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Virtual Teams: a Literature Review

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Abstract: In the competitive market, virtual teams represent a growing response to the need for fasting time-to-market, low-cost and rapid solutions to complex organizational problems. Virtual teams enable organizations to pool the talents and expertise of employees and non-employees by eliminating time and space barriers. Nowadays companies are heavily investing in virtual team to enhance their performance and competitiveness. Despite virtual team growing prevalence, relatively little is known about this new form of team. Hence the study offers an extensive literature review with definitions of virtual teams and a structured analysis of the present body of knowledge of virtual teams. First, we distinguish virtual teams from conventional teams, different types of virtual teams to identify where current knowledge applies. Second, we distinguish what is needed for effective virtual team considering the people, process and technology point of view and underlying characteristics of virtual teams and challenges the entail. Finally we have identified and extended 12 key factors that need to be considered, and describes a methodology focused on supporting virtual team working, with a new approach that has not been specifically addressed in the existing literature and some guide line for future research extracted.

Key words: *Virtual team, Literature review, Effective virtual team,*

INTRODUCTION

Research on virtual teams is still in its nascent stages (Badrinarayanan and Arnett, 2008, Prasad and Akhilesh, 2002) and because of the relative newness of virtual teams, many areas of research have not been examined (Badrinarayanan and Arnett, 2008). Camarinha-Matos and Afsarmanesh (2003) conclude that, setting-up an infrastructure for virtual team still requires a large engineering effort, which represents a major obstacle for the implantation of this new paradigm. Effective and efficient cooperation across disciplines and distributed teams becomes essential for the success of engineering projects (Zhang *et al*., 2008). Therefore the experiments suggest that more research is needed to explore the ways to enhance the performance of virtual teams (El-Tayeh *et al*., 2008).

Organizations are currently facing important and unprecedented challenges in an ever dynamic, constantly changing and complex environment (Rezgui, 2007). Economic activity of all types is moving in the direction of globalization (Acs and Preston, 1997). Zhouying (2005) supports, the economic and technological gap between developed and developing countries can largely be explained by the gaps in the levels of soft technology and soft environments between the two sets of countries. As a result this matter should taking into account. With the rapid development of electronic information and communication media in the last decades, distributed work has become much easier, faster and more efficient (Hertel *et al*., 2005). Responding to the increasing de-centralization and globalization of work processes, many organizations have responded to their dynamic environments by introducing virtual teams that collaborate by communication technologies across geographical, temporal, cultural and organizational boundaries to achieve common goal in their organizations outputs. Virtual teams are growing in popularity (Cascio, 2000). Additionally, the rapid development of new communication technologies such as the internet has accelerated this trend so that today, most of the larger organization employs virtual teams to some degree (Hertel *et al*., 2005). Information technology is providing the infrastructure necessary to support the development of new organization forms. Virtual teams represent one such organizational form, one that could revolutionize the workplace and provide organizations with unprecedented level of flexibility and responsiveness (Powell *et al*., 2004). Virtual teams are important mechanisms for organizations seeking to leverage scarce resources across geographic and other boundaries

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(Munkvold and Zigurs, 2007). Now complex products are designed much more collaboratively with the suppliers being involved in the design process. The production of a new car for example involves different companies in the supply chain acting more as partners in a joint manufacturing exercise (Anderson *et al*., 2007). However by comparison in today's competitive global economy, organizations capable of rapidly creating virtual teams of talented people can respond quickly to changing business environments. capabilities of this type offer organizations a form of competitive advantage (Bergiel *et al*., 2008). Virtual teams represent a large pool of new product know-how which seems to be a promising source of innovation. At present, except for open source software, little is known about how to utilize this know-how for new product development (Fuller *et al*., 2006a).

The main sections of the paper will discuss the findings from the literature survey in a number of areas. There are sections discussing what virtual team is, definitions, types, examples, benefits and drawbacks, virtual teams and its benefits and drawbacks. Last sections provide the basis for a summing up section describing what are effective virtual team and a number of key challenges that are now faced. The next section discusses the definition of virtual team.

What Is Virtual Team?

Virtual Teams: Origins and Trends:

While work teams were used in the U.S. as early as the 1960s, the widespread use of teams and quality circles began in the Total Quality Management movement of the 1980s. In the late 1980s and early 1990s, many companies implemented self-managing or empowered work teams. To cut bureaucracy, reduce cycle time, and improve service, line-level employees took on decision-making and problem-solving responsibilities traditionally reserved for management. By the mid-1990s, increasing numbers of companies such as Goodyear, Motorola, Texas Instruments, and General Electric had begun exporting the team concept to their foreign affiliates in Asia, Europe, and Latin America to integrate global human resource practices (Kirkman *et al*., 2001). Now, due to communication technology improvements and continued globalization, virtual teams have increased rapidly worldwide (Kirkman *et al*., 2002). This era is growing popularity for virtual team structures in organizations (Walvoord *et al*., 2008, Cascio, 2000). 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 *et al*., 2001).

Definition of Virtual Team:

Literature related to virtual teams revealed a lack of depth in the definitions. 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 *et al*., 2005). The concept of a "team" is described as a small number of people with complementary skills who are equally committed to a common purpose, goals, and working approach for which they hold themselves mutually accountable (Zenun *et al*., 2007). It is worth mentioning that virtual teams are often formed to overcome geographical or temporal separations (Cascio and 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 *et al*., 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 and Manz, 2007).

Gassmann and Von Zedtwitz (2003b) 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. Another definition suggests that virtual teams, are distributed work teams whose members are geographically dispersed and coordinate their work predominantly with electronic information and communication technologies (e-mail, video-conferencing, telephone, etc.) (Hertel *et al*., 2005), different authors have identified diverse. From the perspective of Leenders *et al*. (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. Lurey and Raisinghani (2001) defined virtual teams - groups of people who work together although they are often dispersed across space, time, and/or organizational boundaries. Amongst the different definitions of the concept of a virtual team the following from is one of the most widely accepted: (Powell *et al*., 2004), ''we define 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 and Zhao, 2006). Along with Bal and Teo (2001a) 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 and Sankey, 2008) although (Bal and Teo, 2001a, Paul *et al*., 2005, Wong and Burton, 2000) included temporary in virtual team definition but some authors like Gassmann and Von Zedtwitz (2003b) use may be temporary for some team members.

Table 1: Common criteria of virtual team

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

A summary of the definition of virtual team may be taken as: small temporary groups of geographically, organizationally and/or time dispersed knowledge workers who coordinate their work predominantly with electronic information and communication technologies in order to accomplish one or more organization tasks.

Types of Virtual Team:

Generally, we can differentiate various forms of "virtual" work depending on the number of persons involved and the degree of interaction between them. The first is "*telework*" (telecommuting) which is done partially or completely outside of the main company workplace with the aid of information and telecommunication services."*Virtual groups*" exist when several teleworkers are combined and each member reports to the same manager. In contrast, a "*virtual team*" exists when the members of a virtual group interact with each other in order to accomplish common goals. Finally, "*virtual communities*" are larger entities of distributed work in which members participate via the internet, guided by common purposes, roles and norms. In contrast to virtual teams, virtual communities are not implemented within an organizational structure but are usually initiated by some of their members. Examples of virtual communities are Open Source software projects (Hertel *et al*., 2005). Teleworking is viewed as an alternative way to organize work that involves the complete or partial use of ICT to enable workers to get access to their labor activities from different and remote locations (Martinez-Sanchez *et al*., 2006). Telework provides cost savings to employees by eliminating time-consuming commutes to central offices and offers employees more flexibility to co-ordinate their work and family responsibilities (Johnson *et al*., 2001). Cascio and Shurygailo (2003) have clarified the difference form of virtual team by classifying it with respect to two primary variables namely, the number of location (one or more) and the number of managers (one or more) Table 2 illustrates this graphically. Therefore there are four categories of teams:

1. Teleworkers: A single manager of a team at one location
2. Remote team: A single manager of a team distributed across multiple location
3. Matrixed teleworkers: Multiple manager of a team at one location
4. Matrixed remote teams: Multiple managers across multiple locations

Table 2: Forms of Virtual Teams (Cascio and Shurygailo, 2003)

		Managers	
		One	Multiple
Locations	One	Teleworkers	Matrixed Teleworkers
	Multiple	Remote Team	Matrixed Remote Teams

Computer mediated collaborations (CMC) is also used to encompass asynchronous interactions through a collaborative workspace, as well as e-mail, instant messaging, and synchronous interactions using a system that incorporates desktop videoconferencing, shared workspace, chat and other features (Rice *et al*., 2007). On the other hand extended enterprise concept in parallel with the concurrent enterprising looks for how to add value to the product by incorporating to it knowledge and expertise coming from all participants on the product value chain (Sorli *et al*., 2006). Collaborative networked organizations (CNOs) are complex entities whose proper understanding, design, implementation, and management require the integration of different modeling perspectives (Camarinha-Matos and Afsarmanesh, 2007).

Examples of Uses of Virtual Team:

Working in today's business world is like working in a world where the sun never sets. Rezgui (2007) investigates the effectiveness of virtual teams, and any other suitable form of virtual collaboration, in the construction sector and explores the factors that influence their successful adoption. May and Carter (2001) in their case study of virtual team working in the European automotive industry have shown that enhanced communication and collaboration between geographically distributed engineers at automotive manufacturer and supplier sites make them get benefits are better quality, reduced costs and a reduction in the time-to-market (between 20% to 50%)for a new product vehicle. New product development (NPD) requires the collaboration of new product team members both within and outside the firm (Martinez-Sanchez *et al*., 2006, McDonough *et al*., 2001, Ozer, 2000) and NPD teams are necessary in almost all businesses (Leenders *et al*., 2003). In addition, the pressure of globalization competition companies face increased pressures to build critical mass, reach new markets, and plug skill gaps , NPD efforts are increasingly being pursued across multiple nations through all forms of organizational arrangements(Cummings and Teng, 2003). Given the resulting differences in time zones and physical distances in such efforts, virtual NPD projects are receiving increasing attention (McDonough *et al*., 2001). The use of virtual teams for new product development is rapidly growing and organizations can be dependent on it to sustain competitive advantage (Taifi, 2007).

On the other hand, virtuality have been presented as one solution for small and medium enterprises (SMEs) aiming to increase their competitiveness (Pihkala *et al*., 1999). The SMEs are one of the sectors that have a strong potential to benefit from advances in ICTs and the adaptation of new business modes of operation. The combination of explosive knowledge growth and inexpensive information transfer creates a fertile soil for unlimited virtually invention (Miles *et al*., 2000).

Benefits and Draw Back of Virtual Team:

During the last decade, words such as "virtual", "virtualization", "virtualized" have been very often advocated by scholars and practitioners in the discussion of social and economic issues(Vaccaro *et al*., 2008) but the advantages and pitfalls of virtual team is concealed. The availability of a flexible and configurable base infrastructure is one of the main advantages of agile virtual teams. Anderson *et al*. (2007) suggest that the effective use of communication, especially during the early stages of the team's development, plays an equally important role in gaining and maintaining trust. Virtual R&D teams which members do not work at the same time or place (Stoker *et al*., 2001) often face tight schedules and a need to start quickly and perform instantly (Munkvold and Zigurs, 2007). Virtual team may allow people to collaborate more productivity at a distance, but the tripe to coffee corner or across the hallway to a trusted colleague is still the most reliable and effective way to review and revise a new idea (Gassmann and Von Zedtwitz, 2003a). As a drawback, virtual teams are particularly vulnerable to mistrust, communication break downs, conflicts, and power struggles (Rosen *et al*., 2007). On the other hand, virtual teams reduce time-to-market (May and 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 3 summarizes some of the main advantages and Table 4 some of the main disadvantages associated with virtual teaming. We are in a transient phase that is pushing out beyond the envelope of team fundamentals into a space where we begin to lose track of reality (Qureshi and Vogel, 2001). Clearly the rise of network technologies has made the use of virtual teams feasible (Beranek and Martz, 2005). Finally organizational and cultural barriers are another serious impediment to the effectiveness of virtual teams. Many managers are uncomfortable with the concept of a virtual team because successful management of virtual teams may require new methods of supervision (Jarvenpaa and Leidner, 1999).

Forming and performing in virtual teams is useful for projects that require cross-functional or cross boundary skilled inputs and the key to their value creation is to have a defined strategy in place to overcome the issues highlighted, especially the time zones and cultural issues. While communication could be seen as a traditional team issue, the problem is magnified by distance, cultural diversity and language or accent

Table 3: some of the main advantages associated with virtual teaming

Advantages	Reference
Reducing relocation time and costs, reduced travel costs (Virtual teams overcome the limitations of time, space, and organizational affiliation that traditional teams face (Piccoli *et al.*, 2004))	(McDonough *et al.*, 2001, Rice *et al.*, 2007, Bergiel *et al.*, 2008, Cascio, 2000, Fuller *et al.*, 2006b, Kankanhalli *et al.*, 2006, Prasad and Akhilesh, 2002, Olson-Buchanan *et al.*, 2007, Boudreau *et al.*, 1998, Biuk-Aghai, 2003, Liu and Liu, 2007, Lipnack and Stamps, 2000)
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 and Jr., 2005)]	(Lipnack and Stamps, 2000, May and Carter, 2001, Sorli *et al.*, 2006, Kankanhalli *et al.*, 2006, Chen, 2008, Shachaf, 2008, Kusar *et al.*, 2004, Ge and Hu, 2008, Mulebeke and Zheng, 2006, Guniš *et al.*, 2007, Prasad and Akhilesh, 2002, Zhang *et al.*, 2004, Sridhar *et al.*, 2007)
Able to digitally or electronically unite experts in highly specialized fields working at great distances from each other	(Rosen *et al.*, 2007)
More effective R&D continuation decisions	(Cummings and Teng, 2003, Schmidt *et al.*, 2001)
Most effective and rapid in making decisions	(Hossain and Wigand, 2004, Paul *et al.*, 2004b, Bal and Gundry, 1999)
Able to tap selectively into center of excellence, using the best talent regardless of location	(Criscuolo, 2005, Cascio, 2000, Samarah *et al.*, 2007, Fuller *et al.*, 2006b, Furst *et al.*, 2004, Badrinarayanan and Arnett, 2008, Prasad and Akhilesh, 2002, Boudreau *et al.*, 1998, Boutellier *et al.*, 1998)
Greater degree of freedom to individuals involved with the development project	(Ojasalo, 2008, Badrinarayanan and Arnett, 2008, Prasad and Akhilesh, 2002)
Greater productivity, shorter development times	(McDonough *et al.*, 2001, Mulebeke and Zheng, 2006)
Producing better outcomes and attract better employees, Generate the greatest competitive advantage from limited resources.	(Martins *et al.*, 2004, Rice *et al.*, 2007, Chen *et al.*, 2008b)
Useful for projects that require cross-functional or cross boundary skilled inputs	(Lee-Kelley and Sankey, 2008)
On time implementation of the tasks assigned, Less resistant to change	(Precup *et al.*, 2006)
Integrating talent in newly industrialized Facilitating transnational innovation processes	(Gassmann and Von Zedtwitz, 2003b, Prasad and Akhilesh, 2002)
Higher degree of cohesion (Teams can be organized whether or not members are in proximity to one another)	(Kratzer *et al.*, 2005, Cascio, 2000, Gaudes *et al.*, 2007)
Evolving organizations from production-oriented to service /information-oriented, Faster response times to tasks, Providing flexible hours for the employees, More sense of responsibility is more developed	(Johnson *et al.*, 2001, Precup *et al.*, 2006)
Provide organizations with unprecedented level of flexibility and responsiveness	(Powell *et al.*, 2004, Hunsaker and Hunsaker, 2008, Chen, 2008, Guniš *et al.*, 2007, Prasad and Akhilesh, 2002, Pihkala *et al.*, 1999, Piccoli et al., 2004, Liu and Liu, 2007)
Perform their work without concern of space or time constraints	(Lurey and Raisinghani, 2001)
Self-assessed performance and high performance.	(Chudoba *et al.*, 2005, Poehler and Schumacher, 2007)
Optimize the contributions of individual members toward the completion of business tasks and organizational goal	(Samarah *et al.*, 2007)
Reduce the pollution, Creates and disperses improved business processes across organizations	(Johnson *et al.*, 2001)
The ratio of virtual R&D member publications exceeded from co-located publications	(Ahuja *et al.*, 2003)
The extent of informal exchange of information is minimal (virtual teams tend to be more task oriented and exchange less socio emotional information	(Pawar and Sharifi, 1997, Schmidt *et al.*, 2001)
Can manage the development and commercialization tasks quite well	(Chesbrough and Teece, 2002)
Respond quickly to changing business environments	(Bergiel *et al.*, 2008, Mulebeke and Zheng, 2006)
Improve communication and coordination, and encourage the mutual sharing of inter-organizational resources and competencies	(Chen *et al.*, 2008a)
Team communications and work reports are available online to facilitate swift responses to the demands of a global market. Employees can be assigned to multiple, concurrent teams; dynamic team membership allows people to move from one project to another. Employees can more easily accommodate both personal and professional lives	(Cascio, 2000)
Cultivating and managing creativity	(Leenders *et al.*, 2003, Prasad and Akhilesh, 2002, Atuahene-Gima, 2003, Badrinarayanan and Arnett, 2008)
Sharing knowledge, experiences; Facilitate knowledge capture	(Rosen *et al.*, 2007, Zakaria*et al.*, 2004, Furst *et al.*, 2004, Merali and Davies, 2001, Sridhar *et al.*, 2007, Lipnack and Stamps, 2000)

Table 3: Continue

Improve the detail and precision of design activities	(Vaccaro *et al*., 2008)
Provide a vehicle for global collaboration and coordination of R&D-related activities	(Paul *et al*., 2005)
Allow organizations to access the most qualified individuals for a particular job regardless of their location.	(Hunsaker and Hunsaker, 2008)
Enable organizations to respond faster to increased competition	(Hunsaker and Hunsaker, 2008, Pauleen, 2003)
Better team outcomes (quality, productivity, and satisfaction)	(Gaudes *et al*., 2007, Ortiz de Guinea *et al*., 2005, Piccoli *et al*., 2004)
Higher team effectiveness and efficiency	(May and Carter, 2001, Shachaf and Hara, 2005)
Reduce training expenses, Faster Learning	(Pena-Mora *et al*., 2000, Atuahene-Gima, 2003, Badrinarayanan and Arnett, 2008)
Greater client satisfaction	(Jain and Sobek, 2006)

Table 4: some of the main disadvantages associated with virtual teaming

Disadvantages	references
Sometimes requires complex technological applications	(Bergiel *et al*., 2008, Badrinarayanan and Arnett, 2008)
Face-to-Face collaboration (FFC) appears to be better developing a conceptual understanding of a problem (lack of physical interaction)	(Cascio, 2000, Hossain and Wigand, 2004, Kankanhalli *et al*., 2006, Rice *et al*., 2007)
Decrease monitoring and control of activities	(Pawar and Sharifi, 1997)
Everything to be reinforced in a much more structured, formal process	(Lurey and Raisinghani, 2001).
Vulnerable to mistrust, communication break downs, conflicts, and power struggles	(Rosen *et al*., 2007, Cascio, 2000, Kirkman *et al*., 2002, Taifi, 2007, Baskerville and Nandhakumar, 2007)
Challenges of project management are more related to the distance between team members than to their cultural or language differences	(Wong and Burton, 2000, Martinez-Sanchez *et al*., 2006, Badrinarayanan and Arnett, 2008, Jacobsa *et al*., 2005).
Challenges of determining the appropriate task technology fit	(Qureshi and Vogel, 2001, Ocker and Fjermestad, 2008, Griffith et al., 2003, Badrinarayanan and Arnett, 2008, Bell and Kozlowski, 2002, Pawar and Sharifi, 2000)
Challenges of managing conflict	(Hinds and Mortensen, 2005, Ocker and Fjermestad, 2008, Kayworth and Leidner, 2002, Piccoli *et al*., 2004, Wong and Burton, 2000, Ramayah *et al*., 2003)
Cultural and functional diversity in virtual teams lead to differences in the members' thought processes. Develop trust among the members are challenging	(Bell and Kozlowski, 2002, Griffith *et al*., 2003, Shachaf, 2005, Jacobsa *et al*., 2005, Paul *et al*., 2005 , Poehler and Schumacher, 2007, Kankanhalli *et al*., 2006, Badrinarayanan and Arnett, 2008, Munkvold and Zigurs, 2007, Boutellier *et al*., 1998)
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 and Godar, 2000)

difficulties. For migration or similar large-scale projects, personal project management competency, appropriate use of technology and networking ability, willingness for self-management, cultural and interpersonal awareness is fundamentals of a successful virtual team (Lee-Kelley and Sankey, 2008).Thomas and Bostrom (2005) found that a technology facilitator role can be critically important to virtual team success.

Virtual and Traditional 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 5* summarizes these distinctions (Kratzer *et al*., 2005). In particular, reliance on computer-mediated communication makes virtual teams unique from traditional ones (Munkvold and 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

Table 5: Virtual and traditional 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 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.

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 (Chen *et al*., 2007).

Yip and Dempster, (2005) in their study realized that perhaps the most important lesson is that the internet helps companies to be both global and local at the same time. It is possible to derive the virtual teams substitute with internet. The internet can facilitate the collaboration of different people who are involved in product development, increase the speed and the quality of new product testing and validation and improve the effectiveness and the efficiency of product development and launch (Martinez-Sanchez *et al*., 2006). Rice *et al*., (2007) found that the adoption of formal procedures and structured processes significantly increased the effectiveness of virtual teams. (Arranz and Arroyabe, 2008) point out that geographical dimension is not a variable that impacts substantially on the typology and objectives of R&D cooperation, in contrast with the results highlighted in the literature review that they have done. Virtual teams have more effective R&D continuation decisions than face-to-face teams because virtual team has asynchronous communication and it allows for more time for digestion and reduces the pressure of group conformity (Cummings and Teng, 2003).

Physical vs. Virtual:

(Pawar and Sharifi, 1997) study of virtual versus collocated team success and classified physical teams versus virtual teams in six categories. Table 6 summarizes these differences.

Table 6: 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

Most likely, virtual teams will not totally replace conventional teams. Although virtual teams are and will continue to be an important and necessary type of work arrangement, they are not appropriate for all circumstances (Nemiro, 2002). Lurey and Raisinghani (2001) base on 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 efforts in the same direction they would if they were implementing traditional, co-located teams. Hossain and Wigand (2004) conclude that ICT-enabled virtual collaboration would be effective with the existence of face-to-face communication support and would lead to higher levels of satisfaction in collaboration. Diversity in national background and culture is common in transnational and virtual teams (Staples and Zhao, 2006). Past research has found that interaction in computer-mediated communication environments is more impersonal, more task oriented, more businesslike, and less

friendly than in face-to-face settings (Schmidt *et al*., 2001). Akgün *et al* (2008) found that the use of ICT had a positive influence on the knowledge base team's performance.

Challenges for Virtual Team:

Virtual teams face particular challenges involving trust (Malhotra *et al*., 2007, Bal and Teo, 2001b, Paul *et al*., 2004b) which is a key element to build successful interactions and to overcome selfish interests, effective communication (Beranek and Martz, 2005, Dustdar, 2004) that is even more critical for success in the virtual setting (Shachaf and Hara, 2005), deadlines (Jarvenpaa and Leidner, 1999), and team cohesiveness (Dineen, 2005). While there are great advantages that come with the adoption of the virtual teams, new challenges rise with them (Precup *et al*., 2006). Cascio (2000) declared that there are five main disadvantages to a virtual team: lack of physical interaction, loss of face-to-face synergies, lack of trust, greater concern with predictability and reliability, and lack of social interaction. In building a virtual team, all of these issues must be at least implicitly addressed in order to have an effective virtual team (Hunsaker and Hunsaker, 2008). Virtual teams are challenged because they are virtual; they exist through computer mediated communication technology rather than face-to-face interactions (Gaudes *et al*., 2007, Hardin et al., 2007). Sometimes they report to different supervisors and they function as empowered professionals who are expected to use their initiative and resources to contribute to accomplishment of the team goal (Hunsaker and Hunsaker, 2008). Fewer opportunities for informal work- and non-work-related conversations may form challenges to virtual team (Furst *et al.,* 2004). Furthermore, virtual teams member are expected to become interdependent, successfully negotiate cultural differences (Dafoulas and Macaulay, 2002, Dekker *et al*., 2008), and accomplish their tasks through computer-mediated technology (Hunsaker and Hunsaker, 2008). The process to motivate team members may differ depending on their orientation (Paul *et al*., 2004a).

What Is Needed for Effective Virtual Team:

A review of the literature shows the factors that impact on the effectiveness of virtual teams are still ambiguous. Many of the acknowledged challenges of effective virtual team working, focus on ensuring good communication among all members of the distributed team (Anderson *et al*., 2007). For example, Jarvenpaa and Leidner (1999) found that regular and timely communication feedback was key to building trust and commitment in distributed teams. Lin *et al*.(2008) study indicates that social dimensional factors need to be considered early on in the virtual team creation process and are critical to the effectiveness of the team. Communication is a tool that directly influences the social dimensions of the team and in addition the performance of the team has a positive impact on satisfaction with the virtual team.

For teams moving from co-location to virtual environments, an ability to adapt and change can be a long process riddled with trial and error scenarios. This process is seen as necessary to encourage effective virtual teams (Kirkman *et al*., 2002). Despite weak ties between virtual team members, ensuring lateral communication maybe adequate for effective virtual team performance. In terms of implementation, lateral communication in both virtual context and composition teams can be increased by reducing the hierarchical structure of the team (i.e. a flatter reporting structure and/or decentralization) and the use of enabling computer-mediated communication tools (Wong and Burton, 2000).

Malhotra and Majchrzak's (2004) study of 54 effective virtual teams found that creating a state of shared understanding about goals and objectives, task requirements and interdependencies, roles and responsibilities, and member expertise had a positive effect on output quality. As criteria, effectiveness ratings were Hertel *et al*. (2005) collected from the team managers both at the individual and at the team level. The results of the field study showed good reliability of the task work-related attributes, teamwork-related attributes, and attributes related to tele-cooperative work.

Shachaf and Hara (2005)suggests four dimensions of effective virtual team leadership:

1. Communication (the leader provides continuous feedback, engages in regular and prompt communication, and clarifies tasks);
2. Understanding (the leader is sensitive to schedules of members, appreciates their opinions and suggestions, cares about member's problems, gets to know them, and expresses a personal interest in them);
3. Role clarity (the leader clearly defines responsibilities of all members, exercises authority, and mentors virtual team members); and
4. Leadership attitude (the leader is assertive yet not too "bossy," caring, relates to members at their own levels, and maintains a consistent attitude over the life of the project).

Bal and Teo (2001c) similar to their study in (1999) by observation and interview identified 12 elements for effective virtual team working. It is illustrated in Figure 1. The Bal and Gundry (2001c, 1999) model is used as the basic framework for the discussions on topic.

Virtual Team Working: Technology Point of View:

Selection:

Simple transmission of information from point A to point B is not enough; the virtual environment presents significant challenges to effective communication (Walvoord *et al*., 2008). Being equipped with even the most advanced technologies is not adequate to make a virtual team effective, since the internal group dynamics and external support mechanisms must also be present for a team to succeed in the virtual world (Lurey and Raisinghani, 2001). Information richness seemed to be the most important criterion for technology selection; and the greatest impediment to the effectiveness of virtual teams was the implementation of technology (Mikkola *et al*., 2005). Virtual teams are technology-mediated groups of people from different discipline that work on common tasks (Dekker *et al*., 2008) so the way the technology is implemented seems to make virtual teams outcome more or less likely (Anderson *et al*., 2007). Table 7 matrix assist the virtual team facilitator choose the appropriate technology based upon the purpose of the meeting.

Table 7: Tools for virtual teams (Adopted from Thissen et al. (2007))

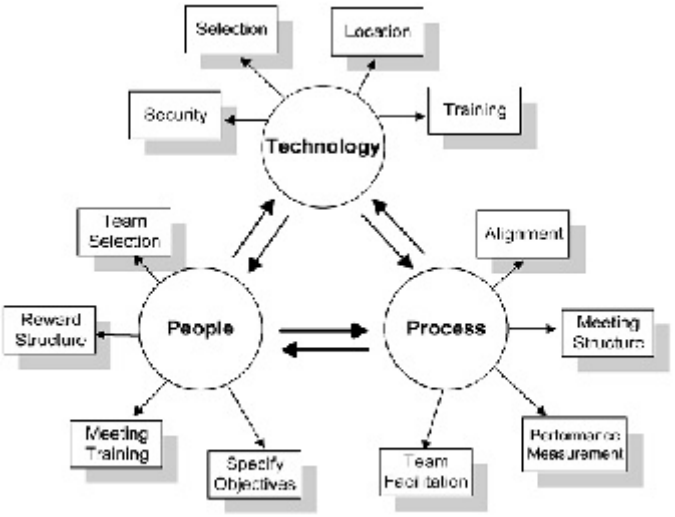
Tool	Examples	Uses and Advantages	Immediacy	Sensory Modes
Instant Messaging and Chat	• Yahoo Messenger • MSN Messenger • AOL Instant Messenger • Skype	• Instant interaction • Less intrusive than a phone call • View who is available • Low cost • Low setup effort	• Synchronous or asynchronous	• Visual • Text and limited graphics
Groupware / Shared Services	• Lotus Notes • Microsoft Exchange • Novell Groupwise	• Calendars • Contact Lists • Arrange meetings • Cost and setup effort vary	• Asynchronous	• Visual
Remote Access and Control	• NetMeeting • WebEx • Remote Desktop • pcAnywhere	• User controls a PC without being onsite • Cost varies • Setup varies	• Synchronous	• Visual • Audio • Tactile
Web Conferencing	• NetMeeting • WebEx • Meeting Space • GoToMeeting	• Live audio • Dynamic video • Whiteboard • Application sharing • Moderate cost and setup effort	• Synchronous	• Visual • Unlimited graphics • Optional audio
File Transfer	• File Transfer Protocol (FTP) • Collaborative Websites • Intranets	• Share files of any type • Cost varies • Moderate setup effort	• Asynchronous	• Varies with file content
Email	• Numerous vendors and • free applications	• Send messages or files • Cost and setup effort vary	• Asynchronous	• Visual • Audio in attached files
Telephone	• "Plain Old Telephone Service" (POTS) • Voice Over Internet Protocol (VOIP)	• Direct calls • Conference calls • Cost varies • Low setup effort	• Synchronous • Asynchronous for voice mail	• Audio

Location:

Virtual team allow organizations to access the most qualified individuals for a particular job regardless of their location and provide greater flexibility to individuals working from home or on the road (Bell and Kozlowski, 2002). Table 8 illustrates the relationship between tool, time and space in virtual teams.

Training:

Suggestions for the training of remote managers and virtual team development can be found in the literature (Hertel *et al*., 2005). The results of Anderson *et al*. (2007) systematic lab study confirm many of the observations include explicit preparation and training for virtual teams as a way of working collaboratively. Fuller *et al*., (2006b) results indicate that in the case of computer collective efficacy, computer training related to more advanced skills sets may be useful in building virtual team efficacy. The Hertel *et al*. (2005) suggested that the training led to increased cohesiveness and team satisfaction.



Source: Bal and Gundry (1999)

Fig. 1: Model for effective virtual team working

Table 8: Time /Space matrix (Adapted from Bouchard and Cassivi (2004))

	Same space	Different space
Same time Synchronous	Face-to-face meeting, Brainstorming, Vote, PC and projector Electronic white board, GDSS, Chat	Chat, Tele-conference, Video-conference, Liaison satellite, Audio-conference, Shared white board, Shared application
Different time Asynchronous	Team room, Document management system, Discussion forum, E-mail, Workflow, Project management	E-mail, Workflow, Document sharing, Discussion forum, Group agenda Cooperative hypertext and organizational memory, Version control Meeting scheduler

Security:

Virtual team working involve exchange and manipulation of sensitive information and data through the Internet, therefore security is always an important issue of concern (Bal and Teo, 2001c). Team leaders should identify the special technological and security level needs of the virtual team and their team members (Hunsaker and Hunsaker, 2008).

Virtual Team Working: People Point of View:

Team selection: Team selection is a key factor which differentiates successful teams from unsuccessful ones. Virtual teams can be designed to include the people most suited for a particular project (Bell and Kozlowski, 2002). Virtual team leaders rather than need to make sure the project is clearly defined, outcome priorities are established, and that a supportive team climate, need to select members with necessary skills (Hunsaker and Hunsaker, 2008). Selection of virtual team members is particularly difficult because of the geographical and organizational separation involved (Bal and Gundry, 1999).

Reward Structure:

The development of a fair and motivating reward system is another important issue at the beginning of virtual teamwork (Bal and Teo, 2001b, Hertel *et al*., 2005). Virtual team performance must be recognized and rewarded (Bal and Gundry, 1999). (Lurey and Raisinghani (2001) in a survey in an effort to determine the factors that contribute to the success of a virtual team, found that reward systems ranked strongly among the external support mechanisms for virtual teams.

Meeting Training:

Comparing teams with little and extensive training, Bal and Gundry (1999) observed a significant drop in performance as both teams went live using the system. However, the latter then improved its performance at a faster rate than the former. Training is a key aspect that cannot be neglected in team building. Virtual team members require some different types of training to ordinary teams. The training includes self-managing skills, communication and meeting training, project management skills, technology training, etc. (Bal and Teo, 2001c).

Specify Objective:

While direct leadership strategies are possible in conventional teams, members of virtual teams might be managed more effectively by empowerment and by delegating managerial functions to the members (Hertel *et al*., 2005). Such an approach changes the role of a team manager from traditional controlling into more coaching and moderating functions (Kayworth and Leidner, 2002). Virtual team leaders should identify commonalities among members early on, while focusing the team on achieving key performance objectives and providing a clear context for recognizing team success.

Virtual Team Working: Process Point of View:

Alignment:

The company's processes need to be re-aligned with the capabilities of virtual teams as opposed to face to face teams. This involves an understanding of the virtual team processes and the existing processes (Bal and Gundry, 1999). However, the key elements in knowledge sharing are not only the hardware and software, but also the ability and willingness of team members to actively participate in the knowledge sharing process (Rosen *et al*., 2007).

Meeting Structure:

Proximity enables team members to engage in informal work (Furst *et al*., 2004). Virtual team members are more likely to treat one another formally, and less likely to reciprocate requests from one another (Wong and Burton, 2000). Shin (2005) argued that lack of physical interactions and informal relationships decrease the cohesiveness of virtual teams. Formal practices and routines designed to formally structure the task, was reported to lead to higher quality output of virtual team (Massey *et al*., 2003). The physical absence of a formal leader exacerbates lack of extrinsic motivation (Kayworth and Leidner, 2002). In virtual teams that rarely meet face-to-face, team leaders often have no choice but to implement a formal team structure. Synchronous written documents helped virtual teams overcome challenges associated with spoken language, and this enabled teams to overcome challenges associated with asynchronous and lean written communication (Shachaf, 2008).

Performance Measurement:

Work on the performance of virtual teams by Kirkman and Rosen, *et al*. (2004) demonstrates a positive correlation between empowerment and virtual team performance. High-performance teams are distinguished by passionate dedication to goals, identification and emotional bonding among team members, and a balance between unity and respect for individual differences.

Team Facilitation:

Virtual team members must have clear roles and accountabilities. Lack of visibility may cause virtual team members to feel less accountable for results, therefore explicit facilitation of teamwork takes on heightened importance for virtual teams. Temporal coordination mechanisms such as scheduling deadlines and coordinating the pace of effort are recommended to increase vigilance and accountability (Massey *et al*., 2003).

Conclusion:

Strong business and social pressures are driving the adoption of virtual team working. This paper with a comprehensive review of literature and related resources covering the topic along with Bal and Teo (2001c), find that success in implementing virtual team working is more about processes and people than about technology. Virtual teams offer many benefits to organizations striving to handle a more demanding work environment, but also present many challenges and potential pitfalls. With comparing Table 3, with Table 4 it is clearly obvious that advantages of utilize virtual teams are far from its disadvantages so dealing with it can bring new findings. Virtual teams are a new and exciting work form with many fascinating opportunities. Due to these opportunities, virtual teamwork becomes increasingly popular in organizations.

This paper has identified and extended 12 key factors that need to be considered, and describes a methodology focused on supporting virtual team working, with a new approach that has not been specifically addressed in the existing literature. These findings provide an important step in studying how virtual team efficacy is formed and what its consequences are in the context of virtual teams. It is apparent from the literature review that significant differences are between virtual teams and co-located teams hence manager of virtual teams should not ignore these differences at their own peril. Suggestions for the training of remote managers and virtual team development can be found in the literature. Manager of virtual team should

overcome the managing conflict, cultural and functional diversity in virtual teams and mistrust among the team members

Future research would now seem to be essential for developing a comprehensive study, combining literature survey with case study in different size of companies (e.g. multinational companies and small and medium enterprises) and various types of activities (e.g. research and development and new product development). Such a study would provide an assessment what patterns, practices, or types of activities must virtual teams carry out to achieve effectiveness in the competitive environment?, How such teams should be managed? What types of process structure and technology support should be provided for facilitating such teams?, What different methods of virtual team are used today and how effective are they?, What benefits and problems arise as a consequence of the creation of virtual team? and How to make the transition from a more traditional team structure to the more distributed team structure?. These questions and many other practical questions wait for future empirical investigation.

REFERENCES

Acs, Z J. and L. Preston, 1997. Small and Medium-Sized Enterprises, Technology, and Globalization: Introduction to a Special Issue on Small and Medium-Sized Enterprises in the Global Economy. Small Business Economics, 9: 1-6.

Ahuja, M.K., D.F. Galletta and K.M. Carley, 2003. Individual Centrality and Performance in Virtual R&D Groups: An Empirical Study Management Science, 49: 21-38.

Akgun, A.E., M. Dayan and A.D. Benedetto, 2008. New product development team intelligence: Antecedents and consequences Information and Management, 45: 221-226.

Anderson, A.H., R. Mcewan, J. Bal and J. Carletta, 2007. Virtual team meetings: An analysis of communication and context. Computers in Human Behavior, 23: 2558-2580.

Arranz, N. and J.C.F.D. Arroyabe, 2008. The choice of partners in R&D cooperation: An empirical analysis of Spanish firms. Technovation, 28: 88-100.

Atuahene-gima, K., 2003. The effects of centrifugal and centripetal forces on product development speed and quality: how does problem solving matter? . Academy of Management Journal, 46: 359-373.

Badrinarayanan, V. and D.B. Arnett, 2008. Effective virtual new product development teams: an integrated framework. Journal of Business and Industrial Marketing, 23: 242-248.

Bal, J. and J. Gundry, 1999. Virtual teaming in the automotive supply chain. Team Performance Management, 5: 174 - 193.

Bal, J. and P.K. Teo, 2001a. Implementing virtual teamworking. Part 1: a literature review of best practice. Logistics Information Management, 13: 346 - 352.

Bal, J. and P.K. Teo, 2001b. Implementing virtual teamworking: Part 2 - a literature review. Logistics Information Management, 14: 208 - 222.

Bal, J. and P.K. Teo, 2001c. Implementing virtual teamworking: Part 3 - a methodology for introducing virtual teamworking. Logistics Information Management, 14: 276 - 292.

Baskerville, R. and J. Nandhakumar, 2007. Activating and Perpetuating Virtual Teams: Now That We're Mobile, Where Do We Go? IEEE Transactions on Professional Communication, 50: 17 - 34.

Bell, B.S. and S.W.J. Kozlowski, 2002. A Typology of Virtual Teams: Implications for Effective Leadership. Group and Organization Management, 27: 14-49.

Beranek, P.M. and B. Martz, 2005. Making virtual teams more effective: improving relational links. Team Performance Management, 11: 200-213.

Bergiel, J.B., E.B. Bergiel and P.W. Balsmeier, 2008 Nature of virtual teams: a summary of their advantages and disadvantages. Management Research News, 31: 99-110.

Biuk-aghai, R.P., 2003. Patterns of Virtual Collaboration. Faculty of Information Technology. Sydney, University of Technology.

Boehe, D.M., 2007. Product development in MNC subsidiaries: Local linkages and global interdependencies. Journal of International Management, 13: 488-512.

Bouchard, L. and L. Cassivi, 2004. Assessment of a Web-groupware technology for virtual teams. IAMOT 2004. Washington, D.C.

Boudreau, M.C., K.D. Loch, D. Robey and D. Straub, 1998. Going Global: Using Information Technology to Advance the Competitiveness Of the Virtual Transnational Organization. Academy of Management Executive, 12: 120-128.

Boutellier, R., O. Gassmann, H. Macho and M. Roux, 1998. Management of dispersed product

development teams: The role of information technologies. R&D Management, 28.

Camarinha-matos, L.M. and H. Afsarmanesh, 2003. Elements of a base VE infrastructure Computers in Industry, 51: 139-163.

Camarinha-matos, L.M. and H. Afsarmanesh, 2007. A comprehensive modeling framework for collaborative networked organizations. Journal Journal of Intelligent Manufacturing, 18: 529-542.

Cascio, W.F., 2000. Managing a virtual workplace. The Academy of Management Executive, 14: 81-90.

Cascio, W.F. and S. Shurygailo, 2003. E-Leadership and Virtual Teams. Organizational Dynamics, 31: 362-376.

Chen, H.H., Y.K. Kang, X. Xing, A.H.I. Lee and Y. Tong, 2008a. Developing new products with knowledge management methods and process development management in a network. Computers in Industry, 59: 242-253.

Chen, M., Y. Liou, C.W. Wang, Y.W. Fan and Y.P.J. Chi, 2007. Team Spirit: Design, implementation, and evaluation of a Web-based group decision support system. Decision Support Systems, 43: 1186-1202.

Chen, T.Y., 2008. Knowledge sharing in virtual enterprises via an ontology-based access control approach. Computers in Industry, Article In press, pp: 18.

Chen, T.Y., Y.M. Chen and H.C. Ch, 2008b. Developing a trust evaluation method between co-workers in virtual project team for enabling resource sharing and collaboration. Computers in Industry, 59: 565-579.

Chesbrough, H.W. and D.J. Teece, 2002. Organizing for Innovation: When Is Virtual Virtuous? Harvard Business Review Article, August 127-135.

Chudoba, K.M., E. Wynn, M. Lu, Watson-manheim and M. Beth, 2005. How virtual are we? Measuring virtuality and understanding its impact in a global organization. Information Systems Journal, 15: 279-306.

Criscuolo, P., 2005. On the road again: Researcher mobility inside the R&D network. Research Policy, 34: 1350-1365.

Cummings, J.L. and B.S. Teng, 2003. Transferring R&D knowledge: the key factors affecting knowledge transfer success. Journal of Engineering Technology Management, 39-68.

Dafoulas, G. and L. Macaulay, 2002. Investigating Cultural Differences in Virtual Software Teams. The Electronic Journal of Information Systems in Developing Countries (EJISDC), 7: 1-14.

Dekker, D.M., C.G. Rutte and P.T. Van den berg, 2008. Cultural differences in the perception of critical interaction behaviors in global virtual teams. International Journal of Intercultural Relations, 32: 441-452.

Dineen, B.R., 2005. Teamxchange: A Team Project Experience Involving Virtual Teams and Fluid Team Membership. Journal of Management Education, 29: 593-616.

Dustdar, S., 2004. Caramba-A Process-Aware Collaboration System Supporting Ad hoc and Collaborative Processes in Virtual Teams. Distributed and Parallel Databases, 15: 45-66.

El-tayeh, A., N. Gil and J. Freeman, 2008. A methodology to evaluate the usability of digital socialization in ''virtual'' engineering design Research in Engineering Design, 19: 29-45.

Fuller, J., M. Bartl, H. Ernst and H. Muhlbacher, 2006a. Community based innovation: How to integrate members of virtual communities into new product development. Electronic Commerce Research, 6: 57-73.

Fuller, M.A., A.M. Hardin and R.M. Davison, 2006b. Efficacy in Technology-Mediated Distributed Team Journal of Management Information Systems, 23: 209-235.

Furst, S.A., M. Reeves, B. Rosen and R.S. Blackburn, 2004. Managing the life cycle of virtual teams. Academy of Management Executive, 18: 6-20.

Gassmann, O. and M. Von zedtwitz, 2003a. Innovation Processes in Transnational Corporations, Elsevier Science Ltd.

Gassmann, O. and M. Von zedtwitz, 2003b. Trends and determinants of managing virtual R&D teams. RandD Management, 33: 243-262.

Gaudes, A., B. Hamilton-bogart, S. Marsh and H. Robinson, 2007. A Framework for Constructing Effective Virtual Teams The Journal of E-working, 1: 83-97.

Ge, Z. and Q. Hu, 2008. Collaboration in R&D activities: Firm-specific decisions. European Journal of Operational Research, 185: 864-883.

Griffith, T.L., J.E. Sawyer and M.A. Neale, 2003. Virtualness and Knowledge in Teams: Managing the Love Triangle in Organizations, Individuals, and Information Technology. MIS Quarterly, 27: 265-287.

Guniš, A., J. Šišlák and Š. Valčuha, 2007. Implementation Of Collaboration Model Within SME's. IN CUNHA, P.F. and MAROPOULOS, P.G. (Eds.) Digital Enterprise Technology-Perspectives and Future Challenges. Springer US.

Hardin, A.M., M.A. Fuller and R.M. Davison, 2007. I Know I Can, But Can We?: Culture and Efficacy

Beliefs in Global Virtual Teams. Small Group Research, 38: 130-155.

Hertel, G.T., S. Geister and U. Konradt, 2005. Managing virtual teams: A review of current empirical research. Human Resource Management Review, 15: 69-95.

Hinds, P.J. and M. Mortensen, 2005. Understanding Conflict in Geographically Distributed Teams: The Moderating Effects of Shared Identity, Shared Context, and Spontaneous Communication. Organization Science, 16: 290-307.

Hossain, L. and R.T. Wigand, 2004. ICT Enabled Virtual Collaboration through Trust. Journal of Computer-Mediated Communication, 10.

Hunsaker, P.L. and J.S. Hunsaker, 2008. Virtual teams: a leader's guide. Team Performance Management, 14: 86-101.

Jacobsa, J., J.V. Moll, P. Krause, R. Kusters, J. Trienekens and A. Brombacher, 2005. Exploring defect causes in products developed by virtual teams Information and Software Technology, 47: 399-410.

Jain, V.K. and D.K. Sobek, 2006. Linking design process to customer satisfaction through virtual design of experiments. Research in Engineering Design, 17: 59-71.

Jarvenpaa, S.L. and D.E. Leidner, 1999. Communication and Trust in Global Virtual Teams. Organization Science, 10: 791 - 815.

Johnson, P., V. Heimann and K. O'Neill, 2001. The "wonderland" of virtual teams. Journal of Workplace Learning, 13: 24 - 30.

Kankanhalli, A., B.C.Y. Tan and K.K. Wei, 2006. Conflict and Performance in Global Virtual Teams. Journal of Management Information Systems, 23: 237-274.

Kayworth, T.R. and D.E. Leidner, 2002. Leadership Effectiveness in Global Virtual Teams Management Information Systems, 18: 7 - 40.

Kirkman, B.L., C.B. Gibson and D.L. Shapiro, 2001. "Exporting" teams enhancing the implementation and effectiveness of work teams in global affiliates Organizational Dynamics, 30: 12-29.

Kirkman, B.L., B. Rosen, C.B. Gibson, P.E. Tesluk and S.O. Mcpherson, 2002. Five challenges to virtual team success: lessons from Sabre Inc. Academy of Management Executive, 16: 67-79.

Kirkman, B.L., B. Rosen, P.E. Tesluk and C.B. Gibson, 2004. THE IMPACT OF TEAM EMPOWERMENT ON VIRTUAL TEAM PERFORMANCE: THE MODERATING ROLE OF FACE-TO-FACE INTERACTION. Academy of Management Journal, 47: 175-192.

Kratzer, J., R. Leenders and J.V. Engelen, 2005. Keeping Virtual R&D Teams Creative. Industrial Research Institute, Inc., March-April, 13-16.

Kusar, J., J. Duhovnik, J. Grum and M. Starbek, 2004. How to reduce new product development time. Robotics and Computer-Integrated Manufacturing, 20: 1-15.

Lee-kelley, L. and T. Sankey, 2008. Global virtual teams for value creation and project success: A case study. International Journal of Project Management, 26: 51-62.

Leenders, R.T.A.J., J.M.L.V. Engelen and J. Kratzer, 2003. Virtuality, communication, and new product team creativity: a social network perspective. Journal of Engineering and Technology Management, 20: 69-92.

Lin, C., C. Standing and Y.C. Liu, 2008. A model to develop effective virtual teams. Decision Support Systems, 45: 1031-1045.

Lipnack, J. and J. Stamps, 2000. Why The Way to Work. Virtual Teams: People Working across Boundaries with Technology. Second Edition ed. New York, John Wiley and Sons.

Liu, B. and S. Liu, 2007. Value Chain Coordination with Contracts for Virtual R&D Alliance Towards Service. The 3rd IEEE International Conference on Wireless Communications, Networking and Mobile Computing, WiCom 2007. Shanghai, China, IEEE Xplore.

Lurey, J.S. and M.S. Raisinghani, 2001. An empirical study of best practices in virtual teams Information and Management, 38: 523-544.

Malhotra, A. and A. Majchrzak, 2004. Enabling knowledge creation in far-flung teams: best practices for IT support and knowledge sharing. Journal of Knowledge Management, 8: 75 - 88.

Malhotra, A., A. Majchrzak and B. Rosen, 2007. Leading Virtual Teams. The Academy of Management Perspectives, 21: 60-69.

Martinez-sanchez, A., M. Perez-perez, P. De-luis-carnicer and M.J. Vela-jimenez, 2006. Teleworking and new product development. European Journal of Innovation Management, 9: 202-214.

Martins, L.L., L.L. Gilson and M.T. Maynard, 2004. Virtual teams: What do we know and where do we go from here? Journal of Management, 30: 805-835.

Massey, A.P., M.M. Montoya-weiss and H. Yu-ting, 2003. Because Time Matters: Temporal Coordination in Global Virtual Project Teams. Journal of Management Information Systems, 19: 129-155.

May, A. and C. Carter, 2001. A case study of virtual team working in the European automotive industry. International Journal of Industrial Ergonomics, 27: 171-186.

Mcdonough, E.F., K.B. Kahn and G. Barczak, 2001. An investigation of the use of global, virtual, and collocated new product development teams. The Journal of Product Innovation Management, 18: 110-120.

Merali, Y. and J. Davies, 2001. Knowledge Capture and Utilization in Virtual Communities. International Conference On Knowledge Capture, K-CAP'01. Victoria, British Columbia, Canada.

Mikkola, J.H., P. Maclaran and S. Wright, 2005. Book reviews. R&D Management, 35: 104-109.

Miles, R.E., C.C. Snow and G. Miles, 2000. TheFuture.org Long Range Planning, 33: 300-321.

Mulebeke, J.A.W. and L. Zheng, 2006. Incorporating integrated product development with technology road mapping for dynamism and innovation. International Journal of Product Development, 3: 56 - 76.

Munkvold, B.E. and I. Zigurs, 2007. Process and technology challenges in swift-starting virtual teams. Information and Management, 44: 287-299.

Nemiro, J.E., 2002. The Creative Process in Virtual Teams Creativity Research Journal, 14: 69 - 83.

Ocker, R.J. and J. Fjermestad, 2008. Communication differences in virtual design teams: findings from a multi-method analysis of high and low performing experimental teams. The DATA BASE for Advances in Information Systems, 39: 51-67.

Ojasalo, J., 2008. Management of innovation networks: a case study of different approaches. European Journal of Innovation Management, 11: 51-86.

Olson-buchanan, J.B., P.L. Rechner, R.J. Sanchez and J.M. Schmidtke, 2007. Utilizing virtual teams in a management principles course. Education + Training, 49: 408-423.

Ortiz de Guinea, A., J. Webster and S. Staples, 2005. A Meta-Analysis of the Virtual Teams Literature. Symposium on High Performance Professional Teams Industrial Relations Centre. School of Policy Studies, Queen's University, Kingston, Canada.

Ozer, M., 2000. Information Technology and New Product Development Opportunities and Pitfalls. Industrial Marketing Management, 29: 387-396.

Paul, S., I.M. Samarah, P. Seetharaman and P.P. Mykytyn JR, 2004a. An Empirical Investigation of Collaborative Conflict Management Style in Group Support System-Based Global Virtual Teams. Journal of Management Information Systems, 21: 185-222.

Paul, S., P. Seetharaman, I. Samarah and P.P. Mykytyn, 2004b. Impact of heterogeneity and collaborative conflict management style on the performance of ynchronous global virtual teams. Information and Management, 41: 303-321.

Paul, S., P. Seetharaman, I. Samarah and J. Peter Mykytyn, 2005. Understanding Conflict in Virtual Teams: An Experimental Investigation using Content Analysis. 38th Hawaii International Conference on System Sciences. Hawaii.

Paul, S., P. Seetharaman, I. Samarah and J. Peter Mykytyn, 2005. Understanding Conflict in Virtual Teams: An Experimental Investigation using Content Analysis. 38th Hawaii International Conference on System Sciences. Hawaii.

Pauleen, D.J., 2003. An Inductively Derived Model of Leader-Initiated Relationship Building with Virtual Team Members. Journal of Management Information Systems, 20: 227-256.

Pawar, K.S. and S. Sharifi, 1997. Physical or virtual team collocation: Does it matter? International Journal of Production Economics, 52: 283-290.

Pawar, K.S. and S. Sharifi, 2000. Virtual collocation of design teams: coordinating for speed. International Journal of Agile Management Systems, 2: 104 - 113.

Pena-mora, F., K. Hussein, S. Vadhavkar and K. Benjamin, 2000. CAIRO: a concurrent engineering meeting environment for virtual design teams. Artifcial Intelligence in Engineering, 14: 203-219.

Peters, L.M. and C.C. Manz, 2007. Identifying antecedents of virtual team collaboration. Team Performance Management, 13: 117-129.

Piccoli, G., A. Powell and B. Ives, 2004. Virtual teams: team control structure, work processes, and team effectiveness. Information Technology and People, 17: 359 - 379.

Pihkala, T., E. Varamaki, and J. Vesalainen, 1999. Virtual organization and the SMEs: a review and model development. Entrepreneurship and Regional Development, 11: 335 - 349.

Poehler, L. and T. Schumacher, 2007. The Virtual Team Challenge: Is It Time for Training? *PICMET 2007*. Portland, Oregon - USA.

Powell, A., G. Piccoli and B. Ives, 2004. Virtual teams: a review of current literature and directions for future research. The Data base for Advances in Information Systems, 35: 6-36.

Prasad, K. and K.B. Akhilesh, 2002. Global virtual teams: what impacts their design and performance? Team Performance Management, 8: 102 - 112.

Precup, L., D. O'sullivan, K. Cormican and L. Dooley, 2006. Virtual team environment for collaborative research projects. International Journal of Innovation and Learning, 3: 77 - 94

Qureshi, S. and D. Vogel, 2001. Adaptiveness in Virtual Teams: Organisational Challenges and Research Directions. Group Decision and Negotiation, 10: 27-46

Rabelo, L. and T.H.S. Jr., 2005 Sustaining growth in the modern enterprise: A case study. Jornal of Engineering and Technology Management JET-M, 22: 274-290.

Ramayah, T., J. Muhamad, M.N. Aizzat and P.L. Koay, 2003. Internal Group Dynamics, Team Characteristics and Team Effectiveness: A Preliminary Study of Virtual Teams. The International Journal of Knowledge, Culture and Change Management, 3: 415-435.

Rezgui, Y., 2007. Exploring virtual team-working effectiveness in the construction sector. Interacting with Computers, 19: 96-112.

Rice, D.J., B.D. Davidson1, J.F. Dannenhoffer and G.K. Gay, 2007. Improving the Effectiveness of Virtual Teams by Adapting Team Processes. Computer Supported Cooperative Work, 16: 567-594.

Rosen, B., S. Furst and R. Blackburn, 2007. Overcoming Barriers to Knowledge Sharing in Virtual Teams. Organizational Dynamics, 36: 259-273.

Ryssen, S.V. and S.H. Godar, 2000. Going international without going international: multinational virtual teams. Journal of International Management, 6: 49-60.

Samarah, I., S. Paul and S. Tadisina, 2007. Collaboration Technology Support for Knowledge Conversion in Virtual Teams: A Theoretical Perspective. 40th Hawaii International Conference on System Sciences (HICSS). Hawai.

Schmidt, J.B., M.M. Montoya-weiss and A.P. Massey, 2001. New product development decision-making effectiveness: Comparing individuals, face-to-face teams, and virtual teams. Decision Sciences, 32: 1-26.

Shachaf, P., 2005. Bridging cultural diversity through e-mail. Journal of Global Information Technology Management, 8: 46-60.

Shachaf, P., 2008. Cultural diversity and information and communication technology impacts on global virtual teams: An exploratory study. Information and Management, 45: 131-142.

Shachaf, P. and N. Hara, 2005. Team Effectiveness in Virtual Environments: An Ecological Approach. IN FERRIS, P.A.G., S., (Ed.) Teaching and Learning with Virtual Teams. Idea Group Publishing.

Shin, Y., 2005. Conflict Resolution in Virtual Teams. Organizational Dynamics, 34: 331-345.

Sorli, M., D. Stokic, A. Gorostiza and A. Campos, 2006. Managing product/process knowledge in the concurrent/simultaneous enterprise environment. Robotics and Computer-Integrated Manufacturing, 22: 399-408.

Sridhar, V., D. Nath, R. Paul and K. Kapur, 2007. Analyzing Factors that Affect Performance of Global Virtual Teams. Second International Conference on Management of Globally Distributed Work Indian Institute of Management Bangalore, India.

Staples, D.S. and L. Zhao, 2006. The Effects of Cultural Diversity in Virtual Teams Versus Face-to-Face Teams. Group Decision and Negotiation, 15: 389-406.

Stoker, J.I., J.C. Looise, O.A.M. Fisscher and R.D. De Jong, 2001. Leadership and innovation: relations between leadership, individual characteristics and the functioning of R&D teams. The International Journal of Human Resource Management, 12: 1141 - 1151.

Taifi, N., 2007. Organizational Collaborative Model of Small and Medium Enterprises in the Extended Enterprise Era: Lessons to Learn from a Large Automotive Company and its dealers' Network. Proceedings of the 2nd PROLEARN Doctoral Consortium on Technology Enhanced Learning, in the 2nd European Conference on Technology Enhanced Learning. Crete, Greece, CEUR Workshop Proceedings.

Thissen, M.R., M.P. Jean, C.B. Madhavi and L.A. Toyia, 2007. Communication tools for distributed software development teams. Proceedings of the 2007 ACM SIGMIS CPR conference on Computer personnel research: The global information technology workforce. St. Louis, Missouri, USA, ACM.

Thomas, D.M. and R.P. Bostrom, 2005. Virtual Team Leader as Technology Facilitator: the missing role. Proceedings of the 2005 Southern Association for Information Systems Conference.

Vaccaro, A., F. Veloso and S. Brusoni, 2008. The Impact of Virtual Technologies on Organizational Knowledge Creation: An Empirical Study. Hawaii International Conference on System Sciences. Proceedings of the 41st Annual Publication.

Walvoord, A.A.G., E.R. Redden, L.R. Elliott and M.D. Coovert, 2008. Empowering followers in virtual teams: Guiding principles from theory and practice", Computers in Human Behavior (article in press).

Wong, S.S. and R.M. Burton, 2000. Virtual Teams: What are their Characteristics, and Impact on Team Performance? Computational and Mathematical Organization Theory, 6: 339-360.

Yip, G. and A. Dempster, 2005. Using the Internet to Enhance Global Strategy. European Management Journal, 23: 1-13.

Zakaria, N., A. Amelinckx and D. Wilemon, 2004. Working Together Apart? Building a Knowledge-Sharing Culture for Global Virtual Teams. Creativity and Innovation Management, 13: 15-29.

Zenun, M.M.N., G. Loureiro and C.S. Araujo, 2007. The Effects of Teams' Co-location on Project Performance. IN LOUREIRO, G. and CURRAN, R. (Eds.) Complex Systems Concurrent Engineering-Collaboration, Technology Innovation and Sustainability. London, Springer.

Zhang, S., W. Shen and H. Ghenniwa, 2004. A review of Internet-based product information sharing and visualization. Computers in Industry, 54: 1-15.

Zhang, Y., M. Gregory and Y. Shi, 2008. Global engineering networks (GEN): Drivers, evolution, configuration, performance and key patterns. Journal of Manufacturing Technology Management, 19: 299 - 314.

Zhouying, J., 2005. Globalization, technological competitiveness and the 'catch-up' challenge for developing countries: some lessons of experience. International Journal of Technology Management and Sustainable Development, 4: 35-46