Abstract: Innovation and the Information Communication technologies (ICT) have been two important topics in the study of competitive advantage for firms since the 1980s. Traditionally, most researches have focused either on ICT or innovation but there are few works about the role played by ICT to improve the innovation process. The main issue of this research which is not really explored in the academic literature is to analysis how firm could exploit ICT in the innovation process in the dilemma context “exploitation vs exploration”. Our analysis highlights 3 ways to use ICT in the innovation process: the involvement of lead users, the electronic collaborative platforms, the knowledge marketplaces.

Keywords: Innovation, ICT, competitiveness, organization

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1 Introduction

The Information Communication Technologies (ICT) have become increasingly pervasive in everyday life and work. Consequently, academics and business professionals are beginning to demonstrate a significant interest in understanding the roles to be played by ICT. These technologies are becoming a key to improve the organizational process in the different industries. Over the last several years they have become a large extent, generic and available technologies to most firms (Clemons and Row, 1987; 1991). Some academic works highlight the opportunities to redesign processes and business organisations through electronic networks, sometimes on a worldwide scale. Consequently, ICT are considered as one of the firm’s competitiveness driver (Malone et al., 1987; Hagel and Singer, 1999). Another powerful competitive factor is the innovation capacity, as said the CEO of Procter & Gamble, “the name of the game is innovation” (Fortune, December 11, 2006). The stake for large firms is to generate continuous innovation within the market, resources and capabilities constraints. Moreover, previous research has found that innovation is an effective strategy for small firms or new entrants in an industry because it avoids head to head competition against larger rivals. Through innovation, ‘the rules of the game’ in an industry are revised, making the playing field more open. To maintain this, firms must manage the ability to pursue exploratory and exploitative innovation simultaneously (March, 1991; Levinthal and March, 1993). Together, ICT and innovation positively enhance the ability of firms to obtain a sustained competitive advantage that is a crucial strategic goal (Porter, 1980; Rumelt and al., 1991).

Traditionally, little research published in the academic journals focused on the relationship between ICT and the innovation process. A limited number of studies have examined complementary effects of practices related to workplace organization, use of information technology, and obstacles to innovation (Ichniowski et al., 1997; Bresnahan et al., 2002; Mohnen and Röller, 2005). The main goal of this research is to highlight how firm could exploit ICT in the innovation process to enhance their competitive positions. We focused on “commodity technologies” as websites, groupwares, intranet, email, among others, all of which are easy for firms to implement and use. These tools support interactive communication. Some of them, such as email or intranet are becoming a powerful application to manage communication within the firm’s network of relationships.
The paper is organized as follows: in a first part, we review the literature concerning the main evolution on innovation in the firm and the theoretical approach about the ICT roles. Second, we present the particular context of this research and our empirical approach based on some interviews of consultants and managers. Third, we examine the three modalities of ICT used in the context of the dilemma choice “exploration vs. exploitation innovation”. Finally, we conclude with a discussion about the results and the issues for further research.

2 The innovation as a complex and combinatory process

The innovation is one of the key concepts to create and maintain a sustained competitive advantage for firms but this is a complex process, which is very difficult to understand for managers. There exist multiple interpretations of innovation (process innovation, organisational innovation, product innovation, among others) implying the term refers not just to an outcome (a new idea) but also a process (how the new idea emerged). Herein, we primarily focus on how ICT could affect the innovation process to generate a tangible output as a product or a new service.

2.1 Innovation is not anymore a stand-alone process

During a long time, the innovation capacity of firms was recognized solely as the Research and Development (R&D) capacity. Other indicators include the patents that comprise an institutional record of invention. Despite these being increasingly used in economic research, they cannot be assumed to be in direct and constant correspondence to a firm’s innovative efforts. Since 1990’s, academic researches show that R&D and patents are not indicators being enough reliable for measuring the firm’s innovative activity. Hence, innovation cannot be sum up only in the R&D efforts. Instead, innovation often requires the development of networks among and between inside and outside actors. In the theory of the network actor, the process of innovation is defined as a succession of tests and transformations during which a series of actants (humans) are themselves in interactive relationships (Callon, 1987). This phenomenon is accentuated by organizations’ and firms’ strategies, and by collaborations with different and complementary actors as suppliers, customers, research labs, competitors. Most successful innovations appear heavily dependent
on trials and error methodology, plagued by uncertainty concerning multiple aspects, and the exploration capacity among more and more actors.

It is very important to understand that innovation is a complex and iterative process with a variable mix between and among internal and external sources for ideas, knowledge, and skills. According to Cohen and Levinthal (1989), the innovation process depends on the capacity to exploit the external knowledge and the internal R&D efforts. Innovation is not a binary reasoning or a dilemma choice between “internal versus external” resources but this is a simultaneous and dynamic process. Innovation is the result of a cumulative and specific process for the organizations within networks have a fundamental role to spread tacit knowledge. Of course, the firm’s innovation capacities are developed over long periods of time resulting in explicit knowledge that often is causally ambiguous and socially complex. Because of this, the main difficulty often is to combine external knowledge with the knowledge generated by in-house R&D activities. Moreover, firms that successfully innovate must be able to recombine different knowledge inputs from different sources and recombine tacit and explicit knowledge, but not necessarily in a linear process (Kline and Rosenberg, 1986).

The knowledge required in the innovation process requires more and more combinations of both search depth and search scope. Consequently the exploration for new knowledge is one of the main explanations of inter-linkage firms, most of the time by acquisitions but there could be other ways. Academic studies underline the crucial role played by the interaction of different firms in fostering the innovation process (Von Hippel, 1988). To produce and diffuse innovation, firms must mix a wider variety of expertise and knowledge produced by more and more complementary sources. In recent research, the innovation is conceptualized as an iterative process which implies collective forms of learning facilitating the access to various internal and external sources of information for the firm (Edquist, 1997). The external sources include various organizations such as research institutes, government agencies, and competitors. Among the external sources used by companies, the customers and the suppliers are most frequently the ones accessed. To increase penetration into the external networks, technologies such as the Internet have promised rapid gains of efficiency through a reduction in transaction costs. Further, these technologies enable new partnership opportunities for the innovation process. One of the main organizational conditions is that firms must enact
specific capabilities to interpret and use available information and knowledge embodied in other organizations or people.

2.2 What are the main traditional activities supported by ICT in the innovation process?

The nature of the task will often determine the type of technologies sought as well as organizational structure necessary in the firm. In the case of the innovation process, the coordination and cooperation among different agents within the value chain is becoming an essential issue. The main theoretical approach to understanding the relationship between ICT and innovation is the resources based perspective for accessing external knowledge and developing absorptive capacity. Most research focuses on the knowledge management which could be used to improve the innovation capacity, especially when involving some ICT. Some skills or knowledge are usually explicit and codifiable by procedures, blueprints, and data warehouses. These can easily diffuse among a set of firms. The more codified the knowledge is, the lower the cost of its transfer between or among firms. ICT has the power to transform a part of tacit knowledge into explicit knowledge, especially because it supports several forms of classification. If the role of ICT as a support of knowledge management tends to be imperative in organizations, it must be moderated by the fact that the knowledge is not going to circulate freely only with the technologies implementation (Alavi and Leidner, 1999; Brown and Duguid, 1991; Feldman and March, 1991).

In the Information System (IS) literature, ICT are used to enhance coordination within or across firms’ boundaries. Underlying this idea, one of the issues is the spatial localisation or geographic proximity of the different actors in the innovation process. Some authors claim that continuous and frequent face to face interactions are a precondition for successful innovation collaborations (Kirat and Lung, 1999; Asheim and Gertler, 2005). However, studies recently demonstrated physical proximity and localisation are becoming less important. For example, in innovation projects with ample access to communication technologies, the need for face-to-face interaction is liable to fluctuate with the degree of modularity of the technology being developed and the strength of the project’s internal knowledge brokering capabilities. This phenomenon is accentuated by recent generations of ICT. Some of them may make face to face interactions unimportant in technical collaborations (Cairncross, 1997) even if friendship, trust and interpersonal communication remain very important. Firms must continue to create a common ground of social action and
sensemaking that enable people from different departments or firms to meet each other and sharing understandings.

3 Presentation of the French context and the methodology

This work investigates how ICT contribute to the improvement of the innovation process. One of the main difficulties in the IS field is that ICT both influences structural properties of the firm and is influenced by them. In order to understand the processes and mechanisms underlying innovations, more and more researchers use detailed qualitative work. We decided to use qualitative methodology in order to better understand the role played by ICT in the innovation process.

3.1 The innovation context in France

Innovation is becoming one of the key to success in France with rapid evolution in the firms’ environment. Firms face increasingly rapid changes, short product lifecycles, necessary processes of creative destruction, and intensification of the competition. This last point becomes more and more important because the outcomes of successful innovation tend to rapidly become diffused over the competitors (Levinthal and March, 1993). One of the main problems in France is the capacity to create and diffuse innovation rapidly thus becoming a market leader. To illustrate this idea, the innovation management observatory created by Bearing Point which analyse large firms highlights in 2007 that 61% of themselves are considered “fast follower” and not as “first mover” (only 19%). Furthermore, in this complex and dynamic environment, firms seek to explore new ideas or processes while, at the same time, leverage current competences. This implies tension between exploration and exploitation. In France, the big firms are more innovative than SME but most firms saw their innovation activity slowed down by financial problems, knowledge access and the innovation diffusion on the market. The table below presents results of the SESSI’s study of the development of innovation in French industry.

\[\text{1 Statistics organization in the French department of trade and industry}\]
Table 1: The main problems for innovation in the French industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>Costs problem</th>
<th>Knowledge access problem</th>
<th>Market problems</th>
<th>No motivation for innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food-processing industry</td>
<td>45</td>
<td>27</td>
<td>39</td>
<td>5</td>
</tr>
<tr>
<td>Manufacturing industry</td>
<td>45</td>
<td>28</td>
<td>27</td>
<td>6</td>
</tr>
<tr>
<td>Energy</td>
<td>26</td>
<td>16</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Construction</td>
<td>44</td>
<td>31</td>
<td>30</td>
<td>13</td>
</tr>
<tr>
<td>Commerce</td>
<td>36</td>
<td>22</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>Transports</td>
<td>42</td>
<td>23</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>Real-estate activities</td>
<td>19</td>
<td>33</td>
<td>22</td>
<td>6</td>
</tr>
<tr>
<td>Firms services</td>
<td>42</td>
<td>22</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>People services</td>
<td>45</td>
<td>45</td>
<td>22</td>
<td>11</td>
</tr>
<tr>
<td>Financial activities</td>
<td>20</td>
<td>13</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>26</td>
<td>25</td>
<td>8</td>
</tr>
</tbody>
</table>

Source: Enquête Statistique publique, réalisation Sessi - CIS4 – 2004

If giving a firm access to knowledge is recognized as an important internal factor, to develop external relations (alliance, partnership, outsourcing, and subcontracting), ostensibly to acquire new knowledge, is another means of exploration with ICT. The main problem noted after studying table 1 is the innovation development cost, especially with the increasing costs for R&D in most industries. Firms also face increasing costs for access to knowledge and resolving market problems. The innovation process involves uncertainty about the potential market response and it is characterized as a complex process where speed is a key competitive advantage against rivals and new entrants.

The results of another SESSI’s study highlight that ICT and electronic networks are becoming new infrastructures that support processes and procedures even in SME in France. Some ICT such as ERP (Enterprise Resource Planning) or EDI (Electronic Data Interchange) continue to be used by major players to manage supply chain relationships efficiently. However, recent technologies such as Intranet, website, and email are increasingly widespread in organizations. Moreover, large firms are emerging as systems integrators that contribute to the alignment of networks engaged in technology development processes (strategic alignment). ICT is not the only factor, nor it is sufficient. Using the diffusion of knowledge through the networks for example, ICT could be a key enabler in successful innovation process. This is one of the reasons that explain the decision to analyse the role of ICT in the innovation process of different kinds of ‘commodities technologies’ implemented in most firms.
3.2 The methodology of the study

As aforementioned, there is a lack of empirical work on the role played by ICT in the innovation process. Our research questions was an “how and why”. This kind of question specifically needs to specify a well suited research design to carry out our project and proves especially useful to advance “grounded theories” (Glaser and Strauss, 1967). In the IS field, case study methodology has been applied in various ways as a generic method (Yin, 1989, 1993). The unit of our analysis is the ICT practices that specifically improve innovation processes in the firms, especially implementation, management and use. Because of the explanatory nature of this work, the study involves multiple case studies with three kinds of actors (innovative firms, software providers, consultants). Each case corresponds to an organization that has developed or used ICT to improve the innovation process. These cases have allowed to meet actors from diverse situations and to investigate ICT practices in the innovation process in various contexts. For each case, additional sources of data have included official documentation, statistics of use, browsing of websites, professional articles. Multiple cases increase the variety of studied contexts and hence the generalizability of conclusions.

The purpose of this research is to focus on a few aspects that are pertinent to the discussion of the role played by ICT in the innovation process. The analyse is based on the French
economic context. Over the more than six months of data collection, research activities alternated between data collection and semi structured interviews to optimize, clarify, and verify data. We conducted interviews with consultants, software providers and managers of innovation in large firms to highlight the potential link between ICT and the innovation process. The core of this research methodology is based on qualitative analyses through face to face interviews with the same questions (Appendix 1).

Table 3: Questions asked to the informants

<table>
<thead>
<tr>
<th></th>
<th>Questions</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>What kind of ICT do you use / do you sell ?</td>
</tr>
<tr>
<td>2</td>
<td>In what steps of the innovation process they are used ?</td>
</tr>
<tr>
<td>3</td>
<td>What are the main advantages/inconveniences of ICT in the innovation process ?</td>
</tr>
<tr>
<td>4</td>
<td>Can you describe in detail one example of ICT used in the innovation process ?</td>
</tr>
<tr>
<td>5</td>
<td>What are the main appropriation and use conditions of ICT in the firm ?</td>
</tr>
</tbody>
</table>

We reviewed the relevant literature and generated some key questions as indicated in table 3. In order to enhance the construct validity of the analysis, we used the same questionnaire to have a deeper understanding. Additionally we reviewed multiple studies on the subject to develop the questionnaire. Interviews followed a common format to obtain comparable data across cases and to ensure that relevant perspectives were taken into consideration. Following some of Miles & Huberman’s (1984) recommendations for qualitative data management, for each case a formatted report and chronological matrix synthesized information. The interviews were transcribed and coded. No further cases were contemplated when redundancy was obtained (Eisenhardt, 1989). We present in the next section the results of our interviews.

4 The role of ICT in the innovation process: from lead user to knowledge marketplace

If a firm implements some ICT, especially it is not currently use by competing firms, it may obtain at least a temporary competitive advantage in the innovation process under some organizational conditions. A review of the literature and the different interviews of professionals, software providers and consultants indicate three specific ways for ICT to improve the innovation process. This represents a continuum between exploration and exploitation ways for innovation. March (1991) suggested that firms must maintain an
appropriate equilibrium using both ways in order to survive. The need for this equilibrium was highlighted by Tushman and O’Reilly (1996) with the concept of “ambidextrous organization”. The organizational question for firms is what and how to use technologies in the different innovation process steps to achieve the equilibrium and survive.

4.1 ICT focused on relevant information markets: the involvement of customers as lead users through electronic networks

The contribution of customers could go from collect opinions or experiments to open co-creation for products or services. Von Hippel and Katz (2002) considered the customers played an important role in the emergence and the orientation of innovation. The concept of lead user appeared in the academic literature to describe customers who are integrated into the process upstream and consequently defend the product partially created from their contribution. Some companies go even farther by choosing to equip select customers with tools that allow the customers to conceive, tailor and develop products best suited to their needs. The new technologies create part of websites or virtual world such as Second Life, permit dynamic interaction with selected customers. These technologies could be consider as a toolkit for generate innovation. Web-based tools designed to involve customers in the innovation process tend to be concentrated in the early stages and in the later stages of product development.

From the 1990’s many solutions built using ICT have emphasized the opportunities for firms to manage relationships with customers directly through electronic networks. This enhances the richness of the firm’s connection with the market (Bakos and Brynjolfsson, 2000 ; Evans and Wurster, 2000). Through this, the assumptions, opinions, experiences of customers concerning the products or services are discovered. These customers are from many different professional backgrounds, thus using the product in different contexts. This methodology allows a firm to redefine the value proposition of its product or service and to introduce new benefits to existing and new customers. Technologies created for collecting information from outside provide a means of simultaneously increasing the quantity and quality of information received by firms. Additionally, these technologies involve creating incentives for actors to ensure their commitment. Moreover, web-based tools can simplify customer integration and knowledge absorption by facilitating systematic interactions with selected groups of
customers at a low cost. Using this logic, ICT introduce a rapid feedback from users and communities, allowing multiple experiments over a short cycle.

Box 1: The case of Résolvadis

Résolvadis is a French marketing institute founded by a sociologist and focused on the qualitative studies, especially for the food processing industries with famous B2B customers as Nestlé or Danone. Since 2007, this institute created a web-based platform to improve its analyses of consumer’s behaviours. Different tools could be used with synchronous or asynchronous communication between experts and consumers including individuals or collective blogs, chat’s rooms and others. The firm could use the web based platform at different stages of product development: exploration, product testing, conceptualization and panels.

The expert could test new methodologies with the web-based platform to better understand the customer’s motivation. The information obtained from the customers is richer because they must write what they think about the products. The main advantages are the rapidity and relatively inexpensiveness of the testing. Further, it is possible to explore original concepts with the customers without incurring the expense of development. For the web expert, the main value added is at the exploratory level with the platform. These advantages surpass the cost of time and specialization necessary to manage the interactions with customers through a web interface.

Websites are being conceived as interactive and communicative tool that enable the creation or development of valuable information exchange with customers. The website facilitates the management of information acquisition enabling faster feedback from the marketplace. The main advantage is to obtain a higher level of interaction with customers, who are ‘proactors’ in the innovation process. Further, the innovation capacity is based on better linkages between marketing and the R&D departments. The common tool to interface between these two departments could be the website. Websites are not only as a marketing tool, but also a master tool in the innovation process. In the French firm Danone where we met the Director of Research, the researchers collected customers’ opinions using a special chat room on the Internet. This enables the collection of data and the formation of a joint corporate team that interacts with the customers. Consequently the web based content management will be one of the main priorities for firms in the near future. The next question is how and who integrates information from website to the internal innovation process and in the knowledge management?
Firms are using interactive and collaborative customer relationships to inform the development of new products. The data directly collected from websites or electronic interfaces support this finding. Moreover, the involvement and collaboration of the existing or potential customers are primary principles in the innovation process. Firms receive new suggestions from their customers concerning their products more rapidly using these technologies. Some new technologies, such as Web 2.0, are able to support richer and more interactive communication with customers. Through their website, firms could extract additional value of their relationships with their customers. Some firms such as Dell, are developing a specific websites to collect the ideas of their customers (Ideastorm.com). Start-ups, such as Feedback 2.0, enter the market as software provider enabling the capture of this information. New product generation can also benefit from online virtual communities of customers, bringing together users who share the same interests and are willing to exchange opinions and experience.

4.2. The electronic collaborative platform as a knowledge medium

The recent generations of ICT have improved internal coordination among employees and teams through electronic infrastructures for communication, document sharing and cooperative work (Fulk et al., 1990; Sproull and Kiesler, 1991). Technologies such as groupwares support cooperative work and knowledge management, especially in large firms. They are more flexible than ERP for example, resulting in faster diffusion in SME. Most firms have limited amount of resources (such as human, financial, organizational) and the implementation of complex technologies requires time and the appropriate transformation of business organizational processes. Electronic collaborative platforms could improve this
coordination by making information processing less costly. Some firms are specializing in the development of platforms such as I-Nova in France. They create a new concept, such as SMI² for “système de management des idées et des innovations” (system of ideas and innovation management), to manage ideas originating from different areas of the firm to improve innovation. Some large French firms such as EDF are trying to implement this kind of platform because it is more powerful and easier to use than its own proprietary platform based on the Intranet network.

**Figure 3 : The I-Nova firm**

According to the taxonomy of Nonaka and Takeushi (1995), ICT represent a formalised interaction mechanism between tacit and codified knowledge. ICT are an efficient tool for three kinds of actions concerning knowledge in the organization: conversion from codified to codified (combination with Intranet or email); from tacit to codified (externalisation with expert system or knowledge management); and from codified to tacit (internalisation with knowledge datawarehouses). ICT provide a simple common information space for shared work ideas. These information spaces could support a digitalisation of knowledge without loosing the richness of the context in which knowledge is embedded (digital objects such as videoconferencing, on line content, among others). Some firms, for example, could share their experience on an interactive basis or use the electronic hubs to stimulate interactive discussions about the product characteristics or uses, technological innovation, and other topics. This recognizes innovation is an emerging process. Cognitively, the primary objectives is the capture of valuable knowledge from individuals through the use of ICT, recognizing its potential for diffusion and use by others in their unique context. The second point examines ICT use in the electronic networks that require codification of technical languages and procedures. In the holist representation of the actors, ICT involve the creation of common
standards that cover everything from how message are sent to how to describe formats for inputs and outputs. Technologies play a crucial role as a mediator for codified knowledge. Some skills and knowledge can be written, codified and transferred at low cost and with little loss in richness or understanding. Consequently, the characterization of complex products is no longer a major difficulty because ICT allow the exchange of complex information (Benghozi, 2001).

There is considerable theoretical and empirical evidence suggesting that the relevant knowledge resources for most firms in many industries are not internal to the industry (Pavitt, 1984; Malerba, 2005). ICT can increase the innovation process value because the firm keeps a high level of expertise and knowledge by enlarging its domains into a worldwide scale on the basis of codification process (Ahuja, 2000). Moreover, the acceleration of the evolution and the necessary complementarities between various technologies make it difficult, or even impossible, to control of all the technological "modules" by a single actor. This tendency involves the mutualisation and partnership of additional experts. The technologies positively impact the firm’s effectiveness for managing distributed work from a distance in real time. The emergence of effective technologies for real-time sharing information and the development of computing platforms development in networks facilitate cooperation with external actors. Some firms such as Danone could experiment with a new product in France using “selected and representatives customers”. Simultaneously, researchers located elsewhere in labs could analyse the simulation and interact between them in real time with an electronic and secure network. The firm’s ability to manage complex innovation process by exploiting the network of collaborative relationships through electronic networks is becoming one of the most important sources for sustainable competitive advantage.

4.3. The knowledge marketplaces

Investments in innovation can be very risky and the capital needed can be large. Consequently, few firms are able to acquire the needed capital to exclusively develop the global innovation process, especially for the exploratory phases of new solutions. Moreover, as demonstrated by Sessi’s study in France, the uncertainty (market, technologies, and products) and time to market requirements are two great barriers. Some small firms exploit the opportunities offered by ICT and redesign their organisational models around
technologies. They mediate to facilitate the collection of knowledge and ideas from different disciplines. With the decrease of transaction costs due to ICT (Malone and al., 1987), some technology providers have developed innovative solutions such as electronic marketplaces where firms post their technical or technological problems and people propose their own innovative solutions or ideas. In some marketplaces, the main incentive is financial, based on a bid offer for the best solution or answer. It is an idea factory that develops innovation. Some insiders, such as Procter & Gamble, also have developed their own platform to collect new solutions coming from outside researchers.

Firms benefit from an electronic hub where they interact with other people or firms who have a solution or ideas to resolve their problems no matter what their location on a global scale. They could overcome advantages mainly based on only physical proximity and extend the choices to answer to a technological problem. This kind of ICT creates a market relationship based on a specific innovation problem. Firms recognize the value of an idea from other sectors or people and transfer it into an innovative solution for their problem. The electronic hubs are a solution that reduce risks associated with contractual holdup and consequently by reducing agency measurement costs. ICT could be seen as a powerful tool to enhance innovation processes towards global networks. Even small firms, with apparently few internal resources, have an access to the needed skills and knowledge. The questions now are: how to maintain an important role in the electronic networks for innovation process in spite of the marketplaces development; and how to regulate and choose between external and internal resources?

Figure 4: Innocentive website
For example, Innocentive which was found by Eli Lilly in 2001 proposes payment in return for resolution or solution to a scientific problem. The intent is to link quickly and cheaply derive solutions to R&D problems from firms and specialists who work outside the boundaries of the firm (e.g. retired scientists, students, people of other countries, among others). The website is reminiscent of an ideas’ Ebay: that is, firms anonymously post their problems on the website and the researchers auction their proposed solutions; the bids can go as high as $100 000. The website is based on finding the solution, but the main advantage of this interaction is that firms can explore unique approaches to find a solution to their problem. This opens the possibility for ‘out-of-the-box” thinking even if they do not get the specific knowledge and skills for the unique problem. There are many different websites such as Innocentive on the market, Nine-Sigma, Connect + Develop, InnovationXchange network, Innovation Relay Centers. These present new opportunity to explore novel ideas within R&D labs, thus creating an innovation ecosystem wherein there are multiple links with actors from other sectors, disciplines, and countries. Some firms are taking advantage of this new concept by specializing in the selling or licensing the intellectual property that is useful to other firms, such as Yet2.com (approximately 100 000 users). This web innovation allows these sites a type of license to exploit patents or intellectual assets that remain under exploited or under used by firms. They are intellectual property vendors more than knowledge marketplaces.

5 Discussion and conclusion

Behind the dilemma choice of “internal vs external” resources, the main issue is the tension between exploration and exploitation for the ongoing innovation in the established organizations. The question today focuses on the right balance between the exploration and the exploitation of the innovation. This subject is the object of numerous theoretical work since the formative article of March (1991). The most recent research focused on the notion of ambidexterity (Tushman and O’Reilly, 1996 ; Ajuha and Katila, 2002 ; O’Reilly and Tushman, 2004). This paper highlights that ICT as one of the key enabler in managing innovation under some organizational conditions because exploration and exploitation imply different aims and resources as showed by table 3.
Table 3: The main differences between Exploitation vs Exploration

<table>
<thead>
<tr>
<th>Exploratory Innovation</th>
<th>Exploitative Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radical innovation</td>
<td>Incremental innovation</td>
</tr>
<tr>
<td>Meet the needs of emerging customers or markets</td>
<td>Meet the needs of existing customers or markets</td>
</tr>
<tr>
<td>New knowledge or skills</td>
<td>Existing knowledge or skills</td>
</tr>
</tbody>
</table>

We could argue that ICT help firms develop an organizational ambidexterity. However, the managers must find the right balance between exploration of new opportunities and exploitation of existing capabilities. A solution to finding the right balance is determining the degree of successful integration of ICT in the firm and its “state of mind” about technologies. Successful innovators focus on technology as a driver of value, not just as a tool for operational efficiency. They are often early adopters of ICT in their industry, even if standard technologies are not in the maturity phase. For example, the famous French firm Danone realized some experiments about the analysis of customers’ behaviours on the virtual word Second Life event this was a failure.

Key questions confronting firms are to either internally develop its own solutions or to purchase solutions from an external services; and, what types of innovation (exploration/exploitation) are best suited to further support discussion about the appropriate ICT for different firms. Most large firms have found it necessary to cut costs by reducing R&D team and in house research capabilities. Despite some academic work indicating ICT leads to greater reliance on markets to organize economic activities, firms are using more technologies to disaggregate some part than the whole process. Some ICT can enhance the innovation processes at particular junctures within and between firms. It’s difficult to imagine an electronic integration of the entire process innovation, especially that ICT are far from homogenous.
After analysing the three ways to use ICT, we conclude they play a new role in organizations. ICT are not simply a tool for automating existing process or create productivity gains. For part of the innovation process, technologies are supplanting hierarchy’s role in coordinating and controlling innovation activities by creating new ways of dealing with complexity. It involves new methods of organizing innovation, even within exploratory phases. The barriers such as the tacitness of competencies, the sunk costs of investment, or the cost to maintain a process of knowledge creation help to explain the choice of market transactions. In this case, the risk concerns the firm’s learning or absorptive capacity that’s why the market way must represents just a part of the entire innovation process.

Changes in the environment lead the firm to be more market-orientated and to integrate organizational learning. They are beginning to perceive the need for better management of innovation process and an enhancement of time to market for new products. Innovation has become so complex that one firm cannot handle it especially within the exploratory phases. The scientific and technological knowledge is increasingly scattered among a large number of people and organizations. The consequence is that firms have come to rely more heavily on “outside workers” not directly employed by the firm. Thanks to ICT, firms are able to build and renew their competitive advantage based on more collaboration and knowledge sharing.
innovations originating from more and more players (such as customers, competitors, suppliers, and research labs). Consequently, ICT contribute by offering different possibilities for the degree and the type of internal and external collaboration with the different actors. The type of established relationship varies from a simple transaction to integration of members in a research network. The primary future objective for firms is to create a more efficient innovation process that incorporates the “voice and ideas of the customer” with the know-how of innovation actors who could be outside of the firm’s boundaries.

ICT have the potential to reduce internal inefficiencies while creating a competitive advantage through the management of network relationships. More and more web based applications support rich interactive communication and facilitate the coordination and the collaboration of people within and among firms (i.e groupware, intranet, emails, and websites). ICT is not the only factor, nor is it a sufficient element, but they play an important role in providing a quick, smart, and cost effective solution by redesigning part of the innovation process. Our research also suggests future research directions: what is the optimal management structure for the innovation process after the introduction of ICT and electronic networks? Under what conditions will firm compete by using ICT to improve the innovation process? What kind of ICT and managerial skills are necessary in the firm? What is the optimal equilibrium point between inside and outside solutions to increase the innovation level? We are aware that further research has to be done in these directions and that empirical test of some research ways will also need to be conducted.
## Appendix: List of interviews

<table>
<thead>
<tr>
<th>Firm</th>
<th>Sector/activities</th>
<th>First name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing Point</td>
<td>Consulting</td>
<td>Charles Xavier</td>
<td>Consultant</td>
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<tr>
<td>Bearing Point</td>
<td>Consulting</td>
<td>Sophie</td>
<td>Consultant</td>
</tr>
<tr>
<td>Bluewiki</td>
<td>Software provider</td>
<td>Bertrand</td>
<td>Consultant</td>
</tr>
<tr>
<td>Danone</td>
<td>Food-processing</td>
<td>Alain</td>
<td>Research Director</td>
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<tr>
<td></td>
<td>industry</td>
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<tr>
<td>EDF-GDF</td>
<td>Energy/facilities</td>
<td>Sandrine</td>
<td>Manager of collaborative</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>innovation</td>
</tr>
<tr>
<td>Farwind</td>
<td>Consulting on</td>
<td>Benoît</td>
<td>Consultant</td>
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<tr>
<td></td>
<td>innovation</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>Software provider</td>
<td>Eric</td>
<td>Co-founder of the firm</td>
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<td>SSII</td>
<td>Emilie</td>
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<td>Marketing Institute</td>
<td>Raphael</td>
<td>CEO</td>
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<tr>
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<td>Marketing Institute</td>
<td>Caroline</td>
<td>Consultant and website</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>designer</td>
</tr>
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<td>Software provider</td>
<td>Guillaume</td>
<td>Developer</td>
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<td>Software provider</td>
<td>Thomas</td>
<td>Project Manager</td>
</tr>
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</table>
References


