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New Product Development in Virtual Environment

Nader Ale Ebrahim

PhD Candidate

Department of Engineering Design and Manufacture,

Faculty of Engineering, University of Malaya

Email: aleebrahim@perdana.um.edu.my

Dr. Shamsudin Ahmed

Department of Engineering Design and Manufacture,

Faculty of Engineering, University of Malaya

ahmed@um.edu.my

Professor Dr. Zahari Taha

Department of Engineering Design and Manufacture,

Faculty of Engineering, University of Malaya

zahari_taha@um.edu.my

Nader Ale Ebrahim is Technology Management PhD candidate in the Department of Engineering Design and Manufacture, Faculty of Engineering, University of Malaya. He holds a Master of Science in the mechanical engineering, as well as more than 17 years experience in the establishing R&D department in different companies, project director and project coordinator and Knowledge based systems implementation in R&D department. His current research interests are focused on managing virtual new product development teams in SMEs R&D centers. His papers have presented in the several conferences.

Shamsuddin Ahmed is currently an Associate Professor in Manufacturing at the University of Malaya (UM), Malaysia. He obtained his first, second, and tertiary degrees from different reputed institutions of higher learning in different countries. He has been in graduate level teaching since 1986. He offered a good number subjects for both undergraduate and postgraduate studies and supervised a large number of students. At present, six PhD, several masters and undergraduate students are working under his supervision. He published more than 60 papers/articles in different international, regional and national journals, conference proceedings and bulletins. He assessed a good number of papers for a few journals including some Emerald journals.

Zahari Taha is currently director and Professor of Centre for Product Design and Manufacturing (CPDM) Faculty of Engineering University of Malaya (UM). He graduated with a BSc in Aeronautical Engineering with Honors from the University of Bath, UK. He obtained his PhD in Dynamics and

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Control of Robots from the University of Wales Institute of Science and Technology in 1987. From 1995 to 1998, he completed his postdoctoral at the University of Wales Institute College Cardiff in the area of engineering design and ergonomics. He was awarded the Hitachi Fellowship in 1992 and also the Young Malaysian Scientist award by Ministry of Science, Technology and Environment in 1997. Dr. Zahari has published more than 100 papers in academic books, journals and proceedings. His major research interest includes mobile robots, underwater robots, surgical robots, ergonomics design, ergonomics at work, software development for traffic applications and motion analysis.

Abstract

Purpose - *The literature on the topic has evolved exponentially since eight years ago. Relaying on a review of studies published in recent years, this article proposes and discusses a framework which incorporates a set of virtual teams involved in a new product development initiative.*

Design/methodology/approach – *A range of academic and practitioner literature related to virtual teams and virtual new product development is reviewed. What is Virtual New Product Development and what determines its development in manufacturing firms? These two questions are answered.*

Findings - *The decision to use a virtual team is often a necessity and not a choice; being ‘virtual’ is in most cases not an alternative but a requirement. Enterprise may benefit from building and maintain the virtual teams in a number of ways such as achieving higher quality, accessing and capturing dispersed knowledge and skills regarding the multifunctional and multi-use components and modules, electronically unite experts in highly specialized fields, collaborating more productivity at a distance, achieving tight schedules and start quickly, reducing travel time and cost, enabling the recruitment of talented employees, builds diverse teams, promoting proactive employment and finally reducing discrimination in enterprises.*

Originality/value - *The results of an academic literature review were employed to the literature so far has not paid adequate attention to the virtual team activities in NPD. The results highlight several avenues which would help managers and policy makers to better foster cyber new product development and designers to better channel of their efforts in the design and manufacturing domain.*

Keywords - New product Development; Virtual teams; Concurrent Collaboration; Review paper

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INTRODUCTION

The pressure of global competitive force exerts producers to continuously innovate and upgrade the quality of existing products (Acs and Preston, 1997). Organizations are currently facing unprecedented challenges in an ever dynamic, constantly changing and complex environment (Rezgui, 2007). Innovation has become the most important key issue for companies to be successful in the 21st century (Sorli et al., 2006). Considering the fact that emerging environment would be more on knowledge-driven, the driving forces are digitization, wider internet access, and high-speed data networks to addressing many of the operational issues from design to logistics and distribution (Noori and Lee, 2006). Consequently, learning networks can generate localized social capital and endogenous growth dynamics (Conceicao and Heitor, 2007).

Companies are growing to be global and this is especially true for companies participating in the global supply chain (Chen et al., 2007). Responding to the increasing de-centralization and globalization of work processes, many organizations have responded to dynamic environments by introducing virtual teams. Additionally, the rapid development of new communication technologies, most of the large organization employs virtual teams to some degree (Hertel et al., 2005). In an increasingly competitive global market, a firm simply cannot survive without new products developed under network cooperation, especially for high-tech industries (Chen et al., 2008a). Firms rely heavily on new product development to successfully compete in increasingly competitive global markets (Batallas and Yassine, 2004).

The review shows that while a considerable number of studies and research efforts have been conducted and concentrated on NPD and virtual R&D teams, limited work have been directed towards exploring and analyzing the existing inter-relation. This paper tries to open a relationship between NPD and virtual R&D which is uniqueness of the research in comparison with existing studies. Therefore future research shall be aimed at shifting away from investigating NPD and virtual R&D teams separately to the formation and development of a collaborative system which can support a dispersed team effectively.

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RESEARCH METHODOLOGY

A range of academic and practitioner literature related to virtual teams and virtual new product development is reviewed. The approach is to examine the recent publications and identify the main interests in the relevant period and extract the topic in studies. By reviewing and context analyzing the answer of following questions has derived. What is Virtual New Product Development and what determines its development in manufacturing firms?

In this paper firstly analyzed new product development in the literature and then elaborate virtual teams and related concern in order to extract diverse aspect of virtual teams. Intensive communication media along with fast growing globalization has enhanced all sources of information flows among business partners, while making possible to integrate businesses in a virtual environment. Finally highlight several avenues which would help managers and policy makers to better foster virtual new product development in the design and manufacturing domain.

NEW PRODUCT DEVELOPMENT

Different products may require different processes, a new product idea needs to be conceived, selected, developed, tested and launched to the market (Sanchez et al., 2006). The ultimate objective of all NPD teams is superior marketplace success of the new product (Akgun et al., 2006). It is firmly believed that product innovations are central in securing a firm's competitive advantage in international markets (Jeong, 2003). NPD is vital and needs to be developed both innovatively and steadily (Chen et al., 2008b).

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 (Kratzer et al., 2005). Virtualization in NPD has recently started. A multidisciplinary approach is needed to be successful in launching new products and managing daily operations (Flores, 2006). 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 (Akgun et al., 2007). ICT helps establish and maintain communicative and cooperative relationships both inside and outside the organization, and makes NPD processes quicker, simpler and less risky (Vilaseca-Requena et al., 2007).

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Since efficiency, effectiveness and innovation management have different and contradictory natures, it is very difficult to achieve an efficient, effective and innovative network cooperative NPD (Chen et al., 2008a). Supplier involvement in NPD can also help the buying firm to gain new competencies, share risks, move faster into new markets, and conserve resources (Wagner and Hoegl, 2006).

VIRTUAL TEAMS AND RELATED CONCERN

Why virtual teams for NPD?

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 (Leenders et al., 2003). In the past an original equipment manufacturer company (OEM) would have a dominant role with its suppliers, determining the specifications for requirements and waiting for suppliers to compete for orders to supply the required components. 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). To shrink the cost and protracted length of total system and product development life cycles, many organizations have moved away from serial to concurrent collaboration through the use of cross-functional, integrated project/product teams (Bochenek and Ragusa, 2004).

It is clear that a team's behaviors in adopting the technology and adapting their processes will be influenced by the feature-set of the computer-mediated collaborations (CMCs) environment that is used (Rice et al., 2007). The growing complexity and competition in the business world are major drivers for increasing the popularity and formation of virtual teams (Chen et al., 2007). Virtual teams were formed to facilitate transnational innovation processes (Gassmann and Von Zedtwitz, 2003a) that innovation has a positive impact on corporate performance (Kafouros et al., 2008). Also a virtual network structure is used to improve communication and coordination, and encourage the mutual sharing of inter-organizational resources and competencies (Chen et al., 2008b). Hence virtuality seems well suited for cultivating and managing creativity in NPD teams (Leenders et al., 2003).

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Team and Innovation

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’s a widely accepted fact that innovation is better achieved by working in team (Sorli et al., 2006). A majority of successful innovations is developed through the collective efforts of individuals in new product development teams (Akgun et al., 2006). All teams and virtual teams in particular, must develop mechanisms for sharing knowledge, experiences, and insights critical for accomplishing their missions (Rosen et al., 2007).

Virtual team

The term of 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 (Gassmann and Von Zedtwitz, 2003a) 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, Leenders et al. (Leenders et al., 2003) defined “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. Virtual teams work across boundaries of time and space by utilizing modern computer-driven technologies.” 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. ”

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Categories of virtual teams

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). Cascio and Shurygailo (Cascio and Shurygailo, 2003) have categorized virtual teams with respect to two primary variables, the number of location (one or more) and the number of managers (one or more) Table 1 illustrates this graphically. Therefore there are four categories of teams:

- Teleworkers: A single manager of a team at one location
- Remote team: A single manager of a team distributed across multiple location
- Matrixed teleworkers: Multiple manager of a team at one location
- Matrixed remote teams: Multiple managers across multiple locations

Table 1: Forms of Virtual Teams (Source: Cascio and Shurygailo, 2003)

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

The statistics show that teleworking is more frequent among information-intensive activities like software development. But it is not so frequent among other activities in new product development (Sanchez et al., 2006).

Diverse aspect of virtual teams

Anderson et al. (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 teams 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, 2003b). Virtual teams are particularly vulnerable to mistrust, communication break downs, conflicts, and power struggles

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(Rosen et al., 2007).Lead Time or Time to market has been generally admitted to be one of the most important keys for success in manufacturing companies (Sorli et al., 2006). Table 2 shows some main advantage and disadvantage of virtual teams.

Table 2: some of the main advantages and disadvantages associated with virtual teaming. (Source: Bergiel et al., 2008)

Advantages	Disadvantages
Reduces travel time and cost	Sometimes requires complex technological applications
Enables the recruitment of talented employees	Lack of knowledge among employees about virtual teams and subsequent, there is the need for HRD interventions
Promotes different areas	Lack of knowledge among some senior mature managers concerning advanced technological applications generally
Builds diverse teams	Not an option for every type of employee because of an employee's psychological make-up and other predispositions
Assists in promoting proactive employment practices for disadvantaged individuals and groups	Nor an option for every company because of the operational environment
Reduces discrimination	

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 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).

Face-to-Face collaboration (FFC) appears to be better suited for relatively unstructured, discussion intensive tasks, such as developing a conceptual understanding of a problem or evaluating key ideas and negotiating how to proceed, in contrast those tasks that lend themselves to a structured approach are most effectively accomplished during computer-mediated collaboration (CMC) (Rice et al., 2007).A

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potential advantage of virtual teams is their ability to digitally or electronically unite experts in highly specialized fields working at great distances from each other (Rosen et al., 2007).

Virtual teams and conventional teams

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 3 summarizes these distinctions (Kratzer et al., 2005).

Table3: Virtual and traditional R&D teams are usually viewed as opposites

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

In particular, reliance on computer-mediated communication makes virtual teams unique from traditional ones (Munkvold and Zigurs, 2007). The joint work is intended to attain the following beneficial objectives (Naveh, 2005).

- to minimize the number of parts and operations;
- to ensure that process capabilities are known, and that the design either falls within these parameters or that there is enough time to improve and acquire new capabilities as needed;
- to use standard procedures, materials, and processes of already known and proven quality;
- to design multifunctional and multi-use components and modules;
- to design for ease of joining, separating, and rejoining;
- to design for one-way assembly;
- to avoid delicate designs requiring extraordinary effort or attentiveness

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Rice et al. (Rice et al., 2007) found that the adoption of formal procedures and structured processes significantly increased the effectiveness of virtual teams. The processes used by successful virtual teams will be different from those used in face-to-face collaborations (FFCs) (Rice et al., 2007). In an innovation network resembling a “traditional” organization, the innovation process is more restricted by location and time. In other words, the innovation process mostly takes place within the framework of physical offices and working hours. In virtual organizations, individuals’ work is not restricted by time and place, and communication is strongly facilitated by IT. Such a product development environment allows a greater degree of freedom to individuals involved with the development project (Ojasalo, 2008). Distributed teams can carry out critical tasks with appropriate decision support technologies (Chen et al., 2007).

ENLARGMENT OF NPD IN VIRTUAL ENVIRONMENT

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 (Chen et al., 2008b). 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 (Sorli et al., 2006). The ultimate objective of all NPD teams is superior marketplace success of the new product (Akgun et al., 2006). In light of the above product innovations are central in securing a firm’s competitive advantage in international markets (Jeong, 2003). NPD is vital and needs to be developed both innovatively and steadily (Chen et al., 2008b). However it should be noted that to survive in a highly competitive industry, strategies to collaborate with or compete with suitable firms within a network should be considered in the NPD process (Chen et al., 2008b).

Different products may require different processes, a new product idea needs to be conceived, selected, developed, tested and launched to the market (Sanchez et al., 2006). 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 (Kratzer et al., 2005).

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Virtualization in NPD

Virtualization in NPD has recently started to make serious headway due to developments in technology-virtuality in NPD now is technically possible (Leenders et al., 2003). Automotive OEMs (Original Equipment Manufacturers) have formed partnerships with suppliers to take advantage of their technological expertise in development, design, and manufacturing (Wagner and Hoegl, 2006). A supply chain is a group of companies, so in manufacturing this starts at the top of the chain with the OEM such as a car manufacturer. Then at the next level there are first tier suppliers, who are companies that supply major components of the product such as braking systems. At the next level down the chain are second tier suppliers who are manufacturers of sub-components (e.g. producers of brake shoes). In a supply chain, individuals from different companies have to communicate. 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 (Anderson et al., 2007).

May and Carter (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. The pressure of globalization competition force producers to continuously innovate and upgrade the quality of existing products. (Acs and Preston, 1997). Akgun et al. (Akgun et al., 2006) shows that when an NPD team finds out technical, manufacturing, and/or marketing shortcomings of the product, it is capable of building the necessary knowledge structure and skills. Supplier involvement in NPD can also help the buying firm to gain new competencies, share risks, move faster into new markets, and conserve resources (Wagner and Hoegl, 2006).

There are many different measurements researchers use to assess NPD performance. For instance, Cooper et al. (Cooper et al., 2004) identify various measures of NPD performance at the program and project level. Measures of the performance of the entire NPD program include the percentage of business revenue generated by new products, percentage growth in sales from new products, overall profits generated by new products, number of major launches per year, percentage of business profits from new products, return on investment on R&D spending, and the success rate of launched/developed products, all measures shows NPD has a positive growth on it. Adoption of collaborative engineering tools and

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technology (e.g., Web-based development systems for virtual team coordination) was significantly correlated with NPD profitability (Ettlie and Elsenbach, 2007).

ICT and virtual NPD growth:

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). 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). Moreover Information and communication technology (ICT) has brought about significant changes in organizations and produced important benefits, including in the areas of marketing and innovation and several works highlighted the importance of ICT as a key element in integrating marketing into the NPD process (Vilaseca-Requena et al., 2007).

Virtual teams are important mechanisms for organizations seeking to leverage scarce resources across geographic and other boundaries. (Munkvold and Zigurs, 2007). The global competition and accelerated improvements in basic technologies demand organizations to develop the ability to manage efficient NPD projects that yield innovative products (Naveh, 2005). The modern work-world is dominated by computer-mediated communication, and this communication is the bread and butter of virtual teams (Walvoord et al., 2008). In other words advancement in technologies and management skills has blurred firm boundaries (Acs and Preston, 1997).

ICT enhance the NPD process by shortening distances and saving on costs and time (Vilaseca-Requena et al., 2007). Some authors such as (Zenun et al., 2007) indicate that the NPD with co-located teams achieves a shorter lead time and a higher productivity when compared to a NPD with not co-located teams. Lakemond and Berggren (Lakemond and Berggren, 2006) found that relation between co-location and physical separation associated with product development performance. It has shown on Table 4

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Table 4: Project location, innovation and project duration

Project duration	Long	Dispersed	Alternating co-location and dispersed location
	Low	(Dispersed)	Co-locate
		Low	high

Level of onnovation

SUMMARY AND CONCLUSION

Virtual team are dramatically influence in organization and being virtual it is not a choice but is an obligation to reduce time-to-market in this intensive competitive market environment. Simple transmission of information between new product team’s members is not adequate; the virtual environment presents significant deal to effective communication. Therefore managers must firmly believe that virtual team in NPD is a vital point of modern organization and then implement the whole system in their organization. The adoption of virtual teams for new product development should take into account its impact on the success factors of new product development.

To sum up, if inadequate attention is paid to the development of virtual teams in new product development within an organization a number of areas may be negatively impacted in particular the time-to-market, saving on costs of NPD, percentage growth in sales from new products, the success rate of launched/developed products, shared risks, penetrating new markets and conserving resources. On the other hand an enterprise may benefit from building and maintain the virtual teams in a number of ways such as achieving higher quality, accessing and capturing dispersed knowledge and skills regarding the multifunctional and multi-use components and modules, electronically unite experts in highly specialized fields, collaborating more productivity at a distance, achieving tight schedules and start quickly, reducing travel time and cost, enabling the recruitment of talented employees, builds diverse teams, promoting proactive employment and finally reducing discrimination in enterprises.

As another important point the evidence shows that management of virtual NPD is largely in its infancy. While most of the research activities relevant to enterprises do not encourage and support international research cooperation and technology transfer, such networking will be potentially

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advantageous. Such potential advantages of forming and performing in virtual teams have been listed in Table 2.

The review shows that while a considerable number of studies and research efforts have been conducted and concentrated on NPD and 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 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. 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 enterprises.

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