

# Enhancing management of technology and innovation for sustainable competitiveness of SMEs

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**Abstract.** Being impacted by the financial and economic crises and the threats of economic downturn spiral, social unrest and environmental pollutions..., businesses and people are talking a lot about sustainable development as a target, a desire and an aspiration of human beings in the 21<sup>st</sup> century. In many countries, small and medium enterprises (SMEs) hold a large number and play a very important role in the sustainable development. How to build and develop sustainable competitiveness for SMEs still remains an unanswered question for many governments. This paper introduces a new approach and a basic tool that SMEs can apply to build sustainable competitiveness in the context of global cooperation, competition, and integration.

*Keywords:* Technology, innovation, sustainable competitiveness.

## 1. Management of technology and management of innovation

Being an interdisciplinary science researched and taught at universities and applied in firms, management of technology is mainly concerned with science and technology and building technological capabilities from state level to individual business through various concepts, models and tools. At the national level, policy makers and authorities undertake legal and supportive activities to stimulate organizations and individuals to innovate science and technology for national security and sustainable development. At the firm's level, management of technology is the ultimate process in which the owners or management board or directors decide which technologies are needed and how to develop

technological capabilities to make new products or services and at the same time to enhance firm's competitiveness. For firms, the management of technology and innovation is considered an important process among other essentially interrelated processes such as management of strategy, human resources, finance, marketing... Therefore, the management of technology and innovation can be practiced and enhanced to the desired degrees depending on firm's core business strategies and requirements. For firms to manage technology and innovation, it is necessary that there have a common understanding on the management process, and the definitions on technology and innovation.

*Technology* (T) is defined as the innovative use of the 3 factors of Machine and tools (M), Knowledge (K) and Skills (S) to transform the input into a product or a service. Technology can also be simply

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understood as the ways we do things to achieve our targets. As per Figure 1, the technology equation is useful to define and

analyze the 3 main factors and the sub-factors of a technology or a technological system.



Figure 1. Technology equation.

Source: Department of MOT, VNU-UEB.

Technologies are integrated in the management systems or production systems of different industries and are often named after the economic branches such as IT, biotechnology, medicine technology, pharmacy technology, construction technology, engineering technology, food technology, tourism technology... There are differences between management technologies and production technologies.

In terms of functions and operations in a value chain, technologies are mainly classified in 3 categories:

- Design Technology
- Processing Technology
- Service Technology

In terms of modernity and standard, technologies are often classified in these categories:

- Emerging Technologies
- High Technologies
- Advanced Technologies
- In-house Technologies
- Industrial Standard Technologies
- Low Technologies

*Innovation* is an act of learning, creating new ideas, new knowledge or using available knowledge in a new way mainly to achieve economic benefits. New ideas or new knowledge including designs, know-hows, formulas... are simply sub-factors of the knowledge factor (K) among the 3 factors of technology equation which are used to transform the input into products or services. In most cases, technology is considered as a tangible or intangible asset depending on its

nature, and innovation is mainly treated as the means, method or process for the development of technology or technological capabilities. Illustrations for this concept can be found in many books on science and technology and especially curriculums and textbooks on technology management where interactive management activities like management of

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*"To many extents, innovation means technological innovation and the management of innovation can be understood as a process within the processes of technology management."*

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R&D and management of technological innovation are designed in chapters and taught in many class hours (1). It is necessary to simplify many theoretical terms to help students and business people to better understand, synthesize, and apply the appropriate theories and tools in decision making. Within this theoretical framework, the innovation of any related factor is an important mean for upgrading or developing new technology resulting in new processes, new products or new services. Therefore in this context, management of technology can cover all related research objectives such as the management of innovation to develop new technologies, new products, and new services...

The criteria presented in Table 1 for assessment of a firm's technological capabilities is another fundamental proving that it is rational and logical to combine the

management of innovation activities within technology management processes to build firm's needed technological capabilities in order to develop and enhance its competitiveness at different levels. As described in Table 1, large firms and SMEs cannot simply buy or import most technological capabilities with money. It is also simultaneously proven that most technological capabilities are often built and developed incrementally through continuous

organizational learning and innovation of which R&D is the main method. Organizational learning and innovation are the main tools and solutions that are preferably used at different levels by millions of SMEs in technology-independence or innovation-based economies such as Korea, Singapore, India, China, and Taiwan... And many of their brand names have helped boost their national economic development and enhance national image to the World.

Table 1. Assessment on firm's technological capabilities

<b>I. Infrastructure &amp; Equipment Capabilities</b>	<b>Assessment</b>
1. Factory/Utilities as per minimum industrial standard	1-2-3-4-5-6-7-8-9-10
2. Quantity, quality, capacity of machines & equipment	
3. Level of equipment synchronization	
4. Level of automation of technology system	
<b>II. Supportive Capabilities</b>	
1. Capability to build technology-based business strategy & technology strategies & plans	
2. Capability to plan & implement R&D projects	
3. Capability to arrange funds & other inputs for technology innovations	
4. Capability to manage humans for innovating knowledge, skills and technologies	
<b>III. Acquisitive Capabilities</b>	
1. Capability to specify needed technologies to be bought/sold based on firm's requirements	
2. Capability to find competitive suppliers/buyers for needed technologies	
3. Capability to create or innovate most suitable mechanisms for technology acquisition	
4. Capability to negotiate efficient & effective terms for technology transaction contracts	
<b>IV. Operative Capabilities</b>	
1. Capability to use or operate technologies efficiently and effectively	
2. Capability to plan, operate & control production/service technologies	
3. Capability to plan, maintain & repair technological equipment	
4. Capability to transform and upgrade technologies to meet production/service demands	
<b>V. Innovative Capabilities</b>	
1. Capability to imitate to innovate technologies to improve quality of products/services	
2. Capability to innovate new product/service	
3. Capability to carry out production/service process innovation	
4. Capability to innovate firm's technology system	

SOURCE: HOANG DINH PHI, 2007.

Apart from being an important means and solution for developing technologies and entrepreneurship, innovation is taken place in all areas of life from politics to art, and it can be managed by different organizations and individuals with different approaches to achieve

various targets and benefits. For many languages, the word 'innovation' covers a broad area including renovation, upgrade, improvement and creativity. In business, innovation takes place in many areas and on many fronts from technology to business

models, design, production, service, supply chains, marketing, and sales... For many managers and scholars, innovation is seen as a process starting from idea generation and recognition of opportunity toward product's concept design, problem solving, developing and launching a new product in the market (2). To this extent, the management of innovation also has the same purpose as the management of technology, and it overlaps many other management activities of a firm. Logically, any functional management involves systematic activities of building and executing its strategies, plans and sub-plans. If a firm wants to apply management of innovation as a function of a separate department by setting up an innovation division, it is very complicated to design and carry out cross-functional innovation strategies and plans. It is better to stimulate every department to carry out continuously innovative activities aiming at building and improving its capabilities to fulfill its mission. Functional managers or directors such as CTO (Chief Technology Officer), CHO (Chief Human Officer), CFO (Chief Financial Officer), CMO (Chief Marketing Officer)... also have the duty to enhance innovation during their practices to achieve better results per given duty toward firm's success. Then firm's CEO has the role to assure the alignment of all

innovative activities across functional departments with firm's general business strategy which is finally measured by the degree of its competitiveness or sustainable competitiveness over its competitors as per Figure 2.

## 2. Management of technology and innovation strongly impacts on the sustainable competitiveness of SMEs

Most SMEs in the World have limited access to land, natural resources, finance, and talents. To survive and grow, SMEs have to compete with first movers, large firms and in many cases big state-owned enterprises (SOE) or multi-national corporations (MNC). Many empirical studies and practical evidence have proven that SMEs can compete and grow sustainably by organizational learning and innovation to develop or create in-house or advanced technologies that are used to transform new ideas and other input into new products or new services which can compete in the market place. To explain about the relationship among technology, innovation and competitiveness, it is necessary to start the common understanding from the concept and definition of competitiveness at different degrees.

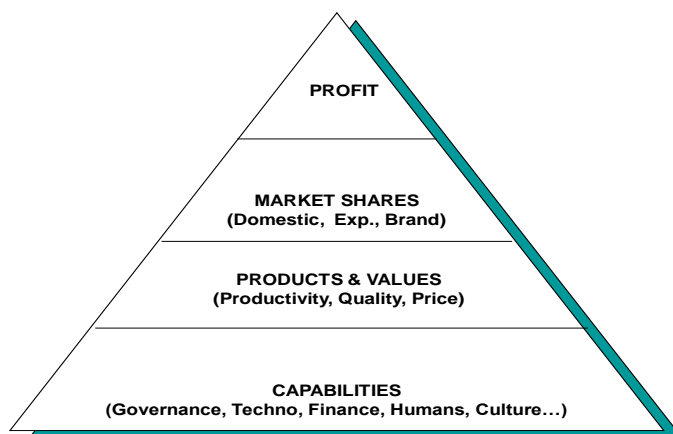


Figure 2. Firm's competitiveness pyramid.

Source: Hoang Dinh Phi, 2007.

Firm's competitiveness is a degree to which a firm can, under normal market conditions, develop its capabilities to produce goods or services that can be marketed with profit (1). Firm's sustainable competitiveness is understood as the firm's competitiveness to be maintained for firm's profit and growth for a long and desired period of time despite the market challenges.

The ups and downs of the world economies and enterprises during economic crises have supported the view point that it is not sustainable for countries and firms to develop and compete solely based on: natural resources (making money mainly from exploiting raw natural resources); financial economy (making money from money); and exploiting extensive labors in poor and developing countries (making money from cheap labor). By educating, training and enhancing learning and innovation of organizations and individuals, countries and firms can innovate new knowledge, skills and technologies to compete sustainably. Figure 2 can be used to explain why the management of technology and innovation is so important and decisive to build firm's sustainable competitiveness.

As is often found in business, the management of firm's business strategy is put at the center of interaction with all other functional strategies from technology to finance, human resources, logistics, production, marketing, sales, and cultures... The successful business management process depends on the success of each functional department in building its needed capabilities to fulfill the duties and reach the set-out targets. In general, the level of firm's success or the degree of

firm's competitiveness varies by size and by field and by time, and it depends on all factors as stated in Figure 2. But for SMEs of similar size competing in the same business area under normal market conditions, it is challenging for one to surpass another by just exploiting the limited resources like finance, human resource, marketing techniques... that become industrial standard knowledge. Let us imagine the case that many SMEs in the same business in normal market conditions can learn, buy, innovate or hire to have enough capital, labor, standard technology, and marketing technique to compete. In this case the competition is tough and no firm can win easily by such limited resources. Only firms with advanced technologies can win the game, capture the market and lead the trend. The collapse of many SMEs in Vietnam textiles, ceramic tiles, automobiles or the closure of many Chinese melamine-contaminated milks and foodstuff firms have the reasons of being weak in both managerial and technological capabilities. Therefore in the context of today's fierce competition, firms and SMEs must pay more attention and invest more in building technological capabilities. This also explains why the management of technology and innovation is so important that impacts strongly on SMEs sustainable competitiveness. And thus it is needed for SMEs to study and apply management processes of technology and innovation in alignment with the formulation and implementation of other main and functional strategies and plans.

### **3. Basic concept for building and ensuring SMEs sustainable competitiveness though practicing and enhancing management of technology and innovation**

As technological capabilities play a decisive role in building firm's production capacities as well as SMEs sustainable competitiveness, it is obviously needed for managers to learn to

practice and enhance the management of technology and innovation.

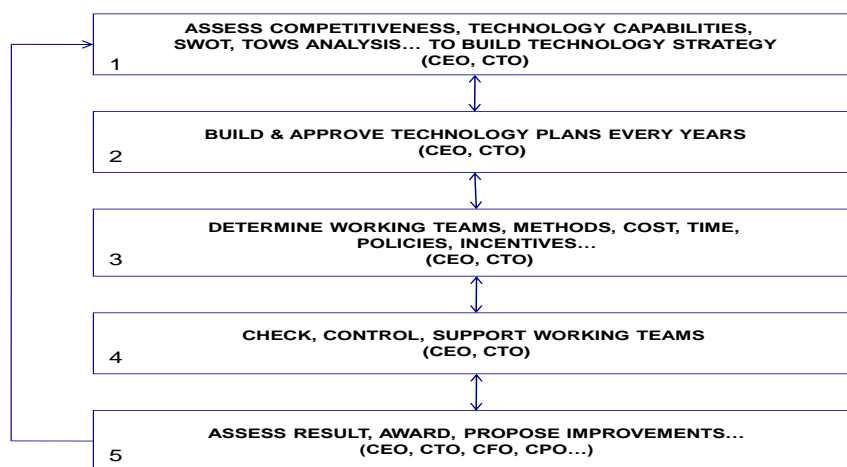


Figure 3. Technology and innovation management process.

Source: Hoang Dinh Phi, 2007.

It can be easier for SMEs' leaders and managers to study and apply the knowledge and tools of technology and innovation management through a simple process with clear steps to follow. Based on illustration in Figure 3, and depending on the size, the business nature and corporate governance capability, a firm can organize a separate working team to follow 5 basic steps involving the use of various tools to set the strategic objective and plans, to mobilize resources to implement and measure the success of each management process of technology and innovation in alignment with the core business strategy. In the first step, the CEO and CTO or the managers in charge have to start to make a technology strategy by assessing firm's overall competitiveness and technological capabilities over its competitors or firm's need to produce competitive products... For SMEs without a position of CTO, CEO can do this step together with other capable managers. To build and approve any technology strategy, besides basic tools of management such as business environment scan model, SWOT, TOWS, BCG Matrix, product life cycle, technology cycle analysis... the team has to study, adapt, develop, adjust and apply new specialized tools such as an assessment table of firm's competitiveness, assessment on winning criteria

of a technology, an assessment table of firm's technological capabilities. The first step is most important in the whole process as a wrong strategic decision in technology development often leads a firm to failures and big losses.

The second step is continued on an annual basis to build and approve detailed technology plans including technology acquisition plans, R&D plans and sub-plans... based on the technological strategic objectives set out in the first step. At the 3<sup>rd</sup> step, the CEO or CTO has to coordinate with other managers to use different tools from human resource management to financial management...

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*"Most managers and staffs have to coordinate during the implementation of technology strategy and plans as the final success is often resulted in new technologies and new products."*

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to determine the working team, methods, and resources for each technology plan or each technological innovation project. At this step, a clear policy on incentives to stimulate the working team is a source of energy needed for the journey toward the goal. At step 4, the CEO or CTO will be busier with their regular checking, controlling and supporting to help the team carry out the

plans and sub-plans. Therefore they should gather in the meeting to assess the progress and propose any change or further improvement in the next management process.

Based on 5 steps as described in Figure 3 and the final results, the management (CEO and board members) can assess its general management skills as well as the efficiency and effectiveness of firm's management of technology and innovation in alignment with its core business strategies. Within the research framework of our UEB

technology management department, for assessing SMEs management of technology and innovation, Table 2 consisting of 4 groups of assessment criteria was built based on the nature of industry, firm's activities, and tools involved during the management process steps as described in Figure 3. And Table 2 has also been used by our researchers as a basic tool to design questionnaires to survey the management of technology and innovation at some industrial firms in Vietnam during 2010-2011.

Table 2. Groups of criteria for assessing the management of technology and innovation

Group 1	Number of leaders and managers involved in the process and the degree of their involvement.
Group 2	Number of tools and resources being used during technology management practices in alignment with firm's core business strategy.
Group 3	Number of new technologies and/or new technological capabilities acquired and developed as per business and technology strategy.
Group 4	Approximate contribution of technological capabilities to firm's sustainable competitiveness.

Source: Hoang Dinh Phi, 2011.

#### 4. General assessment of Vietnamese SMEs' management of technology and innovation for sustainable competitiveness in comparison with SMEs of Singapore and China

As stated in many statistical reports and surveys, by October 2011 Vietnam had about 350,000 active enterprises of which 95% were SMEs with weak competitiveness of both firm's level and product's level. Many researchers have pointed out that apart from factors of external business environment, the root cause of Vietnam SMEs' weak competitiveness is that most Vietnam SMEs have weak capabilities in corporate governance, human resource management and technology management. This shows that most SMEs and their directors do not have sufficient conditions to practice or enhance the management of technology and innovation.

Output is the main measurement for any process. Figures in Table 3 describe the results

of technology and innovation management process of 300 Vietnam SMEs in 6 industries. Based on group 3 of assessment criteria in Table 2, the survey's results in Table 3 is an illustration on how Vietnam SMEs managed their technology and innovation during 2006-2010. Because of weaknesses in general business management and technology management, most firms assessed their technological capabilities at low and medium levels. Data drawn from this survey and other interviews of 300 Vietnam SMEs during 2006-2007-2010 also shows that most firms did not have a CTO position and a specific technological strategy. Most of them stated some directions on technology and innovation in the minutes or resolutions of annual general meetings of shareholders. Most firms did not follow any technology management process or use assessment tools to manage and align technology plans to the core business strategy.

The quantity and quality of technologies and technological capabilities resulting from general management process were limited. Many firms did not invest in any R&D or innovation project.

Despite different definitions on the size of SMEs among countries, in the context of globalization and cross- border competition

most SMEs in the World have to compete by technologies and by final products and services under pressure of clients' increasing demands on quality. Therefore it is meaningful to compare the competitiveness as well as the technological capabilities of Vietnam SMEs with the counterparts.

Table 3. Technological capabilities of SMEs in branches  
40 SMEs, mostly privately owned, representing each branch were surveyed.

	ECONOMIC BRANCH	RESULTS (%)		
		LOW	MEDIUM	HIGH
1	MECHANICAL INDUSTRY	10.89	58.11	31.00
2	ELECTRICS & ELECTRONICS	9.10	60.34	30.57
3	WOODEN PRODUCTS	14.70	59.16	26.14
4	PHARMACY	13.49	52.64	33.88
5	FOODSTUFF	18.95	51.27	29.78
6	TOURISM SERVICES	25.65	58.70	15.66

Source: Hoang Dinh Phi, SMEs survey, 2006-2007.

Estimated that the figures were not changed much during 2007-2010 because of crises and high inflation in Vietnam.

Being a very small country without natural resources, having only around 5 million people and 2010 nominal GDP of 222 billion USD, but Singapore has large firms and more than 300,000 SMEs with quite strong technological capabilities and sustainable competitiveness. Singapore SMEs are quite dynamic in learning and innovating technologies. With a long history of open and free market development, CEOs and managers of Singapore SMEs are well-educated in English, IT and business

management and most of them are eager to learn to innovate and compete in the international markets (4). Basically, all SMEs in Singapore are privately owned while a large number of SMEs in China and Vietnam are state-owned enterprises or newly-privatized companies. There are differences in the fundamental starting point, but all SMEs have the same challenge of global competitiveness that requires them to compete on relatively flat markets with capabilities including technology



and innovation. Therefore it is useful to study and learn about the experiences of Singapore SMEs. Many surveys suggest that the main reasons for the Singapore SMEs success stories come from 2 sides, the guides and supports of the Singapore government and the enormous efforts made by SMEs managers in learning and building capabilities including technological capabilities. Many Singapore SMEs' brands are very competitive in the World in the areas of new water technologies, pharmacy products, electronics, appliances, engineering, construction, shipping, tourism, and education...

Vietnam is large and rich in natural resources with about 90 million people but 2010 nominal GDP is just around 100 billion USD. Standing between Singapore at the South and China at the North, Vietnam's SMEs have to learn to compare to see the reasons and find the solutions to compete on the long run. Scanning some supermarkets in Vietnam can help see a big number of made-in-China

consumable products like bicycles, garments, shoes, chopsticks, toothpicks, bottles... being imported and sold. These simple products just require raw materials that Vietnam exports to China and some simple industrial standard technologies. Why cannot Vietnam SMEs produce, sell and compete in the local market? The answer lies in the ways the government drives the economy and the SMEs owners and managers govern their firm's core business strategy and manage their technologies, human resources, and finance.

China is a giant country with about 1.35 billion people in population and 2010 nominal GDP of 7,000 billion USD, having the largest number of SMEs in the World, but Chinese SMEs also have challenges of competition like other Vietnamese SMEs. Having strong economic development and a trade surplus from manufacturing and export for many years, but Chinese scholars and business people are quite modest in assessing their achievements in technology and innovation management.

Table 4. Comparison of SMEs in Chongqing and Zhejiang regarding innovation activities

ITEM/ QUESTIONS	SIMILARITIES	DIFFERENCES
WHY TO INNOVATE?	To develop new markets & new products	Zhejiang firms emphasize improvement of existing products, cost reduction, complying with regulations & standards
HOW TO INNOVATE?	Manage to build R&D team	Zhejiang firms make more use of external resources by collaborating with suppliers, clients, and competitors, and by M&A
COOPERATION WITH R&D INSTITUTES & HIGHER EDUCATION INSTITUTIONS?	Technical consulting is the main method	Joint research is more important to Chongqing firms. Training is more important to Zhejiang firms
DIFFICULTIES EXPERIENCED?	Shortage of talents	Chongqing firms suffer more from lack of capital & market demands. Zhejiang firms have more difficulties with technological capabilities.

Source: World Bank CSMEI survey, 2006-2007.

CSMEI: Chinese Small and Medium-sized Enterprise Innovation Survey, covering 367 SMEs, mostly privately owned.

“Large and medium-sized SOEs accounted for 34 percent of China’s R&D expenditure in 2006, compared with 3.5 percent for their domestic private counterparts... The innovation capacity of the private sector is weak... Most Chinese private firms now are young SMEs and run by inexperienced owners and managers operating with relatively low technology. For the private sector to play a leading role in innovation in China, building its capacity for technology absorption and creation is of strategic importance. The World Bank CSMEI Survey, conducted in late 2006 and early 2007, provides information on characteristics of the innovation activities of SMEs in two regions, the southwestern inland city of Chongqing, where the sample firms are more technology-based, and the coastal province of Zhejiang, where the sample firms are mostly in traditional manufacturing industries...” (3). They share some characteristics while differing in some other ways in the management of technology and innovation as per Table 4.

If time is taken analyzing and comparing carefully all figures and findings from reports of the two independent surveys as per Table 3 and Table 4, it can be very interesting to see the similarities and differences regarding management of technology and innovation of Vietnam’s SMEs and Chinese SMEs. With the fundamental figures above, it can be said that most SMEs in Vietnam and China have the same difficulties and face the same challenges in building technological capabilities for sustainable competitiveness, and that most Chinese SMEs try to practice management of technology and innovation while only a few Vietnamese firms do that.

## 5. Recommendations

As analyzed above, it is very important to practice and enhance the management of technology and innovation to build and develop technological capabilities for large firms and SMEs to sustain competitiveness, and to

respond faster and better to challenges caused by current crises as well as future changes and turbulences in the context of global competition, cooperation and integration.

Knowing which technological capability needed to be built is good, but to determine how to execute correctly to achieve the desired result is even more crucial for firm’s sustainable competitiveness. To do that SMEs leaders and managers should set some time aside from busy business

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*“It is recommended that besides exploitation of financial and human resources, SMEs should focus on management of technology and innovation to build and ensure firm’s sustainable competitiveness.”*

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transactions to read books, learn from regional and international SMEs, to choose and apply the concepts, models and tools in management of technology and innovation. Full-time MBA or part-time MBA courses provide some kind of training on the capability building. For specialized training courses on interdisciplinary management of business, technology and innovation, managers can participate in the quality-assured courses such as the Master Degree Program on Management of Technology and Entrepreneurship provided by the reputable University of Economics and Business (UEB) under Vietnam National University Hanoi (VNU).

For Vietnam, private SMEs are the main economic actors of the national economy. The government should focus appropriate policies on helping SMEs build their sustainable competitiveness thus contributing to the national sustainable development. There is a need for a set of comprehensive policies to reform the legal system, industry associations, R&D institutions, university and vocational education..., and to ensure the state effective management on fair competition, standardization, measurement and testing services... Besides ensuring a fair business environment for all firms, the national science and technology strategies and policies should focus to

help SMEs in chosen branch to develop needed technological capabilities to make sustainably competitive products or services. This would also be an enabler for SMEs to compete, cooperate and integrate with other international firms in the course of building a better World with sustainable development.

## 6. Conclusions

This paper provides a set of basic concepts and tools to help SMEs to think strategically and to make better decisions in building firm's sustainable competitiveness by practicing and enhancing management of technology and innovation in alignment with other competitive business strategies.

With limited resources and time constraints, this research cannot cover more surveys and address further issues relating to the sustainable competitiveness of firms of various sizes in different economic branches or industrial classifications.

More interdisciplinary or trans-disciplinary researches should be jointly undertaken with countries in Asean, China, India and developed countries to address the problems and propose

appropriate solutions for building the sustainable competitiveness of firms and nations. Examples of issues for further study include: the assessment on public and private R&D spending and efficiency; the assessment on the levels of technological innovation of firms; the ways to enhance technology and innovation management within firms; the development of supportive services for innovation; the relationship among technology, innovation and entrepreneurship; and the role and actions of the government in driving the innovation-based economy.

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# Tăng cường quản trị công nghệ và quản trị đổi mới sáng tạo vì khả năng cạnh tranh bền vững của các doanh nghiệp nhỏ và vừa

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**Tóm tắt.** Dưới tác động của các cuộc khủng hoảng kinh tế - tài chính và các mối nguy về suy thoái kinh tế, bất ổn xã hội, ô nhiễm môi trường..., người dân và các doanh nghiệp đang nói nhiều tới sự phát triển bền vững như là mục tiêu, mong muốn và khát vọng của loài người trong thế kỷ 21. Tại nhiều quốc gia, doanh nghiệp nhỏ và vừa (DNNVV) chiếm đa số và đang đóng một vai trò quan trọng trong quá trình phát triển bền vững. Làm thế nào xây dựng và phát triển khả năng cạnh tranh bền vững của các DNNVV đang là một bài toán chưa có lời giải đối với nhiều quốc gia. Bài viết này giới thiệu một cách tiếp cận mới và một số công cụ cơ bản mà các DNNVV có thể vận dụng để xây dựng và duy trì khả năng cạnh tranh bền vững trong bối cảnh hợp tác, cạnh tranh và hội nhập toàn cầu.