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SMEs and Virtual R&D Teams: A Motive Channel for Relationship between SMEs

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Abstract-This paper explores potential advantages and barriers of virtual teams toward making an interrelation between small and medium-sized firms (SMEs) with a comprehensive review on different aspects of virtual teams in SMEs based on authentic and reputed publications. The purpose of the state-of-the-art literature review is to provide an overview of what is known about the structure and dynamics of virtual collaboration in SMEs which they are the back bone of the world business. This study seeks to address some of the advantages of virtual R&D team in the existing extensive literature on the increase SMEs interrelations. Besides of identify benefits of virtual R&D team in SMEs, propose the way of further studies and recommend improvements. We argue that the routines used to promote interrelation between SMEs, based on virtual collaboration can sometimes create problems for firms as they ignore new challenges. We elaborate various theories on the virtual R&D team by reviewing the precedent papers.

I. INTRODUCTION

Faced with the challenges of increased globalization of markets and of technological change, SMEs need reinforced support through transnational research cooperation to enhance their innovation and research investment. SMEs' survival depended on their capability to improve their performance and produce goods that could meet international standards [1]. In other words, a certain level of competitiveness may be a prerequisite for an SME's survival when dealing with dynamic conditions in the business environment. To compete with global competition and, overcome the rapid technology change and product variety proliferation in the new manufacturing environment, SMEs must be able to sustain product innovation [2]. Internationalization holds much potential for the growth of SMEs [3]. One very important trend to enable new knowledge creation and transfer in and to SME's is the development of collaborative environments and networks to increase their innovation capabilities as a single unit but also the capabilities of the network as a whole through collective learning [4].

O'Regan et al. [5] Investigated in a sample of 207 manufacturing SMEs and found a positive correlation between R&D investment and technological change in products and processes in firms with static or declining sales. Kuo and Li [6] argue that the empirical result in Taiwan's SMEs indicates that a firm's likelihood in undertaking foreign direct investment (FDI) reaches a maximum when its R&D intensity reaches 11.08 percent hence a strong quadratic between R&D intensity in SMEs and FDI exist. O'Regan et al. [5] with discussions with Managing

Directors of six organizations they suggested that, in general, investment in R&D, the number of new products introduced the need to meet technological changes in both processes and products and the importance of prototype development are the most important attributes of innovation in manufacturing SMEs. Gassmann and Keupp [7] found that managers of SMEs should invest less in tangible assets, but more in those areas that will directly generate their future competitive advantage (e.g., in R&D to generate knowledge, and in their employees' creativity to stimulate incremental innovations in already existing technologies).

Global market requires short product development times, and so SMEs are also forced into transition from sequential to concurrent product development [8]. SMEs are the key players in the innovation system and the economy of a country, despite their size limits, they bring about a lot of creativity into the products and services they offer through research and development, therefore networking seems to be a suitable strategic solution for technology based enterprises in order to grant them a competitive edge and the opportunity to tap into the knowledge base of other networked partners. Putting an SME in the way to Information Society or in the way to making the best ICT investment in terms of economic return through company benefits is more of an art than engineering [9]. Lawson et al [10] studied focuses on R&D in SMEs, and consequently, provides novel insights currently lacking in the published literature. In this paper based on comprehensive literature review of recent articles, at the first step provides a primary definition of virtual teams; next, the importance of SMEs, the major characteristics of SMEs, differences in R&D between SMEs and large firms, SMEs and virtual teams working, described and lastly a guide line for future study evolved. It is argued that the establishing of virtual teams should be given consideration in the management of SMEs. Although computers' widespread use for personal applications, very few programming frameworks exist for creating synchronous collaborative applications between SMEs.

II. VIRTUAL TEAMS

It is a worth mentioning that virtual teams are often formed to overcome geographical or temporal separations [11]. 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 [12].

Virtual teams are comprised of members who are located in more than one physical location. This team trait has fostered an extensive use of a variety of forms of computer-mediated communication that enable geographically dispersed members to coordinate their individual efforts and inputs [13]. Gassmann and Von Zedtwitz [14] 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.) [15]. Different authors have identified diverse areas. From the perspective of Leenders et al. [16] 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 organizations. Lurey and Raisinghani [17] defined virtual teams - groups of people who work together although they are often dispersed across space, time, and/or organizational boundaries. Among the different definitions of a virtual team, the following concept from which the term employed in this paper is one of the most widely accepted definitions: [18], ‘virtual teams are as groups of geographically, organizationally and/or time dispersed workers brought together by information technologies to accomplish one or more organization tasks ’.

III. THE IMPORTANCE OF SMALL- AND MEDIUM-SIZE ENTERPRISES (SMEs)

The importance of small and medium-sized enterprises (SMEs) in economic growth has made them a central element in much recent policymaking [19]. MEs are a major part of the industrial economies [20, 21]. Their survival and growth have therefore, been a prominent issue. Beck et al. [22] explores the relationship between the relative size of the Small and Medium Enterprise (SME) sector, economic growth, and poverty alleviation using a sample of 45 countries, and found that a strong, positive association between the importance of SMEs and GDP per capita growth. SMEs can successfully enter the global market if they can fulfill the customer needs regarding features and quality of products [8]. Acs, et al. [23] argued that small firms are indeed the engines of global economic growth. Small and Medium Enterprises (SMEs) play an important role to promote economic development. SMEs in the beginning of R&D activities always face capital shortage and need technological assistance. In most countries, SMEs dominate the industrial and commercial infrastructure [24]. More importantly SMEs play an important role in foreign direct investment (FDI) [6]. Many economists believe that the wealth of nations and the growth of their economies strongly depend upon their SMEs’ performance [25]. In many developed and developing countries, small and medium-sized enterprises (SMEs) are the unsung heroes that bring stability to the national economy. They help buffer the

shocks that come with the boom and bust of economic cycles. SMEs also serve as the key engine behind equalizing income disparity among workers [26]. China’s recent rapid growth is also linked to the emergence of many new small firms in village townships and in coastal areas, often in new industries [23].

SMEs seem to be appropriate units to behave like network nodes because of their lean structure, adaptability to market evolution, active involvement of versatile human resources, ability to establish a sub-contracting relation and good technological level of their products [27]. In light of the above, SMEs have advantages in terms of flexibility, reaction time, and innovation capacity that make them central actors in the new economy [28]. Gassmann and Von Zedtwitz [14] based on 204 interviews with R&D directors and project managers in 37 technology-intensive multinational companies ,have shown five trends in organizing virtual R&D teams, which are:

Continued internationalization of R&D will further increase the importance of and reliance on virtual R&D teams.

1. Virtual R&D teams will better integrate talent in newly industrialized countries.
2. Advances in information and communication technologies will further enhance the functionality of virtual teams.
3. Relative costs of running virtual R&D projects will decrease due to learning curve effects.
4. Highly decentralized virtual R&D teams will gain importance in open system architectures such as internet-based applications.

Susman et al. [29] have probed more deeply than existing theories into the psychological and social dynamics of virtual teams and propose a model that articulates the processes that intervene between recognition of a misalignment, and appropriations that reduce or eliminate them. From the human resources point of view, SMEs employees are given the authority and responsibility in their own work areas that can create cohesion and enhance common purposes among the workforce to ensure that a job is well done [24]. In order to implement an appropriate knowledge management strategy in SMEs, cultural, behavioral, and organizational issues need to be tackled before even considering technical issues [30]. Acs, et al. [23] further argue that the international diffusion of SMEs innovations is important for global economic welfare. The traditional independence of small firms is being replaced by a network environment [31]. Generally speaking three types of technologies are picked up by SMEs: small scale technologies, labor intensive technologies, and specialized high technology know-how [32] creating networks in the cycle of the management of these technologies is of a high importance.

IV. THE MAJOR CHARACTERISTICS OF SMEs

In order to have a better understanding of SMEs, a brief knowledge of the characteristics of SMEs is a must therefore, the major characteristics of SMEs are listed in the TABLE 1 and TABLE 2 (These are generalizations, and not all may hold true for every SMEs.).

TABLE 1
SOME OF THE MAJOR ADVANTAGES OF SMEs

Advantages	Reference
Generally dominated by the entrepreneur (owner-manager)	[33-39]
Able to respond quickly to customer requests and market changes, Customers focused	[33, 34, 40-45]
Flexible and fast-response to change, easily adaptive to new market conditions , dynamic in behavior, developing customized solutions for partners and customers	[24, 27, 34, 40, 45-51].
Concentrated production and sales in their home country	[46, 52].
Driven by client demands Quick decision making process (decisions are made by an individual or a small number of people, or a single individual)	[10, 24, 34, 53]
Strongly correlated and inter-related with respect to Innovation and entrepreneurship High innovative potential	[20, 54-58]
More extensive use of external linkages for Innovate.	[19, 59, 60]
Un bureaucratic processes, flat and flexible structures	[24, 34, 40, 53, 54, 61-63]
Strong inter and intra-firm relationships , managing a great amount of information	[64, 65]
Good at multi-tasking	[34, 62]
Focused on gaining instant gratification with technology solutions.	[34]
Informal and dynamic strategies	[54]
Capable of going international early and rapidly	[7]
Possessing tight control over production processes due to close management involvement	[40]
Productive	[22]
Knowledge creating	[35, 66]
Capable of fast learning and adapting routines and strategy. Great potential to adapt new production methods	[53]
Creating astute alliances, networking	[63, 67-70]

TABLE 2
SOME OF THE MAJOR DISADVANTAGES OF SMEs

Disadvantages	Reference
Scarce resources and manpower	[2, 3, 31, 45, 47, 48, 62, 68, 70-75]
limited degree of information technology (IT) implementation	[21, 35, 39, 54, 71, 76, 77]
Weak at converting research and development into effective innovation	[5, 78]
Lacking some of the essential resources for innovation (poor innovative capabilities) Severe resource limitations in R&D	[54, 63, 79-82]
Strategy is based on low price, high quality offerings, rather than new product innovations	[83]
Not having formal R&D activities	[37, 84]
Strategy formulation on the basis of what available, lack a long run perspective	[1, 85]
Reliance on the small number of customers, and operating in limited markets. Reactive and fire fighting mentality.	[54]
Rely on outdated technology, labor intensive and traditional management practices	[22, 24, 73]
Lagging in the export, lack the resources necessary to enter foreign markets	[74, 86]
Lack of formal competitor analysis, data collection during NPD processes.	[87]
Absolute size , fewer technological assets	[46]

Dickson and Hadjimanolis [79] state that since small companies typically lacks some of the essential resources for innovation, they have to acquire them from external sources, such as other companies, technical institutions, etc. Therefore, the management of inter-organizational relationships and networking in general may well be critical for successful development in small companies. It is also important that the companies have the ability to network. As firms become 'networked' the critical capabilities are moving from within to between firms, and innovation will need to move too [31]. Cooperative R&D is a useful way to overcome the lack of internal business resources and to improve innovativeness and competitiveness, particularly SMEs [88].

V. DIFFERENCES IN R&D BETWEEN SMES AND LARGE FIRMS

Small and medium sized businesses are often edged out by their larger counterparts in today's competitive business environment. Until now, large multinational corporations enjoyed the advantage of having affordable resources spread out across the globe. Small and medium sized enterprises (SMEs) typically suffer from a lack of resources, their central role in the development of technology and science-driven industries are paradoxical [68]. Therefore, virtual teams are able to provide a reliable structure to promote SMEs. Most products are multi-technology in nature, and multiple competences are needed, few firms, regardless of size, can afford to maintain R&D facilities with world-class competences in so many different sectors [46]. Innovation is equally important for large and small firms in the contemporary competitive and changing market [79]. The ability of SMEs to meet growing consumer expectations is largely based on their capability to innovate and deliver new products at competitive prices. Innovation is a key driver of sustainable competitive advantage and one of the key challenges for SMEs [78]. Building global teams and Internet-related capabilities are now options for all companies, regardless of size and location [89]. Every organization, regardless of size, profit, over the last decades, R&D teams have become increasingly virtual [16, 90].

In the other hand, some authors argue that large firms appear to have been more innovative rather than small firms [91]. Especially in IT industry large firms create more IT innovation than do small firms [92]. In multinational companies, the use of dispersed constellations in R&D activities is seen to be increasing [93, 94]. Jeong [95] in a survey of 179 US and 250 Chinese firms, explores the role of firm size in facilitating the relationship between multinational expansion and new product performance. The study shows that the firm size effects appear to be significant among Chinese's firms, but not in the US sample. The article also shows that US firms can incorporate the benefits of international expansion into their new product development efforts, irrespective of their size. On the other hand, although large companies have sufficient resources for investing in innovation, they suffer from a variety of issues that may make them less innovative [2] larger firms are able

to avail themselves of the flexibility long enjoyed by SMEs [46].

VI. SMEs AND VIRTUAL TEAMS WORKING

Virtuality has been presented as one solution for SMEs aiming to increase their competitiveness [96]. Karaev [69] in a comprehensive literature has shown the benefits of establishing clusters as an efficient tool for overcoming the size limitations of SMEs. Geographical proximity brings so-called agglomeration effects in terms of higher specialization, innovation and knowledge transfer, which results in cost reduction and improving the competitiveness of industrial sectors, regions and nations. Small businesses must leverage the adoption process to maximize the speed and ease of technology transfer from its partners. Only through cooperation in the adoption of innovations can inter-organizational networks function optimally [82]. Past literature often hypothesized that SME did not innovate in formally recognized ways, and that they made much more extensive use of external linkages [19, 59, 60]. To survive in the global economy SMEs have to improve their products and processes exploiting their intellectual capital in a dynamic network of knowledge-intensive relations inside and outside their borders [77]. If small firms want to make a step change in their technological and innovation base, they may have to rethink their approach to cooperation [31]. SMEs need to focus on core competences for efficiency matters; they need to cooperate with external partners to compensate for other competences and resources. This is especially the case in the field of new product development, where SMEs face specific problems in comparison to large firms [72].

Despite the widespread publicity of information technology, the application of Internet technology to upgrade and enhance the product design and business operation by most enterprises, especially for the small and medium sized enterprises, is still at its infancy [97]. Lin et al. [76] was found that although most senior executives and managers were committed to the IT investments in enterprise during the implementation stage, most of these organizations did not manage user resistance effectively. 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 [98]. The use of ICTs can be considered as key factors for innovation and entrepreneurship. ICTs are a must for SMEs to innovate [9]. Web resource services can help the enterprises to get external service resources and implement collaborative design and manufacturing [99]. It is especially urgent for SMEs to construct a service platform of networked to speed up the product development process [100]. SMEs have the lack of capital investment for systematic use of information, developing organization processes and technology development. Three out of the eleven organizations used the intranet for knowledge identification. This is basically a data warehouse with data on previous projects and employees (those involved in

projects, together with their skills and competences) [35]. This indicates that organizations, especially SMEs, do not fully exploit the potential benefits of IT for growth. Levy et al. [66] state that SMEs are knowledge creators but are poor in knowledge retention. They need to be proactive in knowledge sharing arrangements to recognize that knowledge has value and the value added is derived from knowledge exchange [35].

VII. CONCLUSION

Many SMEs have limited recourses, and it is well-known for their dynamic behavior in contrast the difficulty of diverting skilled personnel from day-by-day activities, to undertake process re-engineering and R&D therefore, applying virtual R&D team in SMEs is a foundation of high-growth SMEs. While larger organizations by their nature can afford the risk of making mistakes, small to medium enterprises (SMEs) are typically more vulnerable and, hence, need a structured low risk approach such as virtual R&D teams. With virtual R&D team the gap between large organizations and SMEs is closing and the pattern of winning in the market space is changing due to technological advances. Competitive advantage, which once belonged exclusively to the large firms, is now becoming available to SMEs through geographically open boundaries created by virtual teams. Reviewing the literature shows that the usage of virtual teams is dependent on the technological as well as the market force for introducing the new product by R&D activities of SMEs. SMEs can achieve higher growth rates and higher profitability by pertain to virtual R&D team.

Most of the research activities relevant for SMEs do not encourage and support R&D collaboration and technology transfer. Benefiting from the cross functional virtual R&D teams beyond the organizations or countries are therefore, vital to fill this gap, unlock growth opportunities for SMEs through research, and help them to carry out or outsource research in order to develop new technology based products, processes and services, exploit research results, acquire technological knowhow and train their employees to incorporate new developments. However, the literature so far has not paid adequate attention to the virtual R&D team activities in SMEs. While some studies have been conducted on model usage in MNCs and large companies, applications within SMEs remain largely un-documented. In the competitive era, it is obvious that the survival of the SMEs will be determined by their ability to manufacture/supply more, at competitive cost, in less delivery time, with minimum defects, using fewer resources. In order to face this challenge SMEs reinforce to create synergies via virtual R&D team that allow firms to overcome difficulties and succeed. Therefore, managers of SMEs should invest less in tangible assets, but more in those areas that will directly generate their future competitive advantage such as virtual R&D. Future research need to design infrastructures to support virtual R&D team in SMEs. New ways of communicating and interacting among team members in virtual environments will necessitate being developed and implemented.

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