A REVIEW OF TECHNOLOGICAL CAPABILITY IN MALAYSIAN MANUFACTURING SECTOR

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ABSTRACT

Today, manufacturing industry plays a crucial role of the economy in most countries. Due to the dynamic nature of manufacturing, its market and environmental situations, manufacturing firms are facing a serious and great importance challenges. Malaysia is striving to compete in the global market and therefore have to maintain and boost local industries for economic strengthen. The economic expert of the country had advised local companies to strengthen and upgrade their technological capabilities in order to achieve better economic performance. As the technological capability involved in the production and operation which are the cornerstones of every manufacturing company, therefore it should then be improved and monitored periodically. Substantial bodies of literatures on technological capability predominantly have investigated on various roles of the capability, to some point it shows the importance of technological capability acquisition for industrial development. However, the creation of technological capability is not a short term commitment. It takes effort on every aspect to realize its effects on the performance of organizations while gaining competitive advantages and sustaining commercial success in the local and global market along their operational period. Based from the resource-based view theory, the main idea of this paper is to review on how technological capability gives an impact towards manufacturing performance of Malaysian manufacturers. Finally, this paper will identify the measurements of manufacturing performance which are important to be scrutinized in manufacturing plants hence to improve their operational and production performance therefore achieved competitive advantages.

Keywords: Technological capabilities; performance; manufacturing sector

Introduction to Malaysian manufacturing sector

The manufacturing sector has become the most dynamic sector in an industrial economy compared to other sector of construction, mining and quarry, and utilities (Idris, Wahid, Nor, Mohamed, & Kechot, 2004). It plays a crucial role in the economy in most countries. This sector is considered as the leading catalyst to the world economy and it successfully contributed to the economic growth mostly in the third world countries. In the earlier trend, the manufacturing grows faster in exports other than other sectors. Before that, the manufacturing growth was sluggish in early 1961 until 1970, and become stronger when foreign firms started to expand local

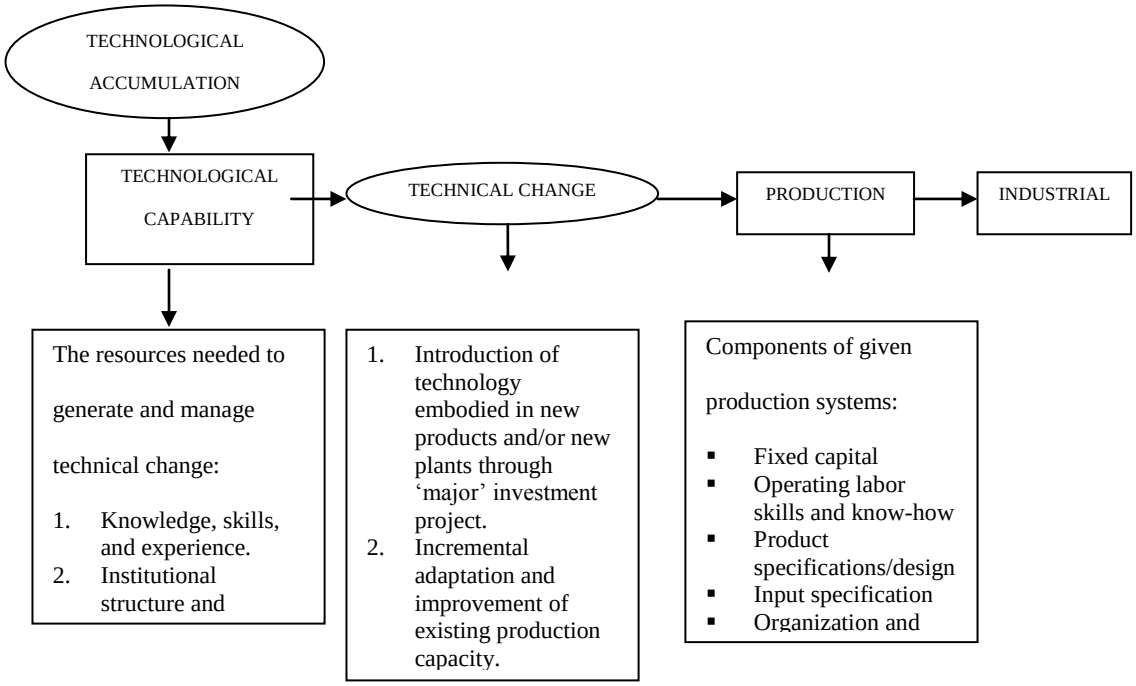
export processing operations (Rasiah, 1996). Recently, in the mission to achieve the global competitiveness, the government has targeted to stimulate the economy by the growth of the manufacturing sector at 5.6 per cent annually and contributed 28.5 per cent to gross domestic product (GDP) in the year 2020 with the total investments of RM687.7 billion, hence RM27.5 billion annually (IMP3, 2006). In addition, the major contributors to the country's manufacturing sector which indicated over 90 per cent of the sector come from the Small and Medium Enterprises (SMEs).

According to the Economic Report produced by Department of Statistics Malaysia, showed that the GDP grew by 7.2 per cent in 2010, while the manufacturing sector contributed 27 per cent to GDP. The report also claimed that the manufacturing sector attained the highest performance of GDP growth of 11.4 per cent besides other significant performance growth in other sectors such as services (6.9 %), construction (5.2 %), agriculture (1.7 %), and mining (0.2 %). According to the Productivity Report on 2010/2011 produced by the Malaysian Productivity Corporation (MPC), it showed that the productivity of Malaysian economy had improved by 5.8 per cent to RM 51,591.00 in 2010 which was shown by the notable recovery of all economies activities reported by the Department of Statistics, Malaysia in the Economic Report, Ministry of Finance. It also highlighted the most significant driver of the Malaysian productivity performances is mainly by the manufacturing sectors which contributed 9.4 per cent followed by the services sectors contributed 4.7 percent. It is clearly seen that the manufacturing growth scored higher than the national growth was mainly due to the improved industrial production in the country.
With the achievement of 5.8 per cent of a national productivity growth in 2010, Malaysia registered as the highest productivity growth compared to the other 15 Organization of Economic Corporation Development (OECD) which was computed from the Economic Reports, Ministry of Finance. Among the selected Asian countries, the productivity report showed that Malaysian productivity growth had left far behind Singapore and Taiwan. By comparing Malaysia to the industrially advanced countries such as Japan, USA, and the United Kingdom, Malaysia is a developing economy struggling to achieve a high-income economy, thus productivity growth of every manufacturing company in the country plays as the key contributors for a better national economic performance.

Technological development

Malaysia is still behind to catch-up to the higher level of technology as it is proposed that the government should stimulate upgrading in technological capacity by deploying learning policies for better spillovers among local firms (Rasiah & Malakolunthu, 2009). Manufacturing sector contribution through the purchasing of technology is widely recognized as one way medium to upgrade local technologies. In the case of automobile manufacturing, Malaysia can learn from the technology frontier such merger of Nissan-Renault from Korea and China to raise competitiveness in local firms hence upgrading the TCs (Rasiah, 2008). Basically, technology in organization consists of the hardware which includes machinery and equipments, and software which are the processes and routines associated with the organization's word and knowledge embodied to the hardware (Scott, 1987). Whereas, there are three areas in which technological change has primarily occurred in; information technology, materials technology, and manufacturing process technology (Gunn, 1987). A basic concept in the development of TC in an industrial organization, it involves the technological learning process and TC is needed to generate and manage technical change (see Figure 1).

Figure 1 Technological Accumulation: Basic Concepts and Terms
Adapted from M. Bell and Pavitt (1995)



What is exactly the technological capability?

Technological capability (TC) is a term used to encompass the system of activities, physical systems, skills and knowledge bases, managerial systems of education and reward, and values that create a special advantage for an organization. Normally, a firm is capable of operating, maintaining, adapting, and assimilating the transferred technology. There are two main dimensions of TC which are activities and strategies (Bergerk, Tell, Berggren, & Watson, 2008). Activities consist of R&D activity in term of patenting, product launching, and problem solving whereas strategy will consider on the technology sourcing strategy. There were substantial numbers of research being done in TC studies until recent years. TC plays an important role in achieving competitive advantages and increase performance of organizations, industries, industrial clusters, and as well as for the countries. In earlier studies, there are various definitions of TC (see Table 1).

Table 1 Technological Capability Definitions

Author	Technological capability connotations
Kim (1980)	The degree of capability of organizations in developing new products which related to the organizations' age.
Lall (1990)	The capability to execute all technical functions entailed in operating, improving, and modernizing firm's productive facilities.
Lall (1993)	The abilities of productive enterprises to handle industrial technologies and cope with technological change.

Martin Bell and Pavitt (1992)	The resources needed to generate and manage technical change which are accumulated and embodied in skills, knowledge, experience, and organizational system.
Wilson (1995)	The ability to select technologies appropriate for the work being undertaken, the ability to absorb and adapt technologies into local settings, and the ability to develop new technologies, processes and products via local innovations.
Lall (1996a)	The skills, technical knowledge and organizational coherence required to make industrial technologies function in an enterprise.
Kim (1997)	The ability to make effective use of technological knowledge to imitate and assimilate existing technologies, create new technologies, and develop new products and processes in response to the changing economic environment.
Teece, Pisano, and Shuen (1997)	The ability to perform any relevant technical function or volume activity within the firm including the ability to develop new products and processes and to operate facilities effectively.
Aw and Batra (1998)	The ability to adapt or assimilate technology imported from abroad and to incorporate the additional and distinct resources needed to manage and put to productive use the newly acquired technology.
Costa and Queiroz (2002)	The skills, knowledge, and experience required for a firm to achieve technological change at different levels.
Zahra and Nielsen (2002)	The set of skills the firm has in building and leveraging different technologies and system.
Figueiredo (2002)	The resources needed to generate and manage improvements in processes and production organization, products, equipment and engineering projects.
Madanmohan, Kumar, and Kumar (2004)	The knowledge and skills required for firms to choose, install, operate, maintain, adapt, improve, and develop technologies.
Oyebisi, Olamade, and Agboola (2004)	The ability of a country to choose, acquires, generate and apply technologies which contributes to meeting its development objective (International Labour Office, 1986).
Tsai (2004)	The assimilation and application of the technological knowledge from R&D activities to production.
Coombs and Bierly III (2006)	The firm's ability to be effective during the transformation process of turning inputs into outputs, relative to its competitor.
Wang, Lo, Zhang, and Xue (2006)	The ability to develop and design new products and processes and upgrade knowledge about the physical world in unique ways, thus transforming this knowledge into designs and instructions for the creation of desired outcomes.
Garcia-Muina and Navas-Lopez (2007)	The generic knowledge-intensive ability to jointly mobilize different scientific and technical resources which enable a firm to successfully develop its innovative products and/or productive processes, by implementing competitive strategy and creating value in a given environment.
Sethi, Khamba, and Kiran (2007)	The skills and know-how required to manage, create, and extend the existing pool of technological knowledge.

Figueiredo (2008)	The resource needed to generate and manage technological change.
Iammarino, Padilla-Perez, and von Tunzelmann (2008)	The knowledge and skills embedded in individuals, organizations, and institutions located in a geographically-bounded area and conducive to innovative activity.
Jin and von Zedtwitz (2008)	To make effective use of technical knowledge and skills, not only in an effort to improve and develop products and processes, but also to improve existing technology and to generate new knowledge and skills in response to the competitive business environment.

Besides the broad definitions of TC, a large number of previous studies covered the manufacturing industry against other sectors (Hajihoseini, Akhavan, & Abbasi, 2009; Iammarino et al., 2008; Isobe, Makino, & Montgomery, 2008; Khan & Haleem, 2008; Rasiah, 2009), biotechnology, automotive, high technology and telecommunications. A few had covered industries such as software, hospitality, paper, dessert, electronics and also construction. This has brought an idea saying TCs studies are almost known in the industry that heavily involved in the process that relates to the use of machinery equipments. TC is therefore known as critically important for the manufacturing companies' competitive advantages that drives performance of an organization (Coombs & Bierly III, 2006).

By the broad definitions of the TC, it is therefore can be described as a set of knowledge, skill, experience, and ability to choose, install, operate, maintain, adapt, assimilate, improve, and develop new values to the processes and products in a dynamically changing manufacturing environment. Hence, it creates strategic capability to the organization in gaining competitive advantage while surviving in the global market turbulence as what's been defined earlier that TC is a set of functional abilities, in which reflected an organization's performance through various technological activities and whose ultimate purpose is organizational value management by developing inimitable organizational abilities (Panda & Ramanathan, 1995).

Type of technological capability

Table 2: Industrial Technological Capabilities: An Illustrative Framework

	Primary Activities				*Supporting Activities*	
	Investment		*Production*			
	Facility user's decision-making and control	*Project preparation and implementation*	*Process and production organization*	*Product centered*	*Developing linkages*	*Capital goods supply*
Basic production capabilities Capacities to use existing production techniques	Engaging primary contractor. Securing and disbursing finance. Officiating at opening ceremony.	Preparation of initial project outline. Construction of basic civil works. Simple plant erection.	Routine operation and basic maintenance of 'given' facilities. Efficiency improvement from experience in existing tasks.	Replication of fixed specification and designs. Routing QC to maintain existing standards and specifications.	Procurement of available inputs from existing suppliers. Sale of 'given' products to existing and new customers.	Replication of unchanging items of plants and machinery.
TECHNOLOGICAL CAPABILITIES (CAPABILITIES TO GENERATE AND MANAGE TECHNICAL CHANGE)						
BASIC	Active monitoring and control of feasibility studies, technology choice/ sourcing, and project scheduling.	Feasibility studies. Outline planning. Standard equipment procurement. Simple ancillaries engineering.	Commissioning and debugging. Improved layout, scheduling, and maintenance. Minor adaption.	Minor adaption to market needs, and incremental improvement in product quality.	Searching and absorbing new information from suppliers, customers, and local institutions.	Copying new types of plants and machinery. Simple adaptation of existing designs and specifications.
INTERMEDIATE	Search, evaluation and selection of technology/ sources. Tenders/ negotiation. Overall project management.	Detailed engineering. Plant procurement. Environment assessment. Project scheduling and management. Commissioning. Training/ recruitment.	Process improvement. Licensing new technology. Introducing organizational changes.	Licensing new product technology and/ or reverse engineering. Incremental new product design.	Technology transfer to suppliers and customers to raise efficiency, quality, and local sourcing.	Incrementally innovative reverse engineering and original design of plant and machinery.
ADVANCED	Developing new production system and components.	Basic process design and related R&D.	Process innovation and related R&D. Radical innovation in organization.	Product innovation and related R&D.	Collaboration in technology development.	R&D for specifications and designs of new plant and machinery.

Source: Lall (1992)

The impact of technological capability on performance

TC literatures have become substantially observed by researchers on its impact towards varied performance measures. Some of past studies covered TC gives impact on export performance (Figueiredo, 2008; Flor & Oltra, 2005; Wignaraja, 2001, 2007), innovative output and technological impact (Kotha, Zheng, & George, 2011), product innovation (Zhou & Wu, 2010), innovativeness (Renko, Carsrud, & Brännback, 2009), launch strategies success (Hsieh & Tsai, 2007), value creation (Garcia-Muina & Navas-Lopez, 2007), system efficiency (Oyebisi et al., 2004), technology development process (Hajihoseini et al., 2009), strategic orientation and strategy growth (Zou, Liu, & Ghauri, 2010). Most of the previous studies have recently focused on the effect of TC towards firm performance (Coombs & Bierly III, 2006; Isobe et al., 2008; Kylaheiko, Jantunen, Puumalainen, Saarenketo, & Tuppura, 2011; Lee, Lee, & Pennings, 2001; Ortega, 2010; Schoenecker & Swanson, 2002; Tsai, 2004; Wang et al., 2006). Hence it is widely known that TC development and strengthens helps an organization to gain competitive advantages (Panda & Ramanathan, 1995, 1996; Prasnikar, Lisjak, Buhovac, & Stembergar, 2008). It is also to create a performance in the technological development with the specific capacity of R&D-related resources (Praest, 1998). Overall, it shows that TC is an important component of the organizational capabilities and need to be thoroughly considered for manufacturing companies and plays as a salient contribute to the organizational performance.

Coombs and Bierly III (2006) stated that it is difficult and complex to interpret the relationship between TC and organization performance constructs. They measure the performance on six items which are return on assets, return on equity, return on sales, market value, market value added, and economic value added. The result on 201 manufacturing companies showed that R&D spending is a poor measure of TC when it gives a strong negative correlation with return on assets and return on sales. However, it increases the ability of firm to better understand, interpret, and apply external knowledge. Patents showed no significant relationship on most of the performance measures in the study which are return on assets, return on equity, return on sales, and market value added. Even though this study is not a comprehensive analysis of all the constructs measures, it provided an illustration that somehow the traditional measures of TC which are the number of patents or the amount of R&D spending could be very misleading toward the organization performance measures.
Tsai (2004) strongly supported that TC has significantly positive impact on organizational performance. The capability proves to play as a significant determinant of productivity growth for high-tech firms. Technological knowledge seems to improve the TC which therefore prolongs the exceptional performance in terms of productivity growth or value added. However, TC has a greater impact on productivity growth or value added compared to physical capital or labor due to the advantage of knowledge-base input factors in production. In addition, he had measured TC in the perspective of stock instead of the flow of technology itself. TC proved to have directly affected on overall business performance and new product development performance (Wang et al., 2006). The capability is not only has the direct effect but also an indirect impact on both performances whereas the customer value plays as mediator. Customer value itself has a significant effect on overall business performance and new product development performance and therefore does mediate the effect on TC on both performances. However, the result on the effect of TC on environmental turbulence and learning orientation is contingent, whereas the moderating effect of market turbulence is negatively moderates the relationship between TC and customer value and the relationship between TC and new product development performance, while the moderating effect of technological turbulence marginally moderates only the relationship between TC and overall

business performance same as the learning orientation shows a weak relationship and the effect size is small but positive.

Organization performance can also be measured by operational efficiency and strategic performance. The two classifications of TC are used to investigate the relationship between the two capabilities and firm performance measures are refinement capability and reconfiguration capability (Isobe et al., 2008). The results show a positive association between refinement capability and operational efficiency. Refinement capability had been observed to have more positively related to the operational efficiency than reconfiguration capability, hence contributes primarily to short-term improvement and superior operational performance. On the other hand, reconfiguration capability was believed to have more positive impact on strategic performance than refinement capability, while influence long-term improvement and superior strategic performance. The study also showed with a positive association, an organization with superior refinement capability tends to posses superior reconfiguration capability. Another study had measured organization performance by realizing growth and profit. The result showed that technological capabilities do have a significant and positive relationship with innovation-based growth and positive significant relationship with growth through Internationalization (Kylaheiko et al., 2011).

In the study of automobile component manufacturing firms, Khan and Haleem (2008) found that manufacturing cost and quality of final product have been measured to be affected by technology absorption capability, whereas TC is a very important component for technology absorption process. It has been proven that organizational performances do not affected by technological and people capability directly. However, organizational performance was affected directly by the manufacturing processes. TC plays as the predictor of the manufacturing processes together with the person's capability. Therefore, manufacturing processes strictly depended on technological and people capability. Manufacturing processes encompass innovation, flexibility, and improvement. A study on strategic implications of manufacturing performance in comparisons of newly industrializing countries, Husseini and O'Brien (2004) had mentioned on the effect of process technology towards quality, cost, speed, reliability, and flexibility of manufacturing operation. They highlighted the importance of taking into consideration other environmental aspects as well as manufacturing long term strategies. Longer term strategies refer to the development of TC itself, as it aids to accumulate and develop the technology. They emphasized that the manufacturing strategy process should be in line with the long-term technology development strategy and not just for short-term response or market needs.

Conclusion

Developing and improving TC in an organization is a long-term commitment. It takes the effort of every person involves in the organization. TC plays important roles from the beginning of new ventures to the stage of caretaker firms that help them to survive in the dynamically changing market for a long span. Manufacturing company in general and SMEs particularly should start evaluating their level of TC and improves it to the extend level while operating the plant accordingly in order to meet customer requirement. Overall, most studies in TCs literatures have shown the significant roles played by TCs on various organization's performance measures. Therefore, TC is labeled as a crucial determinant together with another firm capabilities that promote competitive advantage and firm performance growth (Tsai, 2004). With the basic understanding of TC and its impact on performance, the company may develop suitable strategies to improve the performance and, hopefully, improve

its competitive as well. Their commitment on TC will determine a long term success for the company.

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