily accessible, also providing opportunities and tools for communication and discourse is important to speed up knowledge transfer (e.g. Robey et al. 2000). Collaboration tools such as Lotus Notes are still widely used to support collaborative work. Web 2.0 technologies provide further possibilities to cooperate and exchange knowledge (McAfee, 2006).

Crating standard methods is also a much appreciated feature of WBIs. Innocentive, Yet2.com, Yourencore and the other WBIs pay great attention in communicating to their customers how the methods they developed are able to make the exchange easier. They continuously modify their methods in order to adapt them to emerging customer needs. The methods developed by WBIs are meant to coordinate the processes of innovation seekers and providers. For example Innocentive provides consultancy services and formats to firms seeking a new technology in order to formalize a technology need (which in Innocetive's language is called "a challenge"). At the same time it provides solvers with interaction procedures consistent with the expectations of the seekers. The interaction takes place in a structured virtual room dedicated to the specific challenge. Structuring the innovation process through ICT and KMS, however, can also have drawbacks, since it is possible that established methods will not be revised and will become not adaptable to changing conditions (Robey et al. 2000).

Finally WBIs can enhance RAC by providing virtual organizational structures for managing the innovation exchange. Organizational structures are virtual when they are temporary, geographically dispersed and based on electronic communication (Jarvenpaa & Leidner, 1999). Virtual organizational structures are especially common in R&D, due to the internationalization of research and to the frequent formation of R&D partnerships (e.g. Hagedoorn 2002). WBIs, through their web-sites and their permanent structures are able to create temporary groups in which members of the provider and of the recipient organizations are involved. Such groups, guided by the norms and methods set by the intermediary, carry out the innovation exchange overcoming the difficulties created by differences in organizational structures.

5 CONCLUSIONS AND FUTURE RESEARCH

The enthusiasm about web-based intermediaries for OI is due to the promising features they show. In particular the possibility to bring together a large number of potential buyers and sellers of innovation, to act on a global scale and to provide structured and searchable information about innovation and innovation needs. The use of ICT and KMS by WBIs, however, seems to be limited to more or less advanced search techniques.

In the previous section we showed how a sense-making and an absorption effort are needed in OI exchanges. We argue that WBIs should provide tools and services able to support sense-making and the creation of RAC. Recent developments in the services, provided tools and business models of some web-based intermediaries for OI seem to support this hypothesis.

Since sense-making is an unstructured process, which produces unstructured outcomes (it produces sense, exactly), also the tools needed have been described by grouping them according to the phase of the process they support. The same tool, however, can be used in more than a phase. It is the way the user approaches the tool that makes the difference between phases (and, actually, also between sense-making and RAC creation). RAC creation, instead, produces structured outcomes that can be used also in future exchanges. So we grouped the tools for RAC creation according to the specific outcome they contribute to produce.

We expect that WBIs effectively supporting sense-making will experience a larger number of exchanges. On the other hand the percentage of successful exchanges will increase if RAC formation is effectively supported. The importance of sense-making and RAC creation support is likely to vary according to the context. In particular if the involved companies are familiar with each other and/or they show high levels of RAC the role of an intermediary will be less critical from a knowledge related point of view.

In this paper the two theories have been discussed separately. We presented OI processes as comprised of two sequential phases: recognizing the opportunity for profitably exchanging innovation and transferring the innovation and adapting it to its new context of use. While sense-making theory supports the analysis of the first phase, RAC theory supports the analysis of the second one. We have discussed OI processes considering an isolated exchange between firms which are characterized by low familiarity and low similarity. In this case the participating actors need to go through the whole sense making process and to spend a strong effort in building RAC. In practice, however, the two phases overlap. The same tools can be used to support both sense-making and RAC formation and there is not a temporal separation between sense-making and RAC creation. The difference is mainly in the use of the (often common) outcomes produced by the two processes. A database can be created and used both to support sense-making and RAC creation, but it is used differently (and probably using different functionalities) in the two cases. It is used in a structured and systematic way when supporting RAC, it is used in a less structured way when supporting sense-making.

The sense-making process influences the RAC creation process, by posing emphasis on same aspects of the innovation problem rather than on others.

If we consider repeated exchanges it is likely that much sense and RAC will be inherited from previous exchanges. In this case the sense-making process in a new exchange will build on the same knowledge made available during RAC creation in previous exchange which, in turn, had been influenced by the sense-making process.

In repeated interactions, sense-making and RAC creation intertwine and it is not possible to distinguish activities aimed at sense-making from activities oriented at RAC creation. This does not mean, however, that mechanisms to support both processes do not need to be devised and properly designed.

To our knowledge no other study has applied sense-making theory to OI. Decisions regarding OI, however, rely on highly ambiguous and uncertain data. As a consequence mangers are more likely to use plausible narratives than rational methods when deciding to externally source/exploit innovation. In our opinion, then, sense-making support by WBIs is often more valuable than other forms of decision support. Few studies also exist on RAC in OI processes (Lichtenthaler 2008b). In this paper we considered RAC as a temporary capability which can be developed as a part of an exchange process relying also on the complementary capabilities of an intermediary. Supporting the rapid development of RAC is both a need for companies involved in global innovation exchanges and an opportunity for WBIs. The use of ICT to globally source or exploit innovation is still limited. In this paper we argue that a proper use of the available tools by web-based intermediaries can provide the innovation market with the needed liquidity, eventually enhancing OI on a global scale.

We suggest two main line of future research: 1) behavioral science research, and 2) design science research (Hevner & Chatterjee 2009). Future behavioral science research will, based on our two underpinning theories, describe and explain how ICT and KMS can enable and support sense-making and RAC formation. The intrinsically unstructured nature of the sense-making process makes the measurement of related constructs especially challenging. In the Absorbtive Capacity field, instead, extensive research has been conducted which may provide insights into empirically examining the formation of RAC. Research aimed to the study of the performance of WBIs is needed, for example exploratory research involving interviews to WBIs' personnel. This kind of research could also support the refinement of our framework. Future design science research will, based on our two underpinning theories, develop practical design knowledge for the design and implementation of WBIs. The design knowledge can be in the form of algorithmic or heuristic design propositions, design exemplars, design models or frameworks, and stories or narratives.

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