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INNOVATION PROCESS IS FACILITATED IN VIRTUAL ENVIRONMENT OF R&D TEAMS

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Abstract

Innovation is becoming the most important key issue for company's success in the 21st century. In the competitive environment it is necessary for the enterprises to put together different capabilities and services with the goal. It is widely accepted that innovation can be better achieved by working in team particularly in the virtual environments. The employed web services technology, although very popular nowadays but it is still not mature enough, so dealing with it can bring new findings. Virtual teams base on information technology are formed to facilitate transnational innovation processes and it should be noted that innovation has a positive impact on corporate performance if it is well guided. This has the pronounced effect when it comes to the learning issues as the virtual preconditions persist. In this environment the possibility of getting closer to the interest of learner from the new environment raise as the barriers being imposed by the service provider is reduced and the freedom of what is require to learn is improved. Information and communication technology has brought about significant changes in organizations and produced important benefits, including in the areas of innovation which is recognized as a prime source of national competitive advantage.

This contribution proposes a conceptual model for understanding and analyzing the process of virtual R&D team as an innovation and technology assimilation facilitator when it comes to the issue of conveying innovative message for learning by individuals. The context of the knowledge-based economy introduces a major shift from serial to simultaneous R&D in the way of idea conception to technology creation is conceived. This paper briefly reviews the existing perspectives on virtual teams and their effect on innovation and technology regarding the learning capability which is being altered. It also discusses the main characteristics of virtual teams and clarifies the different aspects of virtual team application in the topic. To support the theoretical analysis, this paper provides a comprehensive review based on authentic and reputed publications. We argue that scanty research has been conducted to facilitate understanding the problem of systematically governing creative innovation toward a technology through virtual R&D teams in the atmosphere of educating individuals based on what they interest them to learn.

Keywords - Virtual team; e-learning; Innovation; Research and development, Learning

1 INTRODUCTION

International collaboration in research and development (R&D) is becoming increasingly important in creating the knowledge that makes research and business more competitive. R&D networks allowed companies to obtain both fast access to relevant knowledge and the synthesis of knowledge domains, which increase their competitiveness [1]. The pressure of globalization competition force the producers to continuously innovate and upgrade the quality of their existing products [2]. Innovation is becoming the most important key issue for company's success in the 21st century [3]. In this knowledge-based environment, the driving forces for this phenomena are revealed as digitization, the internet, and high-speed data networks which are keys for addressing many of the operational issues from design to logistics and distribution affairs [4].

R&D activities have now been more geographically dispersed. This indeed reveals the increasing value of collaboration & the virtuality. These multiple sites encourage the development of more ideas, due to the varied international backgrounds in global networks [5]. Information technology is providing the required infrastructure to support the development of new organizational forms. Virtual teams are representing such an organizational form, one that could revolutionize the workplace and provide organizations with unprecedented level of flexibility and responsiveness [6]. Moreover, information and communication technology (ICT) has brought about significant changes in organizations & produced important benefits, including in the areas of marketing and innovation and many works highlighted the importance of ICT as a key element [7].

The employed Web Service technology, although very popular nowadays but it is still not mature enough, so exploring it can yield new findings [8]. Considering that R&D teams need to access and retrieve information from as many sources as possible [9], virtual teams are important mechanisms for organizations seeking to leverage scarce resources across geographic and other boundaries [10]. As another milestone phenomenon, over the last decades, R&D teams have become increasingly virtual [11]. They have become critical for the companies to survive. [12] The main advantage of implementing a geographically dispersed R&D network structure, is the ability to tap selectively into centre of excellence [13]. To shrink the cost and protracted length of total system and product development life cycles, many organizations have moved away from serial to concurrent collaboration through the use of cross-functional, integrated project/product teams [14]. Howells et al. [15] state that the shift from serial to simultaneous and parallel working in innovation, has become a more commonplace and Blomqvist et al. [16] have emphasized on collaboration as a meta-capability for innovation. Collaborative R&D have unquestionably generated real economic effects, in terms of the creation of new products, processes, innovative capability, options, knowledge and new networks in research or production [17].

Based on a comprehensive review in this paper, the different aspects of virtual collaborative R&D teams are analysed. By providing a definition of virtual teams and importance of R&D collaboration in innovation, the relationship between them are examined. Finally through concentrating on previous research gaps, the way of further studies is proposed and some improvements are also recommended. This paper intends to help researchers, managers and policy makers to better foster innovation through virtual collaborative R&D.

2 DIFFERENT ASPECT OF VIRTUAL TEAM

2.1 Virtual Team's Definition

The popularity of virtual team structures in the organizations, are ever-growing these days [18; 19]. Martins et al. [20] in a major literature review on virtual teams, have concluded that to some extent with a rare exception, all organizational teams can be regarded as virtual. Virtual teams are comprised of members who are located in more than one physical location. This team trait has fostered extensive utilization of a variety of forms of computer-mediated communication that enable geographically dispersed members to coordinate their individual efforts and inputs [21]. Gassmann and Von Zedtwitz [22] have defined virtual team as a group of people and sub-teams who interact through interdependent tasks guided by common purpose and work across links strengthened by information, communication, and transport technologies.

Amongst the different definitions of a virtual team's concept, the following one is most widely accepted: [6], they are groups of geographically, organizationally and/or time dispersed workers brought together by information technologies, to accomplish one or more organizational 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, up to having each member located in a different country [23].

2.2 Virtual Team's advantages and disadvantages

For the purpose of having a clear perceptive of virtuality and the function of a virtual team, different aspects of such issue require investigation and are to be examined in more details. Alike other management paradigms, implementing the concept of working within virtual teams can bring about positive as well as negative impacts. Therefore a careful comparative analysis of the different angles is fruitful. Virtual teams reduce time-to-market [24]. Lead Time or Time to market has been generally

admitted to be one of the most important keys for success in manufacturing companies [3]. Table 1 summarizes some of the main advantages and

Table 2 some of the main disadvantages associated with virtual teaming.

One of the advantages of virtual teams, from a teaching, learning and its assessment point of view, is the ability to have an accurate record of the discussions that have occurred within the team. In face to face teams, unless there is a secretary taking excellent notes of all exchanges, much information is lost. In virtual teams, the computer (via a course management system or an e-mail file system) maintains the exchanges [25]. Zangrando [26] reviewed a book "Teaching and Learning with Virtual Teams" and conclude that, teaching and learning with virtual teams is especially useful for those educators and instructors, mainly from higher education context, interested on improving the teaching-to-learning process by assuming virtual team methodology.

Table 1 some of the main advantages associated with virtual teaming

Advantages	Reference
Reducing relocation time and costs, reduced travel costs	[19; 27; 28; 29; 30; 31]
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 [32]]	[3; 24; 31; 33; 34; 35; 36; 37]
Able to tap selectively into centre of excellence, using the best talent regardless of location	[13; 19; 30; 38]
Greater degree of freedom to individuals involved with the development project	[39]
Higher degree of cohesion (Teams can be organized whether or not members are in proximity to one another)	[19; 40; 41]
Provide organizations with unprecedented level of flexibility and responsiveness	[6; 33; 42]
Sharing knowledge, experiences	[43; 44]
The extent of informal exchange of information is minimal	[45]
Respond quickly to changing business environments	[29; 37]
Facilitating translational innovation processes	[22]
More effective R&D continuation decisions	[46]
Accurate record of the discussions within learning team	[25]

Table 2 some of the main disadvantages associated with virtual teaming

Disadvantages	references
Lack of physical interaction	[28] [19; 31; 47]
Decrease monitoring and control of activities	[45]
Challenges of determining the appropriate task technology fit	[48; 49]
Challenges of managing conflict	[49; 50]
Cultural and functional diversity in virtual teams lead to differences in the members' thought processes. Develop trust among the members are challenging	[31; 51; 52]
Will create challenges and obstacles like technophobia (employees who are uncomfortable with computer and other telecommunications technologies)	[53]

2.3 Team and Innovation

It's a widely accepted fact that, innovation is better achieved by working in team [3]. A majority of successful innovations are developed through the collective efforts of individuals in new product development teams [54]. All teams and virtual teams in particular, must develop mechanisms for sharing knowledge, expertise, and insights which are critical for accomplishing their missions [43]. Virtual teams are offering business applications which make the concurrent design of the product and

development process feasible as well as being responsive to the variations and changes in product/process information[37]. Virtual team facilitate innovation and leverage learning and knowledge-sharing.

3 R&D AND DISTRIBUTED TEAM

R&D are subject to different location drivers [55]. Many firms started to acquire their knowledge from external sources [56]. International R&D units have gained more responsibilities and competencies besides the still-existing traditional mode of adapting products developed in the home country and technical support for production abroad [57]. Trends over the last decade have shown China and India emerge as attractive R&D destinations for U.S. [58]. In a recent study, Li and Yue [59] building on von Zedtwitz and Gassmann's [55] seminal work, suggested that international research and development processes have two key dimensions: functional focus (either research oriented or development oriented) of R&D activities and geographic dispersion or concentration of R&D sites. These two dimensions lead to four categories of R&D configuration in a host country:

- Concentrated R&D;
- Dispersed research and concentrated development;
- Concentrated research and dispersed development;
- Dispersed research and development.

Changes in telecommunications and data processing capabilities make it possible to coordinate research, marketing and production operation globally [2]. Technological change is a highly dynamic process that may quickly relocate to take advantage of optimum conditions for growth [58]. For most R&D teams, being virtual are a matter of degree [60]. Spontaneous communication which occur in virtual R&D team, will play a central role in mitigating conflict on distributed teams because it allows team members to learn informally about what others are doing, enabling them to identify and resolve issues before they escalate [50]. Virtual team facilitate training, collaboration and R&D across distributed teams using information technologies.

4 VIRTUAL COLLABORATIVE R&D

To respond to competitive challenges, the complex customer requirements and the high instability on the market, firms have become more open to collaboration with other parties than in the past [61]. The use of collaboration is particularly acute in knowledge-intensive sectors [62]. Knowing how to collaborate helps a company to create and transfer knowledge [63]. Ahn et al [64] noted that "in virtual collaboration environments, the utilization of contextual information is even more significant for several reasons. First, since virtual teams are usually organized for temporal objectives, contextual information can be easily lost between the dynamic changes. Second, virtual teams are composed of distributed groups of people where the communication is mainly restricted to Internet-based methods, which is a narrower channel for accumulating context compared to face-to-face collaboration. Third, the tasks of virtual teams are usually non-routine and knowledge intensive, which require a high level of understanding along with contextual information".

Internal coordination and collaboration are still major challenges, and cross-functional in-company collaboration must be enhanced e.g. by setting up cross-functional teams, external R&D networks include collaboration and integration with complementary corporations, suppliers and customers and research centres [16]. Grinmaldi and Tunzelmann [17] classified the benefits of R&D collaboration from companies point of view and extract the following benefits:

- Economies of scale and scope in research;
- Reducing product or process costs;
- Acceleration of R&D;
- Avoidance of unnecessary duplication of research;
- Risk management;
- Financial support for costly projects or equipment;
- Technology and knowledge transfer, assimilation and utilization;
- Hiring university students or graduates;
- Enhancement of reputation.

New ideas and insights do not occur in isolation; they are the result of collaboration. However the innovation era ultimately unfolds, knowledge is its key asset and collaboration is the meta-capability by which knowledge will be exploited to drive innovation and reap its economic benefits [63]. The use of

collaboration technology that required users to categorize the comments they received from others , resulted in increased information processing, which in turn led to better decisions and more satisfied participants [65]. Creating a learning organization culture has become an important strategic objective for many firms that hinges on the acquisition of information. In high-risk areas, R&D collaboration can be used as an optional strategy for risk sharing, where small stakes in risky projects enable further investments and it is a major motivators for R&D collaboration [16]. In a virtual team environment, collaborative and competitive conflict behaviour is positively linked with performance [6], as is the degree of virtuality and team connectivity [66].

4.1 WEB Base Collaborative

A web-based collaborative product design platform is enables authorized users which are geographically dispersed to have access to the company's product data such as product drawing files stored at designated servers and carry out product design work simultaneously and collaboratively on any operating systems [67]. Despite computers' widespread use for personal applications, very few programming frameworks exist for creating synchronous collaborative applications [68]. The internet, incorporating computers and multimedia, has provided tremendous potential for remote integration and collaboration in business and manufacturing applications [69]. The integrated system can effectively support a dispersed team [70]. Very little research had been conducted on virtual teams and almost nothing on virtual team facilitation [71]. The intention to introduce a conceptual model for understanding and analyzing the process of virtual R&D team as an innovation and technology assimilation facilitator , lead to develop a modified model base on Stage-Gate.

5 CONCEPTUAL MODEL

5.1 Stage-Gate Process

Figure 1 divides the new product development process into discrete stages, typically five ones which are referred to as gates. Each Stage gathers a set of activities to be performed by a multifunctional project team. To enter into each stage, some conditions and criteria have to be fulfilled. A Gate is a project review in which all the information is confronted by the whole team. Some criticism of the method has surfaced, claiming that the steering group assessment in the gate step halts the project for an unnecessarily long time, making the process abrupt and discontinuous [72]. This process is a method of managing the new product development process to increase the probability of launching new products quickly and successfully.

It seems in the literature to exist a lack of a conceptual model that represents all dimensions and interactions in the virtual R&D team as an innovation and technology assimilation facilitator when it comes to the issue of conveying innovative message for learning by individuals. So a conceptual model for understanding and analyzing the process of virtual R&D team based on Stage-Gate is proposed in the next section.

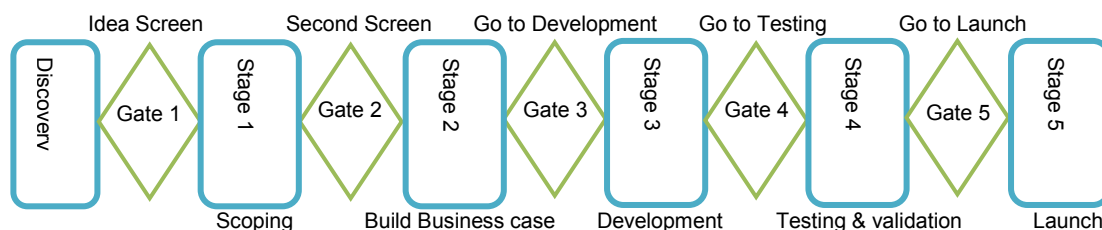


Figure 1 The Stage-Gate process (source [73])

5.2 Modified Stage-Gate: A Conceptual Model

Kusar al. [35] summarized different stage of a new product development affair which in earlier stages , the objective is to make a preliminary market, business, and technical assessment whereas at the later stages the propose is to actually design and develop.

- Definition of goals (goals of the product development process)
- Feasibility study (term plan, financial plan, pre-calculation, goals of market)
- Development (first draft and structure of the product, first draft of components, product planning and its control processes)

- Design (design of components, drawing of parts, bills of material)

Applying virtual team in an entity is like developing a new product within traditional process of employ R&D team. Alike any new product, virtual R&D team need to pass gates before implementing in all R&D activities. Figure 2 shows a conceptual model for understanding and analyzing the process of virtual R&D team. Enabling virtual teamwork through Stage-Gate process represents a fundamental transitioning to more effective virtual team work practices. The use of virtual team will change the communication pattern both within and outside the firm. Successful collaborations require more than the mere use of electronic communication and involve new skills and a supportive context that provides commitment and resources to facilitate collaboration.

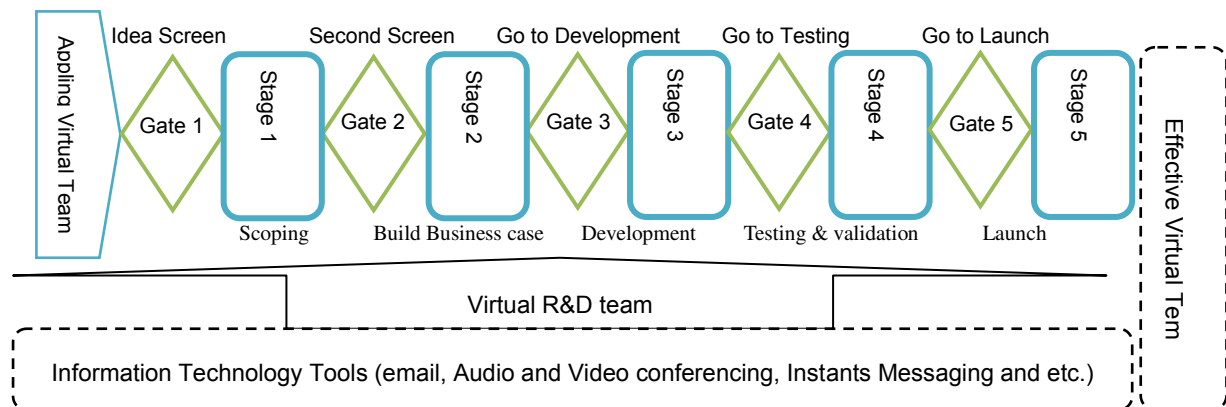


Figure 2 A conceptual model for understanding and analyzing the process of virtual R&D team

6 CONCLUSION AND DIRECTIONS FOR FUTURE RESEARCH

Virtual R&D team should constructively interact in effective communication. Manager of entity are able to use modified Stage-Gate process to evaluate applying virtual R&D team effectively. Therefore as a first step managers of enterprises should move towards the concept that virtual teams in innovation are vital factors in modern organizations. As the next step an action plan for bringing the concept to practice shall be devised and executed. External collaboration is still the major challenge, and virtual collaboration must be enhanced.

The extensive review shows that while a considerable number of studies and research efforts have been devoted & concentrated on innovation, the collaborative R&D 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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