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Technological innovation implementation: A proposed model on organizational learning capability with moderating effect of knowledge complexity

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The purpose of this paper is to explore the relationship between organizational learning capability, knowledge complexity and their impact on technological innovation implementation success. The rapidly rising rate of technological change in manufacturing process presents a lot of challenges and opportunities for organizations. Research has fairly established that technological innovation implementation is associated with organizational learning. However, few studies have investigated on the roles of knowledge complexity on the established relationship. This paper focuses at implementation phase of innovation process, where innovation has been fully developed, then it must be implemented. The issue of implementation is crucial in innovation research. Identification of success or failure of innovation can be done through implementation phase. Furthermore, the success of the technology implementation will determine whether any innovation has achieved its objective or not.

Key words: Technological innovation, knowledge complexity, organizational learning capability.

INTRODUCTION

In competition-based economic system, the role of innovation as a part of management practice is an important factor for survival within the firm and to be effective, managers need to accept this requirement to accelerate the rates of innovation (Lipsey, 1996; Johannessen et al., 1997). Ravichandran (2000) has mentioned that organization has a single choice in today's environment; innovating or creating technological and managerial innovation. Bessant and Francis (1998) and McAdam (2000) argue that the role of innovation in organization must flow through every discipline, process and level to produce effective result. Innovation induces organizational growth, leads future success, and is the important factor that allows businesses to sustain their viability in a global economy (Gaynor, 2002). Cottam et al. (2001) agree that innovation is one of the ways to maintain growth and to achieve desirable organizational performance. Therefore, it is important to link technology to innovation in sustaining competitiveness (Humphrey et al., 2005). Through competitive market, firms need to develop and exploit new technology as an essential element to succeed (Leonard-Barton, 1995). Cooper and Schendel (1976) argue that technological innovation creates new industry and destroys or transforms existing firms.

The main factor for organization to succeed in innovation is organizational learning (Mabey and Salaman, 1995). In fact, organizational learning and innovation can be viewed as "intangible" resources because they are hardly imitated (Edmondson and Moingeon, 1998). Lukas (1996) acknowledged "organizational learning is considered by many scholars as a key to future organizational success". Therefore, organizational learning is recognized as a critical factor to innovation success. Furthermore, Stata (1989) mentioned that organizational learning leads to innovation especially in knowledge-intensive of the

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industry which individual and organizational learning lead to further innovation and creates sustainable competitive advantage. Sinkula et al. (2002) highlighted that the important role of organizational learning capabilities is generating innovation. Organizations that posses a superior learning are able to coordinate and combine their traditional capabilities and resources in new and distinctive methods, providing more value for their customers and, in general, stakeholders compared to their competitors (Teece et al., 1997).

Technological innovation is the incorporation of a new technology into the production process, producing new products that have a propensity to change the profitability or the market share of the innovatory firms (Rosenthal, 1995). Compatibility of a new technology with existing technology provides a firm with an easier way to accept new technology (Rebentisch and Ferretti, 1995). Through competitive market, firms need to develop and exploit new technology as an essential element to succeed (Leonard-Barton, 1995). Study at organizational level has recommended that a process of individuals concentrating to learn new technologies is the answer to implementation success (Aiman-Smith and Green, 2002). The management must prepare to establish appropriate incentive and reward to encourage employee involved in learning especially in life-long learning. Successful exploitation of opportunities from new technology requires integration of those technology with the firm's existing skills and technologies (Saban et al., 2000). Importantly, organizational learning can take effect not only at the initial phase of innovation but also at the implementation phase (Glynn, 1996).

As expressed by Tidd et al. (2001), implementation is the heart of the innovation process; when a problem at implementation phase occurs, an innovation cannot be utilised to the fullest, and the concentration to the related activities will be low (Rogers, 1995). Evidence showed that most failures occurred at this phase. Day (1999) claimed that the failure rate for innovation implementation process is around 75%. A study conducted by Tidd et al. (2001) revealed that a higher failure rate of more than 50 percent were experienced by organization in implementing advanced manufacturing technology (AMT) in 1990s. Arokiasamy (2004) who conducted a research in manufacturing sector found that 59.42% of organi-zation experienced interruption in ERP implementation. Accordingly, the estimated failure rate of 47% for technological innovation took place at this phase (Beatty, 1992; Galbraith, 1990; Majchrzak, 1988). On the other hand, only 30 to 50% success rate of new technology implementation is recorded (Tang, 2000). Instead of high failure rate, innovation implementation remains a main priority to the organization. A new technology implementation is influenced by performance gaps because of the management priority to change the existing technology (managerial pull) or new technology that has a big potential to the organization (technology push) (Zmund, 1984).

Problem statement

The phenomenon of success of technological innovation in manufacturing sector is rather discouraging. However, technology-related innovativeness shows the readiness of firms to encourage new technologies as business prospects (Kimberly, 1981; Kitchell, 1995) despite success or failure in implementing the new technology. The main factor for organization to succeed in innovation is organizational learning (Mabey and Salaman, 1995). Nonaka and Takeuchi (1995) explained that companies innovate through a constant learning process through which they generate new technological knowledge. Ju et al. (2006) argued that when knowledge complexity exists, organizations have difficulties in acquiring, integrating and using the knowledge in organization to achieve objectives. Therefore, knowledge complexity influences organization in pursuing its activities especially in learning and innovation. The alignment between organizational learning capability and knowledge complexity needs to be explored further because it might impact the success of technological innovation implementation.

Objective of the study

In line with the problem afore stated, the objectives of this research are as follows:

1. To identify the level of success of technological innovation implementation among manufacturing firms.
2. To identify the influence of organizational learning capability (OLC) on success of the technological innovation implementation
3. To investigate the extent to which knowledge complexity moderates the relationship between organizational learning capability (OLC) and success of the technological innovation implementation.

THEORETICAL FRAMEWORK

Goh and Richards (1997) define organizational learning capability (OLC) as the managerial and organizational characteristic or element that facilitate the organizational learning process or encourage an organisation to learn. Organisational learning facilitating factors were grouped through a comprehensive analysis so that a simplified essential set of dimensions for organisational learning was obtained (Gatignon et al., 2002). Chiva et al. (2007) identify five underlying dimensions of organizational learning capability: experimentation, risk taking, interaction with the external environment, dialogue, and participative decision making. These dimensions were considered as the most underlined facilitating factors in the literature (Chiva, 2007). Figure 1 present a conceptual model concerning the relationship between

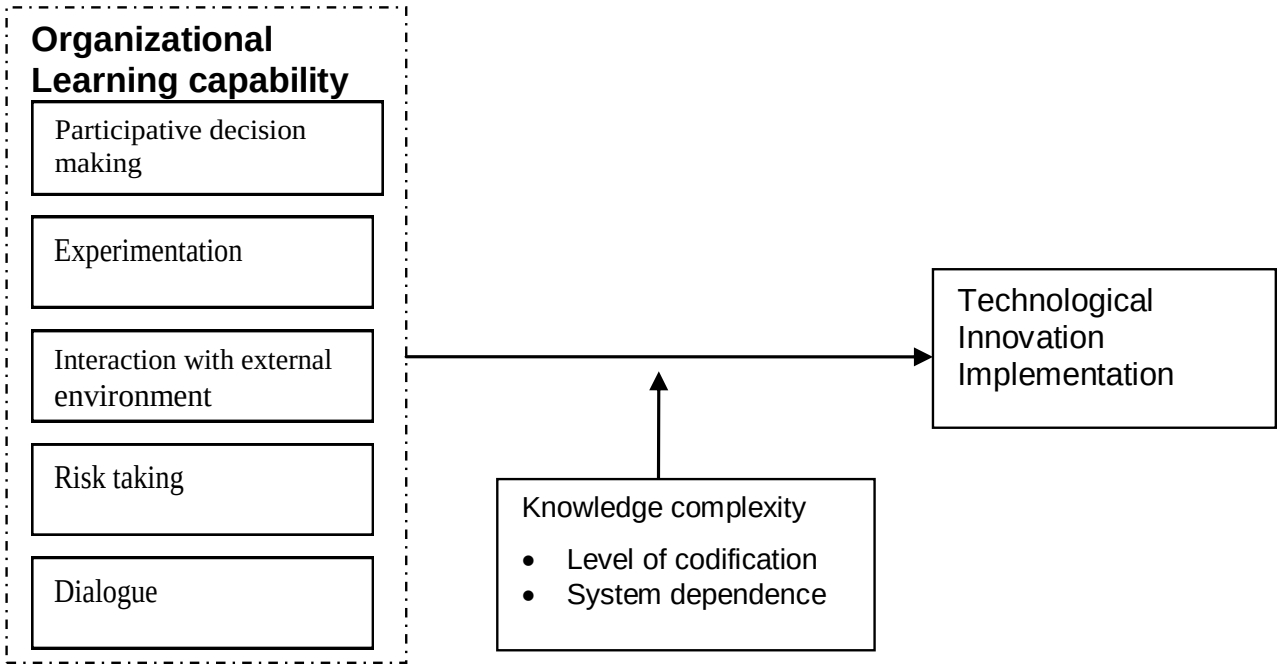

Figure 1. Conceptual model.

constructs of the proposed conceptual model.

According to Gorton and Schmid (2000), organisational learning and competitiveness will be increased through defining the underpinning theory of innovation implementtation more consistently and applying supportive measures. Technology innovation implementation provides a good perspective in which to investigate how organizational routines can be changed. For example, Klein and Sorra (1996) and Tyre (1991) argue that researchers' and managers' values of new technology implementation are crucial in the United State manufacturing firms. Implementation phase is the least understood phase of the innovation process (Van de Ven, 1993). Therefore, when technological innovation is adopted (decision was made), the innovation must be implemented, employees need to know how to use it and integrate it into their daily routines or the expected efficiencies will not be accomplished (Rogers, 1995).

The measurement of innovation implementation success remains unclear. Linton (2002) states that, there is no specific measurement to measure innovation implementation success; it is difficult to measure successful innovation because of the difficulty in generalizing the outcomes of different studies (Wolfe, 1994). The most suitable definition of measurement of innovation success was provided by Cozijnsen et al. (2000), where "innovation success is measured through the degrees to which the innovation goals are achieved". Successful technological innovation projects can be assessed by isolating their contribution to improvement in a firm performance (Narveka and Jain, 2006). Cozijnsen et al. (2000) state that the indirect results of an innovation project, relates to profits and competitive position of the organization. Most common measurement of innovation outcomes involves efficiency and effectiveness. Efficiency involves the extent to which customer requirements are met meanwhile, effectiveness is determined through how firm's resources are utilized (Neely et al., 2005). Therefore, innovation implementation success measurement is through effectiveness and efficiency of new technology.

Theoretical construct

Theoretical foundation of this framework is mainly derived from resource-base view (RBV). Newbert (2007) argues that a current review of empirical RBV literature in management related firm's competitive position depends essentially on its organizing context and on its valuable, rare and inimitable capabilities and core compentencies rather than on its static resources. However, resources are inadequate for gaining a sustained competitive advantage and a high performance as well (Teece et al., 2007; Newbert, 2007). Through the capability-based theory (CBT), it is suggested that firms can achieve sustained competitive advantage by distinctive capabilities owned by the firm (Grant, 1991; Hayes et al., 1996). Being so, firms must be capable to change resources in capabilities, and accordingly, in a positive performance (Ferreira and Azevedo, 2008). Various researchers have discussed the importance of innovation process in

organization. Several phases of innovation have been recognized in innovation study. A clear innovation phase involved three levels namely; generation, development and implementation (Sundbo, 2001). An ultimate innovation impact can be measured through a last innovation process; the implementation phase. Implementation phase starts with application and adoption activities commenced for an innovation through previous phases which innovation is generated and developed, and then the implementation phase takes place involving transferring innovation to the operating locations, establishing the innovation into the market and reaching it to possible users (Angle and Van de Ven, 1989).

In this study, resource based view (RBV) and capability based theory (CBT) are used to explain the effect of organizational learning capability on the success of technological innovation implementation. Specifically, the study utilizes the assumptions of RBV in providing plausible explanation on how organizational learning capability is practiced among organizations. From innovation process perspective, this study will concentrate at implementation phase.

The study identifies organizational learning capability adopted in the manufacturing sector. Given the importance of learning, the study might contribute considerable knowledge to this area and provide a basis for future studies. This study identifies the factors or characteristics of organizational learning which influence the technological innovation implementation. This can add to the knowledge about how organizational learning diffuse among organizations. This knowledge can also enrich theories that deal with organizational learning such as resource based view theory. It will also provide insight into the role of knowledge complexity in moderating the relationship between organizational learning capability and technological innovation. This can add to knowledge about what enables or facilitates the success of technological innovation implementation.

CONCEPTUAL MODEL AND HYPOTHESES

Participative decision making and technological innovation implementation

Participative decision making is where employees have significant influence in the decision-making process (Cotton et al., 1988). Importantly, when a firm is experiencing a major technological change, the use of participative decision making is the main priority mechanism (Brown, 1979). To provide a better innovative solution, management needs to involve all related parties and it can be achieved by reducing bureaucratic problem in organization. The increase in participation during decision making will result in less resistance to change and better possibility for adoption of new technology (Wall and Lischeron, 1977). Bahrami and Evans (1987) assert that successful high technology firms practice decentralized decision-making and high degree of participation by line managers in decision-making when dealing with changes in the environment. Furthermore, the ability to participate in decision making is a key process in enhancing innovation (West and Anderson, 1996). Participative decision making was most essential to technological innovation (Fadzil, 2001):

H_1: Participative decision making has a positive effect on technological innovation implementation.

Experimentation and technological innovation implementation

Experimentation deals with trying out new ideas, being curious about how things work or carrying out changes in work process (Nevis et al., 1995). Experimentation produces a flow of ideas or proposals that challenge the established order and is regarded as a manifestation of the creative environment (Alegre, 2003). Thomke (2001) asserts that experimentation lies at the heart of every company's ability to innovate. Management needs to encourage and support the freedom to conduct experiment with new work methods and innovative process (Senge, 1990; Garvin, 1993; Mcgill and Slocum, 1993). Organization can learn by analyzing the failure and then proceed with experimentation. A meaningful failure should be used as a learning process in organization. To optimize the learning process, team should "embrace failure" and systematically collect as many 'failures' as quickly as possible (Singer and Edmonson, 2006).

Thomke (1998) argue that to ensure that technological implementation works, it often requires experimentation, using trial and error to find solution. Companies that experiment novel technologies are better positioned to have a higher rate of innovation than firms that invest all their efforts in exploiting the existing, familiar technologies (Beerkens, 2004). Precipe (2000) mentions that to understand technological failure and to gain knowledge resulted from failure will be helpful for subsequent technology or product development. By experimenting with novel technologies, it permits an organization to evaluate the potential of technology in effective ways (Cohen and Levinthal, 1990). Through experimenting new technology, organization can acelerate its innovation in effective way especially in new technology:

H_2: Experimentation has a positive effect on technological innovation implementation interaction with external environment on technological innovation implementation.

Firms can learn from their external counterparts and use related information for organizational success. The external environment of an organization consists of those

factors that are beyond the direct control of the organization, and include industrial agents such as competitors, the economic system, the social system, the monetary system and the political/legal system, among others (Alegre, 2004). Interacting with other companies such as customers and suppliers will promote companies to learn (Lundvall, 1988). Cyert and March (1963) argue that an organization needs to deal with external shocks, in turn, they must adapt and learn to cope with that situation in their whole life. External environment demands organization to be more cautious. Monitoring any changes of external environment contributes to learning by organization members. Additionally, it is important for organization to ensure the flow of relevant knowledge from both outside and inside organization so that it can be utilized in the innovation process (Savory, 2006).

Interacting with external sources can boost firms' knowledge about competitive trends and industry benchmark (Mu et al., 2008). Importantly, the affects of organizational learning process take place within a network of actors and importantly, within industrial system (Bagens and Araujo, 2002). Employees other than gatekeepers and technical staff are encouraged by firms to search for information related to technological and market trend then bring back to the firms (Matusik, 2002). In recent years, an escalating number of organizations are forming relationships with other organizations to enhance value through continuous knowledge management (Hagedoorn, 1993; Robertson and Yu, 2001). Organization need to establish relationship with external entities including customer, competitor or government agency, etc. Such collaboration will bring benefit to the firm including the latest changes or developments which affect firm competitiveness:

H_3: Interaction with external environment has a positive effect on technological innovation implementation

Risk taking and technological innovation implementation

Liles (1981) defines risk as the probability of an unconstructive result occurring from various courses of actions. Risk-taking is the organization's enthusiasm to break away from normal path and venture into unknown territory (Venkatraman, 1989; Wiklund and Shepherd, 2003). Risk-taking is also the extent to which managers are eager to make large and risky resource commitments (Miller and Friesen, 1978).

Kouzes and Posner (1987) argue that learning from successes and mistakes resulted from risk taking will lead to increasing business opportunities. Employees need support and collaboration among themselves to reduce fear and gain openness which encourages new risk taking (Hurley and Hult, 1998). When there are growths in new areas, there will be unfamiliarity with new activities and management requires more efforts (Penrose, 1972) to deal with risk. Peter and Waterman (1982) suggest that companies that are able to manage risk taking properly in their industrial context will achieve excellence result. Saleh and Wang (1993) showed that innovative companies are more engaged in risk taking compare to less innovative companies. Rauch et al. (2004) found that the risk-taking is positively related to performance. Begley and Boyd (1987) found that relationship between firm's risk-taking and performance is at maximum level when risk taking is at medium level. Covin et al. (2006) found a positive significant relationship between risk-taking with business performance. The willingness to take risk will open great opportunity to firm in implementing technological innovation:

H_4: Risk taking has a positive effect on technological innovation implementation

Dialogue and technological innovation implementation

Isaacs (1993) defines dialogue as "a sustained collective inquiry into the processes, assumptions, and certainties that compose everyday experience". Dialogue is an interactive process of learning together, aims to achieve deeper levels of understanding between those participating (Ballantyne, 2004). Isaacs (1993) and Schein (1993) state that most scholars and practitioners of organizational learning see the process of dialogue as providing an avenue for communication and collaborative learning within and between groups and teams. Ganesan (1994) has established that the willingness to cooperate improves when partners always make constructive judgments about one another over time. It can be said that dialogue is part of organizational learning which encourages communication and tries to sharing the same conclusion between them. Thinking of each other's thoughts helps them to overcome the hurdles impeding their willingness to work with each other, and enables them to understand some of the difficult attitudes often held by various members (Muayyad Jabri, 2004). In organisational studies, dialogue has become important as an aspect of understanding the difficulties and possibilities of learning and change (Gear et al., 2003).

When team members communicate with each other frequently, an absorptive capacity is more likely to develop among them, enabling them to become more efficient in expanding and using information (Brown and Eisenhardt, 1995). Communicative interaction only takes place when the receiver derives some meaning from the message, which of course is less than what the sender intends (Ballantyne, 2004). Importantly, successful technological innovation is positively influenced by individuals' communication (Balthasar et al., 2000). The role of dialogue among organizational members can produce better understanding by sharing meaning on

related issues. Organizational members can also reach mutual understanding and alleviate the speeding in sharing information:

H_5: Dialogue has a positive effect on technological innovation implementation.

MODERATING EFFECT OF KNOWLEDGE COMPLEXITY

Knowledge can be transmitted by affecting people, technology, or structure to the organization, or by changing people (for example, training), technology, and the structure of the beneficiary organization (Argote, 1999). For successful technological innovation, developing learning and knowledge management strategies has been considered effective and efficient (Martin and Matlay, 2003). Since innovation will strengthen a firm's competitive advantage, knowledge is the key element that combines organizational learning and innovative activities (Ju et al., 2006).

The concept of knowledge is complex and its relevance to organization theory has been insufficiently developed (Blackler, 1995). According to Vinekar (2008), the complexity of an organization's knowledge environment is the variety of knowledge that an organization needs. Knowledge complexity influences the way knowledge is transferred and integrated in organization. The higher levels of knowledge complexity result in more difficulties a company may encounter in the knowledge integration process (Ju et al., 2006). Complex knowledge mirrors the degree to which knowledge contains many different, unique and interdependent parts, for example, how one element works reveals little about how the different elements work together (McEvily and Chakravarthy, 2002). Thus, knowledge complexity raises an understanding from the types knowledge takes (tacit and explicit) and by the mean of which knowledge processes arise (McElroy, 2000).

In this study, knowledge complexity dimension is measured through codification and systems dependence as used by previous researchers (Hansen, 1999; Zandori, 2001). This is based on argument provided by Teece (1977) and Zander and Kogurt (1995), where difficulties happen in transferring non-codified and dependent knowledge. Simon (1962) also explained that complexity of system consists of many unique and interacting elements:

H_6: The relationship between organizational learning capability and technological innovation implementation will influence by knowledge complexity.

Level of codification

Winter (1987) and Zander and Kogut (1995) explained that one dimension of complex knowledge is its level of codification. Hansen (1999) states codification is a degree to which the knowledge is fully documented or expressed in writing at the time of transfer between a subunit and a receiving subunit. Similarly, Zollo and Winter (2002) argue that codification is the process when individuals codify their understandings of the performance implications of internal routines in written tools, such as manuals, blueprints, spreadsheets, decision support systems, project management software. Importantly, knowledge with a low level of codification is closely related to the term of tacit knowledge which is difficult to be communicated or can only be obtained through experience (Polanyi, 1966; Nelson and Winter, 1982; Von Hippel, 1988). Tacit and explicit knowledge are comparable; tacit knowledge is more personal and explicit knowledge is more public (Kane et al., 2006). For tacit knowledge, it is difficult to be formalized and communicated to others (Nonaka and Takeuchi, 1995). Additionally, Polanyi (1966) stresses that two-way communication supported by strong ties is a key to assimilating the non-codified knowledge, because the recipient probably does not obtain the knowledge completely throughout the earliest interaction with the recipient but needs several opportunities to understand. The difficulty in transferring knowledge depends on its level of codification which is easy to understand or difficult to translate into meaningful meaning. Therefore, codification of knowledge consists of the elements of tacit and explicit knowledge, it depends on whether knowledge is hard or easy to be articulated by organizational members. Tacit knowledge creates difficulty in the process of selecting, moving and applying the knowledge (Grant, 1996; Hansen, 1999; Kogurt and Zander, 1992; Simonin, 1999). Besides, explicit knowledge can easily be transferred and it provides deep understanding compared to tacit knowledge which sometimes involves confusion and is difficult to understand. Therefore, tacit and explicit knowledge can be deliberated of as an end-to-end extreme on a range of all knowledge possibilities (Dixon, 2000). It is difficult to identify if knowledge is explicit or tacit in different organization. Every organization has its own experience, process and systems. Therefore, the identification of knowledge, either explicit or tacit, is complex:

H_{6a}: The relationship between organizational learning capability and technological innovation implementation will influence by level of codification

System dependence

Another knowledge complexity dimension is dependence, the level of knowledge to be transmitted or a component of a set of interdependent components (Teece, 1986; Winter, 1987). To perform the task better, individuals

depend on knowledge from other units or departments. For example, production department depends on marketing department to know product demand for production planning.

If knowledge is easily acquired from others, firm operation is efficient and effective. If knowledge is difficult to be acquired from others, it will interrupt or delay the operation. Therefore, when knowledge is more complex, effective internal transfer is more complex and entails strong ties in the form of proper system and regular interaction (Hansen, 1999). If task knowledge is obtained from and dependent on a larger number of people, systems, or processes, then those looking for that knowledge have more possibility to search for knowledge from many diverse sources, more of which are possible to be people, rather than knowledge management system in organization (Bystrom, 2002).

The relationship between departments is crucial especially with regard to sharing different knowledge that is needed to perform tasks. Hansen (1999) considers knowledge sharing among people from different subunits as a dual problem of searching (looking for and identifying) and transferring (moving and incorporating) knowledge across organization subunits, taking into account the complexity of the knowledge that flows through inter-units relationship.

The interaction in organization involves people between units or departments. Most important activities performed by organization members need to involve knowledge from different units or departments. For example, production department needs information from marketing and finance department in operation activities, for example, cost and product acceptance. Marsh and Stock (2003) claim that gathering technological and marketing capabilities from past NPD projects and incorporating that knowledge in a systematic and purposeful manner into the development of future product increases project level performance.

Dependency on other units in an organization might be due to level of knowledge difficulty and how channel influences knowledge integration.

Organization knowledge created through different channels provides different interaction between tacit knowledge and explicit knowledge in organization (Nonaka, 1994). Sharing knowledge from other subunits creates duplication of efforts that can be avoided to increase the management role in handling technical problems (Teece, 1986). However, organization units that are not strongly connected to other units are more responsive because of fewer constrains in organization system (Weick, 1976). Previous research has revealed that access to information through network ties can facilitate performance outcomes (Tsai and Ghoshal, 1998; Tsai, 2001). Thus, in integrating knowledge, the process that is differently interpreted among units needs to be coordinated effectively. Interdependence between units may create divergent understanding. Organizations need to identify the best method in coordinating knowledge that needs to be shared with other units:

H_{6b}: The relationship between organizational learning capability and technological innovation implementation will influence by system dependent.

CONCLUSION

Today, organizational learning issues receive increasing attention throughout a world. The proposed framework focused on examining organizational learning capability and technological innovation implementation relationship with moderating effect of knowledge complexity.

This study also emphasizes on the implementation phase of innovation process. The importance of learning and technological innovation must be emphasized by the organization, especially in knowledge-based industry. Without knowledge application, organizations would not be capable of fully taking advantage of the collective knowledge to achieve superior performance (Alavi and Leidner, 2001). Through organizational learning capability, firms learn how to improve or to change existing technology which contributes to organizational competitive advantage. By implementing latest technology, it will help organization to stay ahead of competitors. Failure to learn from change can lead to inability to survive (Garvin, 1993).

This study will identify factors that encourage organization to learn and provide insight into the role of knowledge complexity, thus, enhance the understanding of managers and policy makers on the influence of motivators on the outcomes of technological innovation. This understanding can help managers design appropriate policies for the technological innovation in organizations.

To sum up, this study highlighted two main issues emerged from the existing literature. First, the research has established that organizational learning capability is critical to success of innovation implementation. Secondly, it is important to manage knowledge in organization as a facilitator for technological innovation implementation.

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