ORGANIZATIONAL LEARNING, PROPRIETARY TECHNOLOGY, AND MANUFACTURING PERFORMANCE: A GLIMPSE FROM THE MALAYSIAN MANUFACTURING FIRMS

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Abstract

The objective of this research is to investigate how manufacturing firms develop capabilities and resources that are inimitable, and non-substitutable in pursuit of higher performance and competitive advantage. This research attempts to find out: firstly, whether organizational learning leads to innovation in terms of proprietary technology development; secondly, whether proprietary technology development enhances manufacturing performance; lastly, whether organizational learning leads to manufacturing performance via proprietary technology development. Data was collected from a sample of 68 managers in manufacturing firms in Northern Peninsular Malaysia. The results of this study indicates that internal learning will lead to more proprietary technology development and in turn proprietary technology will lead to higher level of manufacturing performance. In addition, this study also empirical demonstrates that proprietary technology mediates the relationship of organizational learning and manufacturing performance. The study shows that internal learning and proprietary technology are important means for a manufacturing firm to gain competitive advantage. Thus management need to be aware that excessive use of external sources of learning might cause the companies to lose opportunities to develop proprietary technology. Therefore, management should carefully identify the critical resources and capabilities that should be developed internally.

INTRODUCTION

The importance of the resource-based view (RBV) of strategic management is manifested in its rapid diffusion throughout the strategy literature (e.g., Amit & Schoemaker, 1993; Barney, 1986, 1991; Dierickx & Cool, 1989; Mahoney & Pandian, 1992; Rumelt, 1984; Wernerfelt, 1984). The resource-based theory is grounded on certain concepts that need to be outlined. According to Barney, a company's resources include all the credits, organizational characteristics, processes, aptitudes, information and knowledge controlled by the company and enabling it to conceive and implement strategies to improve its effectiveness. The fundamental postulate of this approach is as follows: leveraging the companies' resources and core competencies to generate a sustained competitive advantage which, in turn, translates into better performance.

Drawing on previous research in RBV, this study places research on the manufacturing strategy in the context of RBV with the aims of illustrating the interrelationships between RBV and manufacturing performance. The manufacturing strategy in this study refers to a pattern of consistent decisions regarding manufacturing resources, practices and capabilities that are aimed at building a competitive advantage for the business (Schroeder & Flynn, 2001). Specifically, this research attempts to study how manufacturing firms develop capabilities and resources in pursuit of higher performance and competitive advantage.

This research extends previous research in the manufacturing strategy literature by examining whether the capability to develop proprietary technology through internal learning and external learning within the manufacturing firm is associated to the competitive manufacturing performance (Schroeder, Bates & Junttila, 2002). These resources and capabilities play an important role in the adoption of specific manufacturing practices as well as the formulation of the firm's manufacturing strategy.

However, within both the theoretical and empirical work to date, there has been limited discussion of how idiosyncratic resources and capabilities are actually developed, deployed, and protected (Schulze, 1994; Teece, Pisano & Shuen, 1997; Zajac, 1992), particularly in manufacturing. Previous research mainly focused on the market driven development of capabilities in manufacturing. Competitive advantage has been assumed to be gained by those who respond most effectively to the external environment (Johnson & Scholes, 1994) and the 'competitive forces' perspective (Porter, 1990). Successful manufacturing firms are those that meet the requirements and can even anticipate the future before it becomes common knowledge.

In Malaysia, there is also limited literature on manufacturing strategy and manufacturing performance. The most recent study on manufacturing performance was conducted on SME that focused on the relationship between business strategy and manufacturing performance (Hashim, 2000). Others studies were focused on the impact of manufacturing practices like Total Quality Management System, Just In Time and Total Productive Maintenance on manufacturing performance (for example, Ng, 1999). There has been no study conducted on how manufacturing firms in Malaysia develop their capabilities and resources in pursuit of better performance and competitive advantage. Therefore, this research will explore how manufacturing firms develop capabilities and resources in pursuit higher performance and competitive advantage.

LITERATURE REVIEW

Manufacturing resources and capabilities

Amit and Schoemaker (1993) argued that there are two key features that distinguish a capability from a resource. They make a clear distinction as well by defining resources as "stocks of available factors that are owned or controlled by the firm," and capability as the "firm's capacity to deploy resources". First, capability is firm specific since it is embedded in the organization and its processes, while an ordinary resource is not (Makadok, 2001). This firm-specific character of capabilities implies that if an organization is completely dissolved, then its capabilities would also disappear, while in contrast, its resources could survive in the hands of a new owner. For example, if Intel Corporation is completely dissolved then its microprocessor patents (a resource) could continue to exist in the hands of a new owner, but its skill at designing new generations of microprocessors (a capability) would probably vanish. The second feature that distinguishes a capability from a resource is that the primary purpose of a capability is to enhance the effectiveness and productivity of resources that a firm possesses in order to accomplish its targets, acting as 'intermediate goods' (Amit & Schoemaker, 1993).

However, both resources and capabilities that are valuable, difficult to trade and imitate, scarce, and non-substitute are considered strategic assets, although capabilities are more likely to result in a sustained competitive advantage (Barney, 1986, 1991; St. John & Harrison, 1999).

Capabilities arising from manufacturing processes and infrastructure may become a valuable resource for the firm. Manufacturing processes are particularly amenable to the RBV approach for two reasons. First, manufacturing resources and capabilities such as custom-designed process equipment, worker experience, and incremental process improvement can create a store of manufacturing capability that is difficult to observe or imitate and subject to causal ambiguity (Hayes & Wheelwright, 1984; St. John & Harrison, 1999). Second, at any one point in time, superior capabilities in manufacturing processes have been demonstrated to confer performance advantages, and consistent improvement of manufacturing processes can lead to a series of competitive advantages (Stalk, Evan & Shulman, 1992). These capabilities evolve, reflecting shifts in technological trajectories, defined as the paths particular technologies follow over time (Dosi, 1982). These evolutionary paths depend on existing scientific knowledge and are fueled by a quest for improving a given technology's performance (Zahra & Nielsen, 2001)

In this research, we are looking at three types of manufacturing resources and capabilities that are built within the manufacturing function and are difficult to imitate and transfer (St. John & Harrison, 1999): (1) proprietary technology, (2) internal learning, and (3) external learning. These resources and capabilities play an important role in the adoption of specific manufacturing practices as well as the formulation of the firm's manufacturing strategy.

Learning and competitive advantage

Empirical studies by researchers such as Morgan, Katsikeas and Appuh-Adu (1998) have demonstrated that a relationship exists between organizational learning and competitive advantage that can provide the basis for delivering superior customer satisfaction. Other researches have provided evidence of links between learning and optimal operation of internal managerial processes.

Bell (1973) proposed that the information and knowledge acquired by employees is now more important than the traditional orientation of assuming that the technology contained within the firm's capital assets can provide the basis for delivering product superiority over competition. Slater and Narver (1995) also concluded that one of the most effective routes to acquiring competitive advantage is to exploit the skills learned by employees as a route through which to offer superior services that lead to the building of closer relationships with customers.

A common conclusion within the management learning literature is the critically important role which learning style plays in providing a mechanism through which firms can acquire and retain competitive advantage (Senge, 1990). In commenting on these materials, Hamel and Prahalad (1993) suggest that merely being a learning organization is not sufficient. The learning style must support the acquisition of new knowledge that can be used to upgrade those areas of competencies, which permit the organization to be more effective in the provision of products and/or services than their competitors.

Goldsmith (1989), for example, proposed that some firms take a different approach to problem solving, being superior in areas such as the ability to be creative and produce original ideas. Mabey and Salaman (1995) argued that the way an organization learns to be innovative is a key variable in determining profitability. Hurley and Hult (1998) and Li and Calantone (1998) both demonstrated an empirical relationship between organizational learning and the successful development of new products and/or services.

Organizations and the individuals often improve their performance over repetitions of the same task. Repetition-based improvements in manufacturing performance have been documented in some detail in studies of learning curve (Yelle, 1979). Such experiential based knowledge can be an important basis of competitive advantage for a manufacturing firm. The re-discovery of learning has been stimulated by current interest among researchers of strategic management in organizational capabilities and knowledge (Prahalad & Hamel, 1990). Successful organizations are described as having capabilities for learning – for responding to experience by modifying their technologies, forms, and practices (Stalk, Evans & Shulman, 1992). In other words, in order to become competitive, manufacturing firms have to acquire knowledge to build up and accumulate technological resources that are imperfectly imitable and difficult to duplicate.

Organizational learning and firm's performance

The organizational structure is recursively organized rules and resources, which organizational members use in their everyday interaction (Sarason, 1995). This interaction constitutes a learning process, which transfers knowledge in replicating activities into organizational routines and behaviors. These routines and behaviors shape how organizations define and solve problems associated with the deployment of technology.

Inkpen and Crossan (1995) stated that firms that learn more effectively will in the long run perform better than their competitors. Slater and Narver (1995) and Morgan et al., (1998) concluded that organizational learning is clearly an attribute which is exhibited by organizations that exhibit excellence in the delivery of products and/or services to their customers. Thus, there should be a link between organizational learning and performance. However, the time lags between the two make the empirical observation very difficult. They added that performance provided important feedback about the efficiency and effectiveness of a learning process and, ultimately, an organization's strategy will come to reflect the accumulated learning. Further, they stressed that the incremental learning should not always lead to incremental performance improvements. Specific performance enhancements may result because of learning, or may also be attributable to efforts of imitation, regeneration, or technological development.

Schroeder, Bates and Junttila (2002) concluded that learning is directly linked to development of proprietary process technology and indirectly to manufacturing performance. Their study also demonstrated that the capability of the plant to incorporate internal and external learning into proprietary processes and equipment emerges as an important contributor to manufacturing performance.

Internal learning

Learning is dependent on the employees themselves who have the knowledge (resources) necessary to operate and improve the plant. Prusk (1997) argued that learning may occur in an unpredictable and sometimes haphazard way and is difficult to codify, leading to the deployment of manufacturing resources. Further, he also stated that learning is the only source of sustainable competitive advantage. Internal learning leads to an adaptable work organization, which can provide a competitive edge for the manufacturing firm (Gerwin & Kolodny, 1992). Adler and Clark (1991) and Pisano (1994) further discussed the importance of internal learning in manufacturing and its relationship with manufacturing performance.

A few studies have been concerned with different practices for learning through day-to-day manufacturing operations and/or experimentation at plant level (Garvin, 1993; Leonard-Barton, 1990, 1992, 1995). Practices can be purposefully created (e.g. through ‘implementation teams’) which allow individuals to learn during day-to-day work on ‘how’ and ‘why’ a technology is designed and operates in a given fashion (Leonard-Barton, 1990). Individuals might also be encouraged to engage in independent problem solving in daily operations (Leonard-Barton, 1992). Successful cases of experimentation on the basis of on-going improvement programs (e.g. diversification of new materials) are associated with continuous knowledge flow from outside the company (Garvin, 1993). This suggests that interaction between learning mechanisms does matter. This also implied that manufacturing companies should create a conducive climate and mechanism to encourage experimentation.

According to Garvin (1993), a variety of mechanisms may lead to the spread of knowledge throughout the organization (e.g. written, oral, and visual reports, rotation of personnel, education and training, standardization practices). Other practices, like shared experience, on-job training, ‘brainstorming camps’, and meetings may lead to knowledge-socialization (Nonaka & Takeuchi, 1995). ‘Internal knowledge integration’ encompasses collection of practices to facilitate the spread of knowledge across the company and the deepening of technological capabilities (Garvin, 1993; Leonard-Barton, 1992; Leonard-Barton et al., 1994; Leonard-Barton, 1995). In other studies a more specific treatment was given to knowledge integration such as problem-solving activities (Iansiti & Clark, 1994) or the integration of groups of individuals for product development (Clark & Fujimoto, 1991). Standardization of production practices and systematic documentation were specified as key practices for knowledge codification in Japanese companies (Nonaka & Takeuchi, 1995).

Bell and Pavitt (1993), gave great attention to the evolution of the intra-firm ‘routine’ and ‘innovative’ technological activities (e.g. process and production organization, product-centered, and equipment). The study also looked at the role of learning mechanisms built in each company to acquire knowledge for capability accumulation (e.g. external training). Although not explicitly, knowledge-conversion mechanisms (e.g. internal training) were also explored. In addition, the study has raised the importance of cumulative interaction between learning mechanisms for proprietary technology generation. In doing so, this study stimulated an interest to further explore this issue.

Extending this study, Ariffin and Bell (1996) focused on a sample of 53 electronics firms in Malaysia to examine whether any internationalization of proprietary technology has occurred in these firms. Drawing on a systematic analysis of rates of proprietary technology, the study found that 85% of the firms conducted at least intermediate innovative activities and took an average 11 years to do so, while two companies conducted advanced and research-based product and process innovations. The contributing factors include (i) time and the agglomeration of learning which reduced learning rates of later entrants, and (ii) the cumulating interaction of diffusion of knowledge and people flows from transnational corporations (TNCs) primarily through subsidiary-parent and supplier-customer links, and independent learning.

External learning

Plants that have close contact to their suppliers and customers will achieve an edge in development of new products and processes. A close customer relationship provides a source of tacit knowledge which is not easy to duplicate or copy by the competitors (Madhok & Tallman, 1998; Ward, Duray, Leong & Sum, 1995). External learning also occurs when a plant works closely with its suppliers to develop better linkages with them. Long-term relationships with suppliers can provide a unique capability for the plant (Gerwin, 1993), which establishes a source of competitive advantage.

Webster (1992) concluded that the survival of firms in highly competitive market conditions depends on how well they learn to build stronger relationships with customers. Similarly DeGeus (1988) suggested that, learning by employees could be the real source of competitive advantage where products and processes can be rapidly copied.

On the other hand, Cohen and Levinthal (1990) pointed out that incorporating outside knowledge into the firm is critical for innovative capabilities. Individuals can achieve this through different 'internal mechanisms'. Other studies have pointed out the relevance of practices for importing and absorbing technological knowledge from outside the company for capability building: through vendors, national laboratories, customers, consultants (e.g. Garvin, 1993; Leonard-Barton, 1990, 1995). Knowledge may also be acquired from suppliers, competitors or through forming a technological alliance with a firm that possesses the knowledge (Huber, 1996a, 1996b). 'Integrating external knowledge' has been viewed as one of the practice underlying the building of capabilities in the successful near-net-shape project in Chaparral Steel (Leonard-Barton, 1992).

Other external learning processes involve pulling in expertise from outside the company by inviting experts to give talks to personnel, hiring in experts, hiring back retired employees, nurturing 'technological gatekeepers' and individuals who can search, interpret and disseminate external knowledge across the company, or fighting the 'not-invented-here' practices (Garvin, 1993; Huber, 1996a, 1996b; Leonard-Barton, 1992b, 1995; Leonard & Sensiper, 1998). Individuals may be hired to bring in expertise in 'problem-solving' and also in 'problem-finding' (Leonard & Sensiper, 1998). Employees may be critical providers of knowledge for the firm through feedback and/or their involvement in development projects or their lead in new development projects (Iansiti & Clark, 1994; Leonard-Barton, 1995).

Proprietary technology

A firm's technological resources regulate its competitive success or failure (Cantwell, 1999). Strong technological resources lower unit costs, improves product quality, and raises profit margins of advantaged firms relative to others.

In order to sustain competitive advantage, the resources and capabilities should be difficult for competitors to imitate. The internal workings of a manufacturing plant are not readily observable, and, in many cases, manufacturing management uses extreme procedures to maintain the secrecy of operation. Custom-designed process equipment, worker experience, and the accumulation of incremental process improvements made over time can create a store of manufacturing capability that is difficult to imitate (Hayes & Wheelwright, 1984). For example, a competitor's engineer can disassemble a product to uncover the details about what it is and why it works, but they rarely know how it was produced and the degree of efficiency and effectiveness it was produced. This causal ambiguity makes imitation difficult (Barney, 1991; Rumelt, 1984)

Amit and Schoemaker (1993) recognize proprietary technology as a potential strategic asset. Proprietary technology is often the only aspect of manufacturing technology that is attributed to High Performance Manufacturing (Schroeder & Flynn, 2001). Proprietary equipment gives a plant the chance to produce more efficiently and to keep this advantage over a long period of time because it uses manufacturing equipment that is not available to the competitors. In addition, companies that develop proprietary equipment know more about it than even equipment suppliers (Hayes & Wheelwright, 1984; Schroeder & Flynn, 2001).

Dutrenit (2000) argued that learning processes of firm play a major role in influencing the firm's technological capability accumulation path and proprietary technology generation. Moving towards the same direction, Figueiredo (2001) focused on the relationship between paths of technological capability accumulation, the underlying learning processes, and operational performance improvement. The study found long running difference in the intensity of efforts to acquire knowledge from external and internal sources and to convert it into organizational assets. These differences in the management of learning processes were reflected in different paths of technological capability accumulation, different rate of improvement in operational performance. In other words, the study indicated that deliberate and effective efforts on learning processes do pay off.

Manufacturing Performance

Literature of the past strongly endorses the view that improved manufacturing performance will translate into higher profits, sales volume and market shares (Hayes, Wheelwright & Clark, 1988). The most common accepted dimensions of manufacturing performance are, cost, quality, delivery, and flexibility (Ferdow & De Meyer, 1990; Hayes & Wheelwright, 1984; Miller & Roth, 1994). Maani et al. (1994) used inventory, delivery, manufacturing cost and flexibility as manufacturing performance measures to relate it to business performance. Their findings indicated that manufacturing performance has a positive relationship with business performance i.e. return of sales, return of assets, sales volume growth and market share growth.

Delaney and Huselid (1996) also employed relative measures to measure organization performance by comparing organizations to its competitors. The dimensions used were quality of products, development of new products, ability to retain essential employees, ability to attract essential employees, customers satisfaction, management and employee relationship, relationship among employees, sales growth, profitability and market share.

In this study, competitive advantage will be assessed through manufacturing performance. Since manufacturing plant does not control measures such as sales or market outcomes, using financial measures may be inappropriate. Therefore, the basic measure of manufacturing plant performance will be used. More specifically, cost, quality, delivery, cycle time and flexibility will be used as measures of plant performance (Cua, McKone & Schroeder, 2001).

In this study, three important aspects of performance have been considered. First, competitive priorities and performance measures vary both within and across industries. Second, a plant cannot attain competitive advantage by concentrating on only one performance dimension. In other words, while a plant must excel on at least one dimension (cost, quality, delivery, cycle time or flexibility), other dimensions must at least exceed some minimum level in order for the plant to be competitive (Ferdows & De Meyer, 1990; Wheelwright & Bowen, 1996). Third, plants deliberately choose different manufacturing strategies and intentionally compete on different dimensions.

METHODOLOGY

Research Framework

Based on the review of related literature, the research model from Schroeder, Bates & Junttila (2002) was adapted as shown in Figure 1.

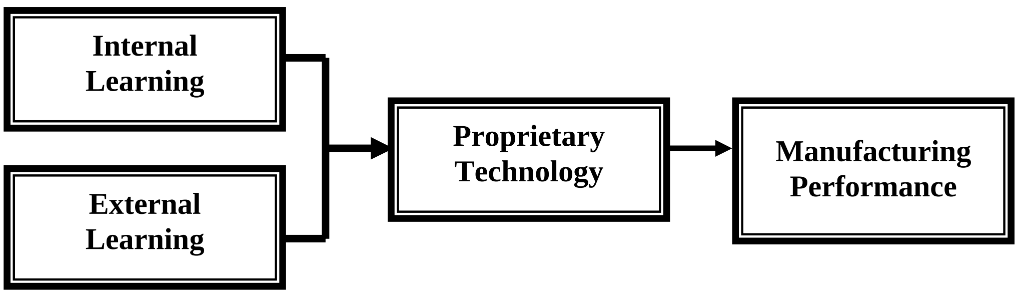

Figure 1: Research Model

Hypotheses

Conner (1991), Kogut and Zander (1996) argued that learning and knowledge generation within the plant is to generate proprietary technology. Meanwhile, St. John and Harrison (1999) stated that the capabilities inherent in learning should result in idiosyncratic manufacturing processes, i.e. proprietary technology. Therefore, the first two hypotheses were framed as:

H1: *There is a positive relationship between internal learning and proprietary technology development*

H2: *There is a positive relationship between external learning and proprietary technology development*

Hayes and Wheelwright (1984) have argued that the development of proprietary technology should lead to competitive advantage. Furthermore, Schroeder and Flynn (2001) stated that the proprietary technology is often the only aspect of manufacturing technology that can be attributed to High Performance Manufacturing. Thus, this leads to the third hypothesis:

H3: *There is a positive relationship between proprietary technology development and manufacturing performance*

Inkpen and Crossan (1995) stated that firms that learn more effectively would in the long run perform better than their competitors. Morgan, Katsikeas and Appuh-Adu (1998), Slater and

Narver (1995) concluded that organizational learning is clearly an attribute which is exhibited by organizations that exhibit excellence in the delivery of products and/or services to their customers. This leads to the last hypothesis:

H4: There is an indirect positive relationship between learning and manufacturing performance via proprietary technology

Population and sample

The population for this study comprises individual manufacturing companies in the Northern Region of Peninsular Malaysia, particularly Bayan Lepas Free Trade Zone, Seberang Prai Free Trade Zone, Kulim High Technology Park and Sungai Petani Industrial Estates. Questionnaires were mailed directly to some targeted manufacturing company address listing maintained by Federation Malaysian Manufacturers website in the Northern Region in Peninsular Malaysia. In addition, questionnaires were also sent through friends and electronic mail to be distributed in their respective companies.

Variables and measurement

For internal learning, external learning and proprietary technology, items were adopted from Schroeder, Bates and Junttila (2002), Zahra and Nielsen (2002), See (2002) and Gold et al. (2001). The respondents were asked to state their agreement/disagreement on a scale with 1=strongly disagree and 5=strongly agree. Whereas for manufacturing performance measure, items were adapted from Cua et al. (2001) and Schroeder, Bates and Junttila (2002). Respondents were asked to rate based on a scale ranging from (1) Poor or low end, (2) Below average, (3) Average or equal, (4) Better than average and (5) Superior, their overall performance against the industry over the past three years on each of these dimensions: (i) Cost efficiency (refers to unit cost of manufacturing), (ii) Quality (refers to quality of product conformance), (iii) Product conformance, (iv) Delivery Performance, (v) Cycle time and (vi) Flexibility.

RESULTS

Profile of respondents

A total of 250 questionnaires were mailed out based on a sampling frame provided by the Federation of Malaysian Manufacturers and of this 73 companies responded to the survey. Five returned questionnaires were rejected due to significant omissions. This gave an effective overall response rate of 27.2%. Of the total of 68 manufacturing firms, 27 firms or 39.7% are local owned, 30 firms or 44.1% are foreign companies and the remaining 16.2% are joint ventures. About 16.2% of the companies came from the small size manufacturing companies, 22.1% from medium, and the remaining 61.8% from large manufacturing companies. A total of 27 (39.7%) firms are in high technology manufacturing, 15 (22.1%) are in medium high technology manufacturing, 16 (23.5%) are in medium low technology manufacturing and 14.7% are in low technology manufacturing companies. Also 89.7% of the companies have been in operation for more than 5 years with 35 (51.5%) of the companies exporting more than 70% of their products, 5 (7.4%) exporting more than 50% but less than 70%, 11 (16.2%) exporting more than 50 but less than 30%, 6 (8.8%) export more than 30 to less than 10%, and 11 (16.2%) export less than 10% of their products.

Factor analysis

Three separate factor analyses with varimax rotation was done to validate whether the respondents perceived the independent, mediating and dependent variables were distinct constructs. We used the same criteria that was suggested by Igbaria et al. (1995) to identify and interpret factors which were: each item should load 0.50 or greater on one factor and 0.35 or lower on the other factor.

Factor analysis of organizational learning measure

The results for the factor analysis for this measure yielded a five factor solution with eigenvalues greater than 1.0 and the total variance explained was 63.12% of the total variance. KMO measure of sampling adequacy was 0.82 indicating sufficient intercorrelations while the Bartlett's Test of Sphericity was significant (Chi square=1236.72, p< 0.01). These factors were named as training, brainstorming, suggestion and problem solving, interaction and discussion (Internal Learning), business partnership, consultation (External Learning).

Table 1: Rotated factors and factor loading for organizational learning

Items	Factors				
In my company…	1	2	3	4	5
<u>Training</u> employees are cross trained so that they can fill in for others if necessary	.19	.15	<u>.67</u>	-.04	.25
employees receive training to perform multiple tasks	.16	.21	<u>.71</u>	.06	.06
employees received extensive training in modern manufacturing techniques	.18	.21	<u>.74</u>	.23	-.07
most problem solving groups are from a variety of functional areas	.14	.22	.45#	.37	.37
<u>Brainstorming, Suggestion and Problem Solving</u> employees are trained and coached in learning how to learn	.08	<u>.66*</u>	.47*	.00	.19
management takes all product and process improvement suggestions seriously	<u>.53*</u>	<u>.52*</u>	.45	-.04	.02
many useful suggestions are implemented	.20	<u>.72</u>	.34	-.01	.02
employees are encouraged to participate in problem solving	.29	<u>.69</u>	.29	.21	.14
employees learn through sharing of experiences	.20	<u>.66</u>	-.02	.26	.38
employees learn through brainstorming session	.07	<u>.62</u>	.24	.18	.30

employees are encouraged to ask others for assistance when needed	.31	<u>.65</u>	-.02	.28	-.10
employees learn through development of new products or projects	.46#	.32	.16	.07	.18
employees learn from failures as well as successes (e.g. mistake are tolerated)	.30	<u>.52*</u>	-.12	.37*	.26
learns by looking at what others do (e.g. benchmarking best practices, conferences and examining published research)	.33*	<u>.50*</u>	.29	-.06	.30*
<u>Interaction & Discussion</u> employees are encouraged to interact with other groups	.26	.06	.07	<u>.83</u>	.20
employees are encouraged to discuss their work with people in other workgroup	.26	.19	.14	<u>.83</u>	-.02
employees are encouraged to explore and experiment	.04	.49*	.06	<u>.52</u>*	.07
<u>Business Partnership</u> strives to establish long term relationships with suppliers	<u>.68</u>	.23	.04	.20	-.14
maintains close communications with suppliers about quality considerations and design changes	<u>.69</u>	.23	.07	.30	.01
actively shares information with our customers, to obtain their ideas and inputs in order to learn and improve products / services	<u>.62</u>	.25	.30	.28	-.05
works closely with our customers in the product design process	<u>.60</u>	.18	.18	.06	-.16
give customers and suppliers opportunity to participate in learning and training activities	<u>.69</u>	.00	.31	.17	.16
actively seeks learning partners outside the company	<u>.72</u>	.14	.20	.00	.26
has processes for acquiring knowledge about our customers	<u>.73</u>	.08	.08	.15	.31
has processes for acquiring knowledge about our suppliers	<u>.74</u>	.21	-.01	.23	.23
has processes for exchanging knowledge with our business partners	<u>.82</u>	.02	.21	-.02	.08
has processes for inter-organizational collaboration	<u>.62*</u>	.42*	-.02	.06	.35*

Consultation has close contact with universities and/or national laboratories	.33*	-.19	.47*	.00	.51*
has used outside consultants in our new product development activities	.15	.24	.16	.07	.68
has used outside consultants in our manufacturing operations	.01	.26	.05	.12	.79
Eigenvalue	11.29	2.55	2.08	1.62	1.39
Percentage of variance	37.62	8.51	6.95	5.41	4.64
Reliability	0.75	0.83	0.84	0.90	0.79
Mean	3.42	3.55	3.74	3.74	2.87
Standard Deviation	0.86	0.77	0.76	0.62	0.91

* items dropped due to cross loading

items dropped due to low factor loading

Factor analysis of proprietary technology measure

The results for this factor analysis yielded a two factor solution with eigenvalues greater than 1.0 and the total variance explained was 59.99% of the total variance. KMO measure of sampling adequacy was 0.788 indicating sufficient intercorrelations while the Bartlett's Test of Sphericity was significant (Chi square=244.44, $p < 0.01$). These factors were named as internal technology development and protection, and proprietary rights

Table 2: Rotated factors and factor loading for proprietary technology

Items	Factor	
	1	2
Internal Technology Development and Protection The technology we use is largely developed internally	.65	.27
The technology we have is uniquely our own	.77	.26
We keep our un-patented technology in secret	.71	.06
We custom-design our process equipment	.67	.20
We develop production (process) technologies internally	.74	.27
Proprietary rights The technology we use is protected by patent rights	.38	.89
We actively develop proprietary technology	.33	.70
We have equipment which is protected by the firm's patents	.48	.82
Proprietary equipment helps us gain a competitive advantage	.48*	.45*
Eigenvalue	4.27	1.13
Percentage of variance	47.39	12.60
Reliability	0.80	0.80
Mean	3.47	3.10
Standard Deviation	0.74	1.00

* item dropped due to low factor loading

Note: N=68; items are group for presentation purposes; the scale contained items in random order; underline loadings indicates the inclusion of that item in the factor.

Factor analysis of manufacturing performance measure

The results of the factor analysis for the dependent variable measure yielded a one factor solution with eigenvalue greater than 1.0 and the total variance explained was 59.15% of the total variance. KMO measure of sampling adequacy was 0.825 indicating sufficient intercorrelations while the Bartlett's Test of Sphericity was significant (Chi square=111.26, p< 0.01). The reliability coefficient was 0.82 indicating that the measure was reliable.

Hypotheses Testing

Effect of organizational learning on internal technology development and protection

From the hierarchical multiple regression analyses (see Table 3), the control variable only explained 0% of the variation in internal technology development and protection whereas the combination of control variable and independent variables explained 24% of the variation in the internal technology development and protection. The R^2 change of 0.24 at p<0.01 indicates that organizational learning explained additional 24% of the variation in internal technology development and protection. Internal learning through brainstorming, suggestion and problem solving (β=0.58, p<0.01) was found to be positively and significantly related to the internal technology development and protection. This provides partial support for H1. It was also found that external learning through business partnership linkages (β=-0.28, p<0.1) was negatively related to the internal technology development and protection, which contradicts with H2.

Table 3: Effect of organizational learning on internal technology development and protection

	Internal technology development and protection		Proprietary rights	
Variables	**Step 1**	**Step 2**	**Step 1**	**Step 2**
Dummy size 1 (Medium)	-0.02	-0.16	0.12	-0.10
Dummy size 2 (Large)	-0.07	-0.14	0.20	0.21
Brainstorming, Suggestion & Problem Solving		0.58***		0.20
Training		0.10		0.44***
Interaction & Discussion		0.00		0.18
Business Partnership		-0.28*		0.07
Consultation		-0.14		0.04
F-Value	0.14	2.70**	0.67	6.73***
R^2	0.00	0.24	0.02	0.45
Adjusted R^2	-0.03	0.15	-0.01	0.38
Change in R^2	0.00	0.24	0.02	0.43
F Change (Change in R^2)	0.14	3.71***	0.67	8.99***

*p <0.10, **p<0.05, ***p<0.01

Also from Table 3, the control variable explained 2% of the variation in proprietary rights whereas the combination of control variable and independent variables explained 45% of the variation in proprietary rights. The R^2 change of 0.43 at p<0.01 indicates that organizational learning explained an additional 43% of the variation in proprietary rights. Internal learning through training (β=0.44, p<0.01) was found to be positively and significantly related to proprietary rights. Thus, H1 is partially supported whereas H2 is not supported.

The relationship between proprietary technology and manufacturing performance

Another hierarchical multiple regression analysis was done to test the relationship between proprietary technology and manufacturing performance, the control variable explained 2% of the variation in manufacturing performance whereas the combination of control variable and mediating variables explained 18% of the variation in manufacturing performance. The R^2 change of 0.16 at p<0.01 indicates that proprietary technology explained an additional 16% of the variation in manufacturing performance. Only the proprietary rights dimension (β=0.35, p<0.01) was found to be positively and significantly related to manufacturing performance. Thus, this result gives partial support for H3.

Table 4: Effect of proprietary technology on manufacturing performance

Variables	**Step 1**	**Step 2**
Dummy size 1 (Medium)	0.20	0.17
Dummy size 2 (Large)	0.18	0.14
Internal technology development and protection		0.06
Proprietary rights		0.35**
F-Value	0.74	3.25**
R^2	0.02	0.18
Adjusted R^2	-0.01	0.12
Change in R^2	0.02	0.16
F Change (Change in R^2)	0.74	5.65***

*p <0.10, **p<0.05, ***p<0.01

Testing the mediating effect of proprietary technology

In order to find the mediating effect of proprietary technology on the internal learning, external learning and performance relationship the procedure suggested by Baron and Kenny (1986) was used.

The beta coefficient when internal training is regressed with performance is (β=0.47, p<0.01) whereas when the mediator proprietary rights is added into the regression, the beta value decreases to (β=0.44, p<0.01) but is still significant thus suggesting a partial mediator effect. Therefore, there is a partial mediating effect between internal learning through training on manufacturing performance via proprietary rights. Therefore, H4 is also partially supported.

DISCUSSION AND CONCLUSION

Organizational learning and proprietary technology development

The results suggest that strong internal learning especially through brainstorming, suggestion, problem solving and training will lead to more proprietary technology development in manufacturing firms. The results support the theoretical framework of Resource Based View (RBV) as well as support the previous research conducted to explain the relationship of organizational learning and proprietary technology development (Schroeder, Bates & Junttila, 2002; St. John & Harrison, 1999). This finding can be explained since informal learning such as brainstorming, problem solving, suggestion and formal learning like training are the most common activities practiced by most of the manufacturing firms in Malaysia. The collaboration between individuals is the basis for socialization of knowledge. Collaboration between individual also brings together different cognitive styles, backgrounds and experiences which help to create knowledge and this knowledge would eventually lead to internal proprietary technology development.

However, internal learning through more interactions and discussions do not exhibit a significant relationship with proprietary technology development. The level of complexity of the manufacturing processes and equipment can perhaps explain the non-significant results as observed. Interaction and discussion should be combined with processes such as problem solving and brainstorming then only would it lead to proprietary technology development.

The study also found that external learning through business partnership linkage was negatively related to internal technology development and protection but was not significantly related to proprietary rights. This finding contradicts the previous study done by Schroeder, Bates and Junttila (2002). However, this result is similar to the study of Zahra and Nielsen (2001), where they found manufacturing capabilities that assemble from external sources are negatively associated with the technology commercialization and number of patents. This indicates that firms might suffer a loss proprietary knowledge because of reliance on external sources. In other words, the high participation of suppliers and customers in process and equipment development; eventually will cause the company to lose proprietary technology development. Thus, external learning through business partnership linkage adversely influences the development of internal technology and protection.

Another possible explanation to this observation would be the differences in culture between the West and the Malaysian workforce. In Malaysia, sharing technical know how with business partners just does not prevail. Being conservative in the relationship, the Malaysian technical staff is likely to hesitate in the socialization process with their business partners, this would adversely influence the development of tacit and firm specific knowledge necessary for internal technology generation. Furthermore, according to Zahra and George (2002) tacit knowledge is not easily transferred in the formal market transactions and substantial effort is needed to assimilate this knowledge. The success of external learning is highly based on trust and shared experiences and goals. The external business partners may not fully understand or share the firm's goals, which would further complicate the integration of knowledge in manufacturing firms, thus, reduce the level of proprietary technology development.

In addition, this study also found that external learning through consultation has no significant influence on proprietary technology development. This can be explained because companies that rely on their consultants for process or technological development will eventually lead to less creativity and innovation within the manufacturing firms. Moreover, in the Malaysian context, consultants are generally afraid to share their tacit knowledge with their clients; this eventually reduces the level of proprietary technology development.

Proprietary technology development and manufacturing performance

This study also found that proprietary right is positively related to manufacturing performance. This finding is consistent with the previous research done by Schroeder, Bates and Junttila (2002). However, the internal technology development and protection do not exhibit a significant relationship with manufacturing performance. In other words, the technology that is developed internally will not lead to higher manufacturing performance even though the technology is kept in secret within the company. Technological capabilities that are not protected by patents are vulnerable to imitation and replication by competitors and thus weaken a firm's ability to capture competitive advantage generated by these capabilities (Teece, 1987). The high mobility of skilled workers, especially in a country like Malaysia explains the loss of proprietary rights on the internally developed technology. Therefore, it is concluded that the un-patented technology, which is developed internally, might not be valuable and could be easily imitated by competitors and therefore, the technology has to be transformed into proprietary rights, then only will it lead to higher manufacturing performance. In short, for a firm to generate and preserve competitive advantage, it is vital that its technology be protected.

Proprietary technology as mediator between organizational learning and manufacturing performance

This study further suggests that only one dimension of internal learning i.e. through training has a positive indirect effect on manufacturing performance via proprietary rights. This implies that training is linked to the development of deployable resources, specifically proprietary technology and in turn leads to higher manufacturing performance. This observation is consistent with that of Gerwin and Kolodny (1992), Schroeder, Bates and Junttila (2002) where internal learning leads to an adaptable work organization and proprietary technology development, which can provide a competitive edge for manufacturing firms.

However, external learning does not exhibit positive indirect effect on manufacturing performance via proprietary technology development. A possible may be that business partners are often very reluctant to put their reputation, capital, or other resources at risk. The situation described as “embedded” ties with business partners refers to “ties that are reinforced by mutual feelings of attachment, reciprocity and trust” (Uzzi, 1996), was not observed in the Malaysian manufacturing context. Thus, due to the lack of trust and mutual attachment in the business relationship, business partners do not commit substantial support in the technological development with manufacturing firms; this would reduce the level of proprietary technology development and in turn affect the manufacturing performance.

Implication

The results of this study provided both theoretical and practical implications. First, this study provides a better understanding of the relationship among manufacturing capabilities and resources, while exploring their influence on firm’s competitive advantage and performance. This study is one of the few to empirically demonstrate how the combination of organizational learning and proprietary technology leads to higher manufacturing performance. The findings from the empirical analyses reveal the importance of internal learning especially through training as well as proprietary rights to manufacturing performance in Malaysia. These findings also supports the framework derived from resource-based view.

Second, this study also highlights that the importance of learning and proprietary rights towards manufacturing performance. It is hoped that the results of this study provides some useful information for Malaysian manufacturing managers in their strategy formulation. Management needs to recognize the importance of internal learning and proprietary technology as the manufacturing capabilities and resources, which lead to higher level of manufacturing performance. Through learning, employees will be equipped with the necessary skills, abilities and knowledge so that they will be able to contribute to proprietary technology development and achieve higher manufacturing performance. On the other hand, the findings also indicate that external learning is negatively related to internal technology development and protection. Therefore, management needs to be aware that excessive use of external sources of learning might cause the companies to lose opportunities to develop the proprietary technology. Thus, management should carefully identify the critical resources and capabilities that should be developed internally.

Limitations of the study

This study has a few limitations. Firstly, proprietary technology is a relatively new issue, thus, managers in Malaysia, especially in the Northern region may have limited exposure in understanding about proprietary technology. Secondly, the study was conducted using subjective measures of manufacturing performance, which is debatable. Therefore, the results of this study are exposed to some degree of biases and should be interpreted carefully. Thirdly, the scope of organizational learning covers internal learning and external learning and its fit on proprietary technology may be too narrow. Other elements like culture, industry process choices and environmental factors, which could exert impact and interaction on the other factors, are not examined. A wider scope of the study is suggested which could cover these other elements. There might also be moderators like country of ownership of the manufacturing firm that may have an effect on the proprietary technology development. Furthermore, the study did not probe a company's motivation for their involvement in the proprietary technology development. Lastly, even though the sample represents the target population, it does not cover all Malaysian manufacturing industries and the results may not apply to all sectors of the economy.

Suggestion for future research

The unit of analysis in this study was the manufacturing plant as represented by individuals in the plant. A more structured study would involve multiple respondents per manufacturing plant where it can increase the robustness of the parameter estimates. Future research can also identify the country of ownership, culture, industry process choices and environmental factors that influence the proprietary technology development. This study can be explained to cover a larger sampling population from different states in Malaysia. Manufacturing firms from different parts of Malaysia represent a better picture of the overall manufacturing industry.

CONCLUSION

The primary purpose of this study was to explore the relationship between organizational learning, proprietary and manufacturing performance, using the resource based view as its underlying premise. This means we posit that resources that are unique, as represented by a firms' proprietary technology, contribute to performance in the form of competitive priorities of cost, quality, delivery and flexibility. The results therefore supports the resource based view in current business climate, where competitive advantage (i.e. cost, quality, delivery, flexibility) are derived from developing resources/capabilities that are unique, inimitable and rare - the very characteristics of proprietary technology. Further this study shows that the development of proprietary technology is more dependent on internal learning (which are unique to each firm) lending further support for RBV of the firm.

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