Virtuality, Innovation and RD Activities

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5 December 2008

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Abstract

Innovation plays a central role in economic development, at regional and national level. In the competitive environment companies are obliged to produce more rapidly, more effectively and more efficiently in new product development which is a result of research and development (R&D) activities. It is necessary for them to put together different capabilities and services with the goal, through cooperation between suppliers and customers, service providers and scientific institutions to achieve innovations of high quality. Depending on the type of industry, the type of business, the type of innovation and the strategic objectives that have been set, firms will regularly have to modify the way in which their R&D and innovation is organized. Nowadays shift from serial to simultaneous and parallel working in innovation has become more commonplace. Literatures have shown that collaboration is as a meta-capability for innovation. By a comprehensive reviewing of literature this article after define a virtual teams and its characteristics, addressing virtual environments innovation and the relationship to R&D activities. Finally conclude that innovation cannot be successful unless the knowledge and information in the R&D project are effectively captured, shared and internalized by the R&D project's virtual team members.

1.0 Introduction

A growing number of flexible and adaptable organizations have explored the virtual environment as one means of achieving increased responsiveness (Furst, Blackburn & Rosen, 2001). Howells et al. (2003) state that "the shift from serial to simultaneous and parallel working in innovation has become more commonplace". Companies put innovation at the heart of their competitive strategy. When innovation is autonomous, the decentralized virtual team can manage the development and commercialization tasks quite well (Chesbrough & Teece, 2002). Blomqvist et al. (2004) emphasized collaboration is as a meta-capability for innovation.

Information technologies offer solutions to typical innovation problems, such as creativity management, new product development, product life cycle management, enabling organizations to tackle the daily challenges of innovation (McKie, 2004). Based on conventional information technologies and Internet-based platforms virtual environments may be used to sustain innovation through virtual interaction and communication. Ozer, M. (Ozer, 2004) study suggested that the Internet's role will be more pronounced for innovative products compared to less innovative products; will be more highlighted for relational new products compared to transactional new products; and will be higher for new industrial products compared to new consumer products. With regard to the organization related factors, the role of the Internet in new product success will be more pronounced when companies' learning, Internet-related technical and marketing capabilities, and collaborative capabilities are high compared to when they are low.

This paper provides a comprehensive review on different aspects of virtual teams and innovation based on authentic and reputed publications, after define innovation and virtual teams and its characteristics, addressing virtual environments innovation and the relationship to R&D activities. Finally conclude that innovation cannot be successful unless the knowledge and information in the R&D project are effectively captured, shared and internalized by the R&D project's virtual team members. Doing an extensive literature survey, further studies are recommended. Managerial implications on those issues are also discussed.

2.0 Innovation

Innovation has long been recognized as crucial to organizational success and as an important field of research inquiry (Huang, Soutar & Brown, 2004). Innovation plays a central role in economic development, at regional and national level (Haga, 2005). Innovation is something new that was introduced in an environment, i.e., a new product, a new way of realizing a process, etc. (Sorli, Stokic, Gorostiza & Campos, 2006). Therefore, an innovation represents the final stage of a development process, representing the final result achieved and implemented successfully. Innovation correlated with the performance of firms and the new products and process improvements partially account for the higher sales and employment growth as well as the higher profit margins (Dickson & Hadjimanolis, 1998). Product innovation is undoubtedly important (Adams, BESSANT, & PHELPS, 2006). Depending on the type of industry, the type of business, the type of innovation and the strategic objectives that have been set, firms will regularly (have to) modify the way in which their R&D and innovation is organized (Erkena & Gilsing, 2005). (Dickson & Hadjimanolis, 1998) in their study conclude that the more innovative firms, not only in terms of new products introduced in the last 2 years and their relative novelty, but also in terms of process innovation adopted or locally developed, tend to follow proactive innovation strategies, being first-to-market with new products and investing in order to solve problems, increase capacity or upgrade quality of products. Sometimes the production of new products also involves a new production line. The proactive firms usually have a wider variety of technology sources than less innovative firms.

3.0 R&D and Innovation

Within the R&D literature, a number of recent studies have explored the connection among complexity of labor, organizational innovation and productivity in R&D (Mote, 2005). In a study von Zedtwitz and Gassmann (2002) analysis of 1021 R&D units and found that research is concentrated in five regions worldwide, while development is more dispersed globally than research. Firms are becoming more interdependent upon each other for successful outcomes in their technological routing. By being a member of an innovation network in one sense can be said to lower the risks of technological failure, as the burden for exploiting the new technology is no longer borne by one firm (Howells et al., 2003). Precup et al. (2006) conclude that project innovation cannot be successful unless the knowledge and information in the project are effectively captured, shared and internalized by the project's virtual team members. Nordic countries (Finland, Sweden, Denmark and Norway) are very active in innovation cooperation (Arranz & Arroyabe, 2008) on the other hand, firms in countries such as China, Taiwan and South Korea are paying more attention to designing and introducing new products to global

markets (Perks & Wong, 2003). Partners take part in R&D networks seeking to gain access to technological resources and to improve their competitive position (Arranz & Arroyabe, 2008). For instance Spanish firms seek to overcome market and technological risks through collaboration with suppliers and customers (Arranz & Arroyabe, 2008).

4.0 Virtual Teams Definition

This era is growing popularity for virtual team structures in organizations (Wayne F. Cascio, 2000; Walvoord, Redden, Elliott, & Coovert, 2008). Martins et al. (2004) in a major review of the literature on virtual teams, conclude that 'with rare exceptions all organizational teams are virtual to some extent.' We have moved away from working with people who are in our visual proximity to working with people around the globe (Johnson, Heimann, & O'Neill, 2001). Although virtual teamwork is a current topic in the literature on global organizations, it has been problematic to define what 'virtual' means across multiple institutional contexts (Chudoba, Wynn, Lu, Watson-Manheim & Beth, 2005). It is worth mentioning that virtual teams are often formed to overcome geographical or temporal separations (Cascio & Shurygailo, 2003). Virtual teams work across boundaries of time and space by utilizing modern computer-driven technologies. The term "virtual team" is used to cover a wide range of activities and forms of technology-supported working (Anderson, McEwan, Bal & Carletta, 2007). Virtual teams are comprised of members who are located in more than one physical location. This team trait has fostered extensive use of a variety of forms of computer-mediated communication that enable geographically dispersed members to coordinate their individual efforts and inputs (Peters & Manz, 2007). From the perspective of Leenders et al.(Leenders, Engelen & Kratzer, 2003) virtual teams are groups of individuals collaborating in the execution of a specific project while geographically and often temporally distributed, possibly anywhere within (and beyond) their parent organization. Amongst the different definitions of the concept of a virtual team the following from is one of the most widely accepted: (Powell, Piccoli, & Ives, 2004), ''virtual teams as groups of geographically, organizationally and/or time dispersed workers brought together by information technologies to accomplish one or more organization tasks''. The degree of geographic dispersion within a virtual team can vary widely from having one member located in a different location than the rest of the team to having each member located in a different country (Staples & Zhao, 2006).

4.1 Virtual Team Characteristics

Along with Bal and Teo (2001) finding, it could be concluded that a team will become virtual if it meets four main common criteria and other characteristics that are summarized in

Table 1. Geographically dispersed teams allow organizations to hire and retain the best people regardless of location. The temporary aspect of the team appears less emphasized (Lee-Kelley & Sankey, 2008) although (Bal & Teo, 2001; Paul, Seetharaman, Samarah & Peter Mykytyn, 2005; Wong & Burton, 2000) included temporary in virtual team definition but some authors like Gassmann and Von Zedtwitz (2003) use may be temporary for some team members.

Table 1 common criteria of virtual team

Characteristics of virtual team	Descriptions	References
Common criteria	1. Geographically dispersed (over different time zones)	(Dafoulas & Macaulay, 2002; Lee-Kelley & Sankey, 2008; Nemiro, 2002; Peters & Manz, 2007; Shin, 2005; Wong & Burton, 2000)
	2. Driven by common purpose (guided by a common purpose)	(Bal & Teo, 2001; Gassmann & Von Zedtwitz, 2003; Hertel, Geister, & Konradt, 2005; Rezgui, 2007; Shin, 2005)
	3. Enabled by communication technologies	(Bal & Teo, 2001; Lee-Kelley & Sankey, 2008; Nemiro, 2002; Peters & Manz, 2007)
	4. Involved in cross-boundary collaboration	(Bal & Teo, 2001; Gassmann & Von Zedtwitz, 2003; Precup et al., 2006; Rezgui, 2007)
Other characteristics	1. It is not a permanent team	(Bal & Teo, 2001; Paul et al., 2005; Wong & Burton, 2000)
	2. Small team size	(Bal & Teo, 2001)
	3. Team member are knowledge workers	(Bal & Teo, 2001; Kirkman, ROSEN, TESLUK, & GIBSON, 2004)
	4. Team members may belong to different companies	(Dafoulas & Macaulay, 2002)

5.0 Benefits and Drawbacks of Virtual Teams

The availability of a flexible and configurable base infrastructure is one of the main advantages of agile virtual teams. (Anderson et al., 2007). Virtual R&D teams which members do not work at the same time or place (Stoker, Looise, Fisscher & De Jong, 2001) often face tight schedules and a need to start quickly and perform instantly (Munkvold & Zigurs, 2007). On the other hand, virtual teams reduce time-to-market (May & Carter, 2001). Lead Time or Time to market has been generally admitted to be one of the most important keys for success in manufacturing companies (Sorli et al., 2006). Table 2 summarizes some of the main advantages and disadvantages associated with virtual teaming.

Table 2: some of the main advantages associated with virtual teaming.

Advantages	References
Reducing relocation time and costs, reduced travel costs	(Bergiel, Bergiel, & Balsmeier, 2008; Wayne F. Cascio, 2000; Fuller, HARDIN, & DAVISON, 2006; Kankanhalli, Tan, & Wei, 2006; McDonough, Kahn, & Barczak, 2001; Rice, Davidson1, Dannenhoffer, & Gay, 2007)
Reducing time-to-market [Time also has an almost 1:1 correlation with cost, so cost will likewise be reduced if the time-to market is quicker (Rabelo & Jr., 2005)]	(T.-Y. Chen, 2008; Ge & Hu, 2008; Kankanhalli et al., 2006; Kusar, Duhovnik, Grum, & Starbek, 2004; May & Carter, 2001; Mulebeke & Zheng, 2006; Shachaf, 2008; Sorli et al., 2006)
More effective R&D continuation decisions	(Cummings & Teng, 2003)
Able to tap selectively into center of excellence, using the best talent regardless of location	(Wayne F. Cascio, 2000; Criscuolo, 2005; Fuller et al., 2006; Samarah, Paul & Tadisina, 2007)
Greater productivity, shorter development times	(McDonough et al., 2001; Mulebeke & Zheng, 2006)
Greater degree of freedom to individuals involved with the development project	(Ojasalo, 2008)

Higher degree of cohesion (Teams can be organized whether or not members are in proximity to one another)	(Wayne F. Cascio, 2000; Gaudes, Hamilton-Bogart, Marsh & Robinson, 2007; Kratzer, Leenders & Engelen, 2005)
Producing better outcomes and attract better employees	(Martins et al., 2004; Rice et al., 2007)
Provide organizations with unprecedented level of flexibility and responsiveness	(T.-Y. Chen, 2008; Hunsaker & Hunsaker, 2008; Katzy, Evaristo & Zigurs, 2000; Powell et al., 2004)
Can manage the development and commercialization tasks quite well	(Chesbrough & Teece, 2002)
Organizations seeking to leverage scarce resources across geographic and other boundaries	(Munkvold & Zigurs, 2007)
Respond quickly to changing business environments	(Bergiel et al., 2008; Mulebeke & Zheng, 2006)
Sharing knowledge, experiences	(Rosen, Furst, & Blackburn, 2007; Zakaria, Amelinckx, & Wilemon, 2004)
Enable organizations to respond faster to increased competition	(Hunsaker & Hunsaker, 2008; Pauleen, 2003)
Better team outcomes (quality, productivity, and satisfaction)	(Gaudes et al., 2007; Ortiz de Guinea, Webster, & Staples, 2005)
Most effective in making decisions	(Hossain & Wigand, 2004)
Higher team effectiveness and efficiency	(May & Carter, 2001; Shachaf & Hara, 2005)
Self-assessed performance and high performance.	(Chudoba et al., 2005; Poehler & Schumacher, 2007)
Cultivating and managing creativity	(Leenders et al., 2003)
Improve the detail and precision of design activities	(Vaccaro, Veloso, & Brusoni, 2008)
Provide a vehicle for global collaboration and coordination of R&D-related activities	(Paul, Seetharaman, Samarah, & Peter Mykytyn, 2005)

Table 3: some of the main disadvantages associated with virtual teaming.

Disadvantages	References
lack of physical interaction	(Wayne F. Cascio, 2000; Hossain & Wigand, 2004; Kankanhalli et al., 2006; Rice et al., 2007)
everything to be reinforced in a much more structured, formal process	(Lurey & Raisinghani, 2001).
Challenges of project management are more related to the distance between team members than to their cultural or language differences	(Martinez-Sanchez, Pérez-Pérez, de-Luis-Carnicer, & Vela-Jiménez, 2006).
Challenges of determining the appropriate task technology fit	(Ocker & Fjermestad, 2008; Qureshi & Vogel, 2001)
Cultural and functional diversity in virtual teams lead to differences in the members' thought processes. Develop trust among the members are challenging	(Kankanhalli et al., 2006; Paul et al., 2005 ; Poehler & Schumacher, 2007)
Will create challenges and obstacles like technophobia (employees who are uncomfortable with computer and other telecommunications technologies)	(Johnson et al., 2001)
Variety of practices (cultural and work process diversity) and employee mobility negatively impacted performance in virtual teams.	(Chudoba et al., 2005)
Team members need special training and encouragement	(Ryssen & Godar, 2000)

6.0 Virtual and Traditional R&D Teams

Unlike a traditional team, a virtual team works across space, time and organizational boundaries with links strengthened by webs of communication technologies. However, many of the best practices for traditional teams are similar to those for virtual teams (Bergiel et al., 2008). Virtual teams are significantly different from traditional teams. In the proverbial traditional team, the members work next to one another, while in virtual teams they work in different locations. In traditional teams the coordination of tasks is straightforward and performed by the members of the team together; in virtual teams, in contrast, tasks must be much more highly structured. Also, virtual teams rely on electronic communication, as opposed to face-to-face communication in traditional teams.

Table 4 summarizes these distinctions (Kratzer et al., 2005). Diversity in national background and culture is common in transnational and virtual teams (Staples & Zhao, 2006).

Table 4: Virtual and traditional R&D teams are usually viewed as opposites.

Fully Traditional Team	Fully Virtual Team
Team members all co-located.	Team members all in different locations.
Team members communicate face-to-face (i.e., synchronous and personal)	Team members communicate through asynchronous and impersonal means.
Team members coordinate team task together, in mutual adjustment.	The team task is so highly structured that coordination by team members is rarely necessary.

In particular, reliance on computer-mediated communication makes virtual teams unique from traditional ones (Munkvold & Zigurs, 2007). Kratzer et al.(2005) research shows that traditional R&D teams have become rare. The processes used by successful virtual teams will be different from those used in face-to-face collaborations (FFCs) (Rice et al., 2007). In an innovation network resembling a "traditional" organization, the innovation process is more restricted by location and time. In other words, the innovation process mostly takes place within the framework of physical offices and working hours. In virtual organizations, individuals' work is not restricted by time and place, and communication is strongly facilitated by IT. Such a product development environment allows a greater degree of freedom to individuals involved with the development project (Ojasalo, 2008). Hence multinational companies (MNC) are more likely to become tightly integrated into global R&D network than smaller unit (Boehe, 2007). Distributed teams can carry out critical tasks with appropriate decision support technologies (M. Chen, Liou, Wang, Fan, & Chi, 2007).

7.0 Physical vs. Virtual

Pawar and Sharifi (Pawar & Sharifi, 1997) study of virtual versus collocated team success and classified physical teams versus virtual teams in six categories.

Table 5 summarizes these differences.

Table 5: Classifying physical teams versus virtual teams

Activity	Physical teams nature	Virtual teams nature
Nature of interaction	opportunity to share work and non-work related information	the extent of informal exchange of information is minimal
Utilization of resources	Increases the opportunity for allocation and sharing of resources	each collaborating body will have to have access to similar technical and non-technical infrastructure
Control and accountability (over and within the project):	the project manager provides the context for ongoing monitoring of activities and events and thus enhances their ability to respond to requirements.	The collaborating bodies were accountable to the task leaders and the project coordinator who had limited authority to enforce any penalties for failure to achieve their tasks
Working environment	they encountered constraints accessing information and interacting with others outside the collocated team within the company	Sometimes not able to share ideas or dilemmas with other partners.
Cultural and educational background	members of the team are likely to have similar and complementary cultural and educational background	the team members varied in their education, culture, language, time orientation and expertise
Technological compatibility:	situated and operating within a single organization, faces minimal incompatibility of the technological systems	compatibility between different systems in collaborating organizations ought to be negotiated at the outset

Lurey and Raisinghani (2001)'s virtual teams survey in 12 separate virtual teams from eight different sponsor companies in the high technology found that organizations choosing to implement virtual teams should focus much of their effort in the same direction as they would in implementing traditional, co-located teams.

8.0 Conclusion

Products are being witnessed every day gaining the knowhow and the right knowledge for keeping pace with the rate and intensity of change has become an inevitable necessity. Virtual teams provide an environment for flourishing innovation in R&D and bring about knowledge spillovers within enterprises bridging time and place, therefore the decision on setting up virtual teams in R&D is not a choice but a requirement. The globalization of and the new waves of global trends in economy, services and business along with advances in telecommunications technology have paved the way for the formation and the performance of virtual teams. While reviewing the previous study refer to Table 2 and
Table 3, it's believed that the advantages of working on the basis of virtual teams far outweigh the disadvantages and innovation cannot be successful unless the knowledge and information in the R&D project are effectively captured, shared and internalized by the R&D project's virtual team members.

This paper has provided an extensive review of literature and related resources covering the theme of virtual R&D teams and innovation. Clearly there is a considerable scope for extending this study to specify filed such as small and medium enterprises (SMEs) and relationship with

virtual R&D team. Further research has to be done on this topic to fully understand the influence of virtual R&D team on innovation practically. The review shows that whereas a considerable number of studies and research efforts have been conducted and concentrated on innovation or virtual R&D teams, limited work have been directed towards exploring and analyzing the existing inter-relation. Therefore future research shall be aimed at shifting away from investigating innovation and virtual R&D teams separately to the formation and development of a collaborative system which can support a dispersed team effectively. Keeping virtual R&D teams in innovation processes, operating innovatively, effectively and efficiently is of a high importance, but the issue has poorly been addressed simultaneously in the previous studies.

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