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Virtual R&D Teams for NPD in SMEs: Past, Present and Future Trend

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Abstract

This paper provides a comprehensive review on different aspects of virtual teams 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 R&D collaboration in SMEs. SMEs are the backbone of the world business. The focus of the investigation is on virtual R&D teams in SMEs. After providing a definition and importance of virtual teams, research and development (R&D), small and medium enterprises (SME) and new product development (NPD), the relationship between them will be examined. This paper seeks to address some of the gaps in the existing extensive literature on virtual teams as a general and virtual R&D teams in new product development in SMEs, as a concentrate topic. Covering previous literatures, the research gaps derive and propose the way of further studies and recommend are provided. Along extending future research some managerial implication will be discussed. It is argued that the preparation for virtual R&D team working should be given consideration in the management of R&D new product development projects.

Keywords: R&D, Virtual Team, Small and Medium Enterprises, Literature Review

1. Introduction:

Responding to the increasing de-centralization and globalization of work processes, many organizations have responded to their dynamic environments by introducing virtual teams. Virtual teams are growing in popularity [1]. 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 [2]. Taking into account that under the increasingly competitive global market, a firm simply cannot survive without new products developed under network cooperation, especially for high-tech industries [3]. Firms rely heavily on new product development to successfully compete in increasingly competitive global markets [4].

R&D teams need to access and retrieve information from as many sources as possible [5]. Virtual teams are important mechanisms for organizations seeking to leverage scarce resources across geographic and other boundaries [6]. Internationalization of markets, specialization of skills and knowledge, and the requirement to involve an increasingly large pool of knowledge simultaneously in the NPD process have all pushed firms to rely more and more on dispersed teams in their NPD endeavor [7].

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 [8]. 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 rapid technology change and product variety proliferation in the new manufacturing environment, SMEs must be able to sustain product innovation [9]. 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 [10].

In this paper first based on earlier work different aspect of virtual R&D teams in SMEs will be analysis. After providing a definition of virtual teams, importance of research and development (R&D), small and medium enterprises (SME) characteristics and new product development (NPD) issues, the relationship between them will be examined. Finally this paper highlight several avenues to address some of the gaps in the existing extensive literature on virtual teams as a general and virtual R&D teams in new product

development in SMEs, as a concentrate topic. With cover all previous research derives research gaps, propose the way of further studies and recommend improvements. This paper would help researchers, managers and policy makers to better foster new product development in SMEs through virtual R&D teams.

2. Virtual team and related concern:

This era is growing popularity for virtual team structures in organizations [1, 11]. Martins et al. [12] in a major review of the literature on virtual teams, conclude that ‘with rare exceptions all organizational teams are virtual to some extent.’ 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 [13]. Amongst the different definitions of the concept of a virtual team the following from is one of the most widely accepted: [14], “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 [15].

2.1. Benefits and pitfalls of virtual teams:

For the purpose of having a clear mentality about virtuality and the function of the virtual teams different aspects of such issue needs to be investigated and examined in more details. Alike other management paradigms, implementing the concept of working within virtual teams can bring about positive and negative impacts, a careful comparative analysis of the different angles therefore would be fruitful.

Virtual R&D teams which members do not work at the same time or place [16] often face tight schedules and a need to start quickly and perform instantly [6]. 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 [17]. As a drawback, virtual teams are particularly vulnerable to mistrust, communication break downs, conflicts, and power struggles [18]. On the other hand, virtual teams reduce time-to-market [19]. Lead Time or Time to market has been generally admitted to be one of the most important keys for success in manufacturing companies [20]. Table 1 summarizes some of the main advantages and Table 2 some of the main disadvantages associated with virtual teaming.

Table 1: some of the main advantages associated with virtual teaming.

Advantages	Reference
Reducing relocation time and costs, reduced travel costs	[1, 21-25]
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 [26]]	[19, 20, 25, 27-31]
Able to tap selectively into center of excellence, using the best talent regardless of location	[1, 24, 32, 33]
Greater productivity, shorter development times	[21, 31]
Producing better outcomes and attract better employees	[12, 22]
Provide organizations with unprecedented level of flexibility and responsiveness	[14, 27, 34]
Self-assessed performance and high performance.	[13, 35]
The extent of informal exchange of information is minimal	[36]
Respond quickly to changing business environments	[23, 31]
Sharing knowledge, experiences	[18, 37]
Enable organizations to respond faster to increased competition	[34, 38]
Better team outcomes (quality, productivity, and satisfaction)	[39, 40]
Most effective in making decisions	[41]
Higher team effectiveness and efficiency	[19, 42]

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

Disadvantages	references
Face-to-Face collaboration (FFC) appears to be better developing a conceptual understanding of a problem (lack of physical interaction)	[22] [1, 25, 41]
Decrease monitoring and control of activities	[36]
Challenges of managing conflict	[43, 44]
Cultural and functional diversity in virtual teams lead to differences in the members’ thought processes. Develop trust among the members are challenging	[25, 35, 45]

3. Importance of Research and Development (R&D):

Around the world innovation is now recognized as a prime source of national competitive advantage [46]. R&D is a strategy for developing technologies that can be commercialized under independent intellectual property rights. R&D enables firms to create new technologies and/or to build on existing technologies obtained through technology transfer [47]. Research and development (R&D) and technology as a result of it, have tremendously

improved our quality of life over the last five decades [48].

Large amounts of money are spent all over the world on R&D, in order to ensure future sustainability [49]. Research is an investment, not an expense, invest in commercial R&D is usually involve a high-risk investment with a deferred payoff although like the other high-risk investments, return can be extremely attractive [50]. From different point of view the increasing complexity and inter-disciplinary nature of the R&D process in turn has increased the cost of research therefore research become less attractive without partners to share the cost [51].

3.1. R&D and Distributed Team:

Research and development are subject to different location drivers[52]. Many firms started to acquire their knowledge from external sources [53]. Trends over the last decade have seen China and India emerge as attractive R&D destinations for U.S. Changes in telecommunications and data processing capabilities make it possible to coordinate research, marketing and production operation around the world [54]. Hegde and Hicks [46] noted that overseas R&D sites are auxiliary outposts, subservient to home R&D laboratories. “corporate growth and positioning” and “knowledge sourcing” are two forces which result in companies having a more global R&D,[55]. Technological change is a highly dynamic process that may quickly relocate to take advantage of optimum conditions for growth [46]. For most R&D teams, being virtual are a matter of degree [7].

4. Small and Medium Enterprises (SME):

4.1. Importance of SMEs:

Small and medium sized enterprises (SMEs) are a major part of the industrial economies [56, 57] in that they serve a very critical function of Creating new jobs and reducing unemployment [58-60]. Their survival and growth has therefore been a prominent issue. Beck et al.[61] 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 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 [62]. Many economists believe that the wealth of nations and the growth of their economies strongly depend upon their SMEs’ performance [63]. 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 [64]. 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 [65].

4.2. SMEs and Virtual Teams:

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 sub-contracting relations and good technological level of their products [66]. 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 [67]. The traditional independence of small firms is being replaced by a network environment [68].Hanna and Walsh [68] found that if small firms want to make a step change in their technological and innovation base they may have to rethink their approach to cooperation. 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 compared to large firms [69].

Most firms today do not operate alone; they are networked vertically with many value-chain partners [70]. The typical Taiwanese production system is a cooperative network of SMEs that are extremely flexible and respond quickly though under-capitalized and sensitive to market demand and highly integrated in the global economy [71]. Gassmann and Keupp [72]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).

4.3. SMEs Readiness for Virtual teams working:

Lin et al.[73] found that although almost all 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. Zhouying [47] pointed out in China e-commerce is developing very slowly amongst SMEs, which account for 60 per cent of the total value of industrial production, and 98 per cent of the total population of enterprises. 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. Web resource services can help the enterprises to get external service resources and implement collaborative design and manufacturing [74]. It is especially urgent for SMEs to construct a service platform of networked to speed up the product development process [75]. Sharma and Bhagwat [76] results of the study reveal that IT in SMEs still takes a backseat despite of the fact that use of computers is continuously increasing in their operations.

4.4. The major characteristics of SMEs:

In order to have a better understanding of SMEs behavior, a brief knowledge of the characteristics of SMEs is a must, therefore the major characteristics of SMEs are listed in the Table 3 and Table 4, however there are generalizations, and not all may hold true for every SME.

Table 3: some of the major advantages of SMEs

Advantages	Reference
Generally dominated by the entrepreneur (owner-manager)	[77-79]
Able to respond quickly to customer requests and market changes, Customers focused	[77, 78, 80-84]
Flexible and fast-response to change, easily adaptive to new market conditions , dynamic in behavior, developing customized solutions for partners and customers	[62, 66, 78, 80, 85-89]
Driven by client demands Quick decision making process (decisions are made by an individual or a small number of people, or a single individual)	[60, 62, 78, 90]
Strongly correlated and inter-related with respect to Innovation and entrepreneurship High innovatory potential	[56, 76]
Un bureaucratic processes, flat and flexible structures	[60, 62, 76, 78, 80, 91, 92]
Informal and dynamic strategies	[76]
Capable of going international early and rapidly	[72]
Possessing tight control over production processes due to close management involvement	[80]
Productive	[61]
Knowledge creating	[79, 93]
Capable of fast learning and adapting routines and strategy Great potential to adapt new production methods	[60]
Having significant intangible assets	[94]

The SME is not a scaled-down version of a large company. SMEs have different characteristics

distinguishing them from large corporations. Such characteristics vary across different countries and cultures; they are generally independent, good at multi-tasking, cash-limited and based on personal relationships and informality , as well as actively managed by the owners, highly personalized, largely local in their area of operation and largely dependent on internal sources to finance growth [95].

Table 4: some of the major disadvantages of SMEs

Disadvantages	Reference
Scarce resources and manpower	[9, 62, 68, 69, 86, 92, 94, 96, 97]
limited degree of information technology (IT) implementation	[57, 73, 76, 79, 96, 98]
Absolute size , fewer technological assets	[85]
Weak at converting research and development into effective innovation	[99, 100]
Lacking some of the essential resources for innovation Severe resource limitations in R&D	[76, 101-103]
Not having formal R&D activities	[104]
Rely on outdated technology, labor intensive and traditional management practices	[61, 62]

5. New Product Development (NPD) Issues:

The product life cycle of goods grows shorter every year. With the needs to respond quickly to dynamic customer needs, increased complexity of product design and rapidly changing technologies, the selection of the right set of NPD is critical to a company's long-term success [105]. Also combination of factors such as ever changing market needs and expectations, rough competition and emerging technologies among others, challenges industrial companies to continuously increase the rate of new products to the market to fulfill all these requirements [20].The ultimate objective of all NPD teams is superior marketplace success of the new product [106]. In light of the above product innovations are central in securing a firm's competitive advantage in international markets [107]. NPD is vital and needs to be developed both innovatively and steadily [105].

5.1. NPD: Is it necessary for SMEs?

New product development is of high importance for both large and small- and medium sized organizations [69]. The pressure of globalization competition force producers to continuously innovate and upgrade the quality of existing products [54]. In these circumstances only those companies can expect market success which offer their customers the right products in terms of

features and quality, at the right time and at the right price [29]. A multidisciplinary approach is needed to be successful in launching new products and managing daily operations [10]. In the NPD context, teams developing new products in turbulent environments encounter quick depreciation of technology and market knowledge due to rapidly changing customer needs, wants, and desires, and technological know-how [108]. Adoption of collaborative engineering tools and technology (e.g., Web-based development systems for virtual team coordination) was significantly correlated with NPD profitability [109].

5.2. Information communication Technology (ICT) growth and NPD:

Various studies also offered a large number of examples from the industry showing how firms have been using the Internet in their NPD activities [110, 111]. Integration is the essence of the concurrent product design and development activity in many organizations [36]. Bullinger et al. [112] argued several tools that are available to shorten the development process and emphasized on technical support of communication and cooperation within the team by adequate synchronous and asynchronous media. Ozer [111] conclude that information technology undoubtedly has the potentials to significantly improve the new product development activities of industrial companies. Manufacturing enterprises needs the wider external resources during the product design phase [74]. This resource-sharing service method has certain of instruction signification for rapid collaborative product development of manufacturing enterprises. Moreover, several recent studies specifically deal with the development of new technologies and their impact on new product development among globally dispersed teams [21, 107]. ICT enhance the NPD process by shortening distances and saving on costs and time [113].

5.3. NPD and Dispersed team:

Different products may require different processes, a new product idea needs to be conceived, selected, developed, tested and launched to the market [114]. The specialized skills and talents required for the development of new products often reside and develop locally in pockets of excellence around the company or even around the world. Firms therefore, have no choice but to disperse their new product units to access such dispersed knowledge and skills [115]. Susman, et al [116] noted research will increasingly focus on geographically dispersed NPD teams as their number will grow faster than will collocated NPD teams.

Virtualization in NPD has recently started to make serious headway due to developments in technology-virtuality in NPD now is technically

possible [7]. As product development becomes more complex, they also have to collaborate more closely than in the past. These kinds of collaborations almost always involve individuals from different locations, so virtual team working supported by IT, offers considerable potential benefits [117]. May and Carter [19] 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.

5.4. NPD and virtuality:

The rate of market and technological changes has accelerated in the past years and this turbulent environment requires new methods and techniques to bring successful new products to the marketplace [118]. The world market requires short product development times [89] therefore in order to successfully and efficiently get all the experience needed in developing new products and services, more and more organizations are forced to move from traditional face-to-face teams to virtual teams or adopt a combination between the two types of teams[49]. New product development requires the collaboration of new product team members both within and outside the firm [21, 111, 114] and NPD teams are necessary in almost all businesses[7]. Given the resulting differences in time zones and physical distances in such efforts, virtual NPD projects are receiving increasing attention [21].

6. Conclusion and Directions for Future Research:

A global market requires a short product development cycle; hence SMEs are also forced into altering from sequential to concurrent product development. 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. Virtual teams are dramatically influencing organizations and doing virtual R&D for SMEs is not a choice but an obligation to reduce the time-to-market in the intensively competitive market environment. Along with the findings of Gassmann and Keupp [72], managers of SMEs should invest less in tangible assets, but more in those areas that will directly generate their future competitive advantage such as R&D. Simple transmission of information between new product teams' members is not adequate; the virtual R&D team should also constructively interact in effective communication. Therefore as the first step managers of SMEs should move

towards the concept that virtual teams in NPD are vital factors in modern organizations and as the next step an action plan for bringing the concept to practice shall be devised and executed. For a successful adoption of virtual teams for new product development their pertinent impact on the success factors of new product development should be taken into account.

As another important point the evidence shows that management of virtual NPD in SMEs is largely in its infancy. While most of the research activities relevant to SMEs do not encourage and support international research cooperation and technology transfer, such networking will be potentially advantageous. Such potential advantages of forming and performing in virtual teams have been listed in Table 3.

Hence it is vital to bridge this gap and unlock growth opportunities for SMEs through research, and help them carry out or outsource research in order to develop new technology based products, processes and services, exploit research results, acquire technological know-how and train their employees to incorporate new development processes.

As specified in Table 4, the major disadvantage and weakness of the SMEs can be summarized as lack of resources and weak IT skills dealing with implementation and application. Bringing about virtual teams within SMEs and performing virtually seems as the best possible solution for SMEs in order to augment their available resources. For the purpose of performing in form of virtual teams existence of the pertinent IT know-how and skills is a must, therefore such skills will undoubtedly be enhanced by the emergence of virtuality concept. Virtual teams can also serve to strengthen the existing advantages within SMEs as listed in Table 3.

The extensive review shows that while a considerable number of studies and research efforts have been conducted and concentrated on NPD, SMEs or virtual R&D teams, limited work have been directed towards exploring and analyzing the existing inter-relation. Therefore future research shall be aimed at shifting away from investigating NPD, SMEs and virtual R&D teams separately to the formation and development of a collaborative system which can support a dispersed team effectively. Keeping virtual R&D teams in NPD processes, operating innovatively, effectively and efficiently is of a high importance, but the issue has poorly been addressed simultaneously in the previous studies, specially from the perspectives of SME collaboration. In many cases the knowledge required in the development of new products, services or processes does not fully reside inside the organizational boundaries. Consequently in high-risk areas, R&D collaboration can be used as an optional strategy for risk sharing and mitigation, among SMEs which are suffering from lack of resources.

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