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Sectoral Innovation Systems in Low-tech Manufacturing: Types, Sources, Drivers and Barriers of Innovation in Malaysia's Wooden Furniture Industry

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Abstract: Drawing upon the framework of Sectoral Innovation Systems, this study explores the patterns of technological innovation among small and medium-sized wooden furniture manufacturers in Malaysia from two perspectives *viz*., sources of knowledge and technology and capability of forming linkages. The empirical evidence for the study was derived from 70 survey respondents. The wooden furniture industry in Malaysia warrants an in-depth analysis as it is among the very few full-fledged home-grown industry that has successfully penetrated the global market. The study reveals that the majority of the innovative enterprises are mainly young home grown SMEs. They are centred on business-driven activities. Clients, customers and suppliers are the key partners for co-operation in innovation, as well as sources of technology and knowledge.

Keywords: innovation measurement, multidisciplinary, SME, technological capabilities

JEL classifications: L69, O30, O32, Q23

1. Introduction

Technological innovation, whether product or process oriented, is the prime driver for a firm's competitiveness (OECD, 1997; Dodgson, 2000; Carlsson, 1997; Thamhain, 1996). Firms are able to leverage on technological innovation in order to achieve high performance, incorporate new features and achieve lower costs that will add the largest value to their products and eventually compete more effectively in the market (Freeman, 1982). In developing this perspective, Ettlie (2000) asserted that addressing the issue of technological change in the workplace is critical because of three primary

reasons: 1) technology-driven change is everywhere and always present; 2) competitors use technology as part of their strategies for success; and 3) value-capture from new technology is challenging and never guaranteed.

Complexity and inter-disciplinarity are the key characteristics that underpin the discourse surrounding technological innovation (Mowery, 1995; Janszen, 2000; Betz, 2003). Technology in this context can be embodied in people, materials, cognitive and physical processes, plants, equipment and tools (Hall, 1994). As the process of technological innovation does not consist of a single or isolated event, Dodgson (2000) strongly contends that its management has to encompass both specific and general areas. Management of research and development (R&D), new product development, operation and production, the commercialization process, technological collaboration and technological strategy are examples of specific area management, while the management of complexity, risks, knowledge, creativity and learning are examples of general area management. A similar argument can be observed in studies by Kline and Rosenberg (1986), Patterson (1996), Janszen (2000) and Chiesa (2007). All the features of technological innovation as mentioned above are fully addressed in the framework of innovation systems. Innovation systems are systemic views of the innovation process that explicitly recognise the potentially complex interdependencies and possibilities for multiple kinds of interactions between the various elements of the innovation process (Edquist and Hommen, 1999).

Although the literature on innovation systems is extensive, the concept is by and large defined at different levels for different purposes of analysis. Among them, the sectoral innovation systems (SIS) level is one of the most influential. SIS is rooted on the hypothesis that innovation differs greatly across sectors in terms of characteristics, sources, the actors involved, the boundaries of the process, and the organization of innovative activities (Lall, 1992; Malerba, 2002, 2004; Rasiah, 2009). Firms, together with other heterogeneous actors, are linked together by market and non-market relationships. All of these actors, characterized by their specific beliefs, expectations, goals, competences and organization, are the key players that are continuously engaged in the process of the generation, adoption and use of new technologies and knowledge (Nelson and Winter, 1982).

The innovation systems approach has led to a more integrated approach to the delivery of innovation-related policies (OECD, 1997). Along the same lines, as technological innovation and the development of capabilities are highly idiosyncratic at the sectoral level, there is a strong need to study sectoral-level innovation in order to provide policymakers with knowledge regarding the current needs and challenges of a particular sector. Drawing upon these viewpoints, and by employing the SIS approach, this study has been designed to empirically explore the significant patterns and processes of

technological innovation at the sectoral level. Different sectors have different needs and requirements, and their patterns and processes of innovation might also be different. In this regard, STI-related policies should not be made on the basis of a "one-size-fits-all" approach which views all sectors as one homogenous entity.

The empirical data and observations for this study were taken from the wooden furniture industry in Malaysia. As the furniture industry has been categorized as low-tech, one of the striking facts about the industry in Malaysia is its relatively low entry barriers compared to medium or high-tech industries, such as pharmaceuticals, electronics and electrical, machinery and equipment and so on. The low entry barrier is deemed to be beneficial to the local industry players, as participation in the industry is not limited to a particular or exclusive group of players. In fact, the whole value chain of the wooden furniture industry in Malaysia is made up of local enterprises. It is among the very few industries in the country that is able to transform the raw materials into the final product, and subsequently to penetrate the global market. In spite of the obvious importance of this industry, its nature in terms of technological innovation has not yet been fully addressed in existing works.

This study aims to address this deficiency as mentioned above, by exploring the patterns of technological innovation in the small and medium-sized wooden furniture manufacturers in Malaysia. The paper is structured as follows. Section two presents an overview of the nature of the wooden furniture industry, which is followed by the conceptual framework of the study. The method used in the study is described in the fourth section. The fifth section deals with the empirical analysis of the data, which is followed by a discussion on the key findings of the study and ends with conclusion.

2. Technological Innovation in the Wooden Furniture Industry: An International and Malaysian Perspective

This section presents a brief background of the furniture industry from a global and Malaysian perspective. One of the striking facts about the furniture industry, a low-tech industry is its relatively low entry barriers compared to medium or high-tech industries, such as pharmaceuticals, electronics and electrical and machinery and equipment. The low entry barrier is deemed to be beneficial to the local industry players, as participation in the industry is not limited to a particular or exclusive group of players.

2.1 Global Trades and the Market Structure

Furniture production is a huge global business that has grown rapidly in recent decades. A sectoral study on the global wooden furniture sector by

Kaplinsky *et al*. (2003) has demonstrated that between the years 1995 and 2000, the trade in furniture worldwide grew by 36 per cent, which was faster than the merchandize trade as a whole (26.5 per cent), apparel (32 per cent) and footwear (1 per cent). This study further showed that by the year 2000, the furniture industry was the largest low-tech sector, exceeding apparel and footwear. Han *et al*. (2009) believe that this surge in the global furniture trade was largely due to innovations in packing and shipping, such as ready-to-assemble and knock-down furniture products, as well as the breaking down of world trade barriers.

The Centre for Industrial Studies (CSIL)[1] (2009) indicates that worldwide, furniture production was worth about USD350 billion in 2008. Of this, 61 per cent was produced by developed countries, while the remaining 39 per cent was produced by emerging countries. The major furniture producers from the developed countries are the United States, Italy, Germany, Japan, Canada, the United Kingdom and France, whilst China, Poland and Vietnam are the main producers from the emerging countries. It is important to note that although furniture production is a resource and labour intensive industry, the major furniture producers are the industrially advanced economies. In fact, a similar observation was made in an earlier study by Kaplinsky *et al*. (2002: 1160-1161) on the top 15 net exporting countries in the years 1994-98:

> …of the 15 major exporters, only six (Brazil, China, Indonesia, Mexico, Malaysia and Thailand) are in the developing world. Given that emerging and developing countries tend to be small importers of furniture, their participation in the group of the largest net exporters is much more significant, with only five industrially advanced countries registering amongst the top 15 countries. Italy remains by far and away the largest net exporter (with a growing surplus during 1994-98), with Canada, Denmark, Spain and Sweden filling the 3rd, 5th, 8th and 11th positions respectively.

2.2 Technological Innovation and Design Economics

Ratnasingam (2004) views the value of furniture as a matter of perception, as it is sold based on a perceived value, rather than on an actual value. This suggests that the creation of value-added furniture is not about using high quality materials or state-of-the-art technologies, but rather it is about expressing a lifestyle in a creative and innovative manner. The artistic part of the piece of furniture drives its value, while the scientific part assists in the consistent production of the piece. Indeed, a similar view of the value of furniture has been advanced by Ettema (1981), who argued that furniture is an important means of self-presentation, and that it is particularly sensitive to ostentation. He asserts that technology has directly caused elaborate and

degraded styles to appear within the furniture industry. In general, machines have allowed furniture production to increase, but they have also failed to democratize style, because machines cannot produce inexpensive copies of an expensive-looking ornament. Proliferation, not elaboration, was the legacy of technological innovation in the nineteenth-century furniture industry.

This is why Ratnasingam (2004) proposed that value-addition in the furniture business is simply about creating a perception of reliability, dependability and value for money among the customers. Hence, the highest value-addition is achieved in the design and marketing stages of the business, rather than the manufacturing stage. Furniture enterprises involved in product design and retailing activities are indeed very profitable. Unfortunately, product design and marketing are not the strong points of the furniture industry. A similar view has been highlighted by Kaplinsky *et al*. (2002), in which design is seen as one of the drivers behind the "functional upgrading" of the furniture industry.

2.3 Malaysian Wooden Furniture Industry

In 2008, wooden furniture accounted for about 79.4 per cent of Malaysia's furniture exports to overseas markets (MFPC, 2009). The major types of furniture which are exported are kitchen furniture, bedroom sets, upholstered furniture and wooden office furniture (MITI, 2006). The furniture which is intended for export is often made in ready-to-assemble or knock-down form (MTC, 1998). In 2008, Malaysia's furniture export reached RM8.72 billion, despite the weakening external demand in the latter part of the year. This makes Malaysia the tenth largest exporter in the world, the third largest in Asia and the second largest in the ASEAN region. Currently, Malaysian furniture is exported to more than 160 countries worldwide. The top five destinations in 2008 were the USA, Japan, the UK, Australia and the UAE (MFPC, 2009). About 80 per cent of the furniture exports are manufactured from Malaysian rubberwood. Wooden furniture is the main contributor to the total export earnings, as it contributed 30.3 per cent of the total export value of the timber industry in 2008 (MPIC, 2009).

As there are no centrally monitored statistics, the precise number of establishments in the industry is difficult to ascertain, let alone the number of innovative enterprises. One of the more reliable references is the *Census of Establishments and Enterprises 2005* by the Department of Statistics (DOS). The census (DOS, 2007) estimates that there are a total of 2,361 SMEs[2] in the Malaysian furniture industry, of which 51.8 per cent are micro-size, 43.6 per cent are small-size, and the remaining 4.7 per cent are medium-size. As with SMEs in other manufacturing sectors, SMEs subcontracting is a bridgehead to competitiveness in the Malaysian furniture industry. Many of

the SMEs do not manufacture complete products. Instead, they specialize in making certain components or performing certain processes (Ratnasingam and Thomas, 2008; MTQ, 1999).

Ratnasingam and Thomas (2008) argue that the level of technology employed by the Malaysian furniture industry is on par with other countries which manufacture furniture, if not higher. The MTC (1998) has stated that most of the country's furniture manufacturers have invested considerably in machinery and equipment. Such investments may not be impressive by the standard of other high-tech industries such as the electronics sector, but the amount invested nevertheless indicates that the industry has moved beyond the traditional wood working mills and carpentry shops.

Meanwhile, Ratnasingam (2000) asserts that the machine-operated process is the most important value-addition operation in furniture production, as it converts the raw materials into a profiled component that is eventually assembled into the finished product. The effectiveness of the gluing and finishing operations is also dependent upon the quality of the machining process. Furthermore, the machining processes also influence the structural rigidity of the furniture, as poorly machined components cannot be joined and fastened tightly. It is for this reason that machining processes, especially through the use of automated machinery, have attracted a great deal of research interest. However, most of the machinery purchased is special function machinery which is aimed at reducing the labour content in the manufacturing outfit, with the ultimate aim of reducing the manufacturing cost or unit cost. This is to be expected, as the industry is labour intensive in nature, and there is an increasing reliance on foreign-contract workers within the industry (Ratnasingam, 2005).

3. Conceptual Framework

The concept of technological innovation has been defined by scholars in many different ways, and each has its nuance. This section describes the concept of technological innovation used in this study, which is drawn extensively from the SIS framework.

3.1 Types of Technological Innovation Activities and their Definitions

Technological innovation activities are generally categorized into two types – technological product innovation and technological process innovation.[3] The *Oslo Manual*, which is the guideline for collecting and interpreting innovation data established by the OECD, cites Technological Product and Process (TPP) innovation activities as:

> … all those scientific, technological, organizational financial and commercial steps, including investment in new knowledge, which actually, or are intended to, lead to the implementation of technologically new or improved products or processes (OECD, 1997: 10).

The term "product" in this sense is used to cover both goods and services. As such, a technological product innovation is the implementation or commercialization of a product with improved performance characteristics designed to deliver objectively new or improved services to the consumer. A technological process innovation is the implementation or adoption of new or significantly improved production or delivery method. It may involve changes to equipment, human resources, working methods or a combination of these (OCED, 1997).[4]

Obtaining a consensus on the necessary degree of novelty is always an issue in technological innovation research, especially for those empirical studies which engage with primary data collection. This is because different people with different backgrounds and interests may form different interpretations of the concept of "new or improved" in technological innovation activities. In order to overcome this problem, the Oslo Manual (OECD, 1997, 2005) proposes that the minimum entry requirement for all technological innovations is that the product or process should be new or significantly improved to the firm, but it does not have to be new to the world. Hence, for the purposes of empirical data collection, a technologically innovative firm is one which has implemented new or significantly improved technological products or processes during the period under review.

3.2 Sectoral Innovation Systems and their Building Blocks

The SIS approach, which is grounded in the innovation systems tradition, is based on the theoretical viewpoint that changes in innovation and technology take place at different rates, types and trajectories depending on the sector in which they occur. The notion of SIS complements other concepts within the innovation systems literature (Edquist, 1997). For Malerba (2005), a sector is a set of activities that are unified by some linked product groups for a given or emerging demand and which share some common knowledge. Firms in a sector have some commonalities and are, at the same time, heterogeneous.

Multidimensional, integrated and dynamic views are the main concepts of SIS. For Malerba (2005), understanding the key sectors which drive an economy with their specificities greatly helps in understanding national growth and national patterns of innovative activities. He makes this point succinctly:

> A rich and heterogeneous tradition of sectoral studies has clearly shown both that sectors differ in terms of the knowledge base, the actors involved in innovation,

> the links and relationships among actors, and the relevant institutions, and that these dimensions clearly matter for understanding and explaining innovation and its differences across sectors (Malerba, 2005: 381).
>
> and
>
> Heterogenous firms facing similar production activities, searching around similar knowledge bases, undertaking similar production activities, and 'embedded' in the same institutional setting, share common behavioural and organizational traits and develop a similar range of learning patterns, behaviour, and organization forms (Malerba, 2005: 387).

A sectoral systems framework focuses on three main dimensions (or building blocks) of sectors, namely: (a) knowledge, technological domain and sectoral boundaries; (b) actors, relationships and networks, and (c) institutions. Provided below are the detailed descriptions of these three building blocks, as advanced by Malerba (2005).

a) *Knowledge, technological domain and sectoral boundaries* – Like other innovation systems approaches, the SIS approach places knowledge at the centre of analysis. Knowledge plays a central role in innovation and is highly idiosyncratic at the firm level. Knowledge does not diffuse automatically and freely among firms, and has to be absorbed by firms through their differential abilities which are accumulated over time. Knowledge differs across sectors in terms of domain and may have different degrees of accessibility. In addition, the sources of technological opportunities differ markedly across sectors. Both knowledge and technologies are eventually affected by the boundaries of sectoral systems. As the accumulation of knowledge and technologies occurs within social systems, the boundaries of sectoral systems are not static.
b) *Actors, relationships and networks* – A sector is composed of heterogeneous agents, comprising organizations or individuals (e.g. consumers, entrepreneurs, scientists). Organizations may be firms (e.g. users, producers, input suppliers) or non-firms (e.g. universities, financial institutions, government agencies, trade-unions or technical associations), and may include subunits of larger organizations (e.g. R&D or production departments) and groups of associations (e.g. industry associations). Agents are characterized by specific learning processes, competencies, beliefs, objectives, organizational structures and behaviours, which interact through processes of communication, exchange, cooperation, competition, and command. Within sectoral systems, heterogeneous agents are connected in various ways through market and non-market relationships.
c) *Institutions* – Agents' cognition, actions and interactions are shaped by institutions, which include their norms, routines, habits, established practices, rules, laws, standards, and so on. Institutions may range from

ones that bind or impose enforcements on agents to ones that are created by interaction among agents (such as contracts). Institutions therefore progress from more binding to less binding, from formal to informal (such as patent laws or specific regulations vs. traditions and conventions). Many institutions are national (such as the patent system), while others are specific to a particular sector (such as sectoral labour markets or sector-specific financial institutions).

4. Data Collection

This cross-sectional research attempts to explore the trends of technological innovation activities among the technologically innovative SMEs in Malaysia's wooden furniture manufacturing sector during the period 2006-2008. Technologically innovative SMEs served as the statistical units.

The questionnaire was divided into two parts and consisted of 18 questions. The sample questionnaire used in the UK Innovation Survey and the Malaysian Innovation Survey were referred to and harmonized in the process of designing it. The first part, which consisted of six open-ended questions elicits demographic information from the respondents. The second part examined the technologically innovative activities of the enterprise from the perspective of the involvement of product and/or process innovation, methods to protect innovation, the sources of innovation expenditures, partners for innovation co-operation, innovation objectives, the sources of knowledge and technology, and factors hampering innovation. The measurement scale that was employed for the second part was non-parametric, namely nominal and ordinal scale. A four point Likert scale was used to elicit the firms' technological innovation trends. Table 1 summarizes the variables used in the questionnaire and their roles in capturing elements of SIS among the respondents.

5. Research Findings

This section presents the main findings of the survey, which are organized in the following sequence *viz*. profile of innovators; types of technological innovation activities; innovation co-operation; sources of innovation; drivers of innovation; barriers to innovation; protection of intellectual property.

5.1 Profile of Innovators

Responses were received from 97 wooden furniture manufacturers from a total of 300 firms contacted through the questionnaire survey, giving a respectable response rate of 32.3 per cent. Of these, 70 firms were active in

Table 1: Measurement of SIS Elements

SIS elements	Indicators for measurement	
	What to measure?	Variables
Knowledge and technology generation and development	Components and coverage of innovation activities	Type of innovation activities and expenditure breakdown (e.g. R&D; acquisition of other external knowledge; acquisition of machinery, equipment and other capital goods; other preparations for product and process innovation; market preparations and training)
	Main developer of innovation	Mainly by the enterprise itself, in co-operation with other enterprises or institutions, or mainly by other enterprises
Linkages and networks	Sources for the transfer of knowledge and technology	Internal (e.g. R&D, production); external (e.g. competitors, clients, consultants); public sector (e.g. universities, government); general information (e.g. patent disclosures, exhibitions, trade unions)
	Source of funds	Own funds; related companies (e.g. subsidiaries or associated companies); other non-financial enterprises; financial companies (e.g. bank loans, venture capital); government (e.g. loans, grants); international organisations; other sources
Institutions and routines	Objectives, obstacles and outcomes of innovation	Competition, demand and markets (e.g. replace products which are being phased out, increase range of goods and services, develop environmentally-friendly products, enter new markets, etc); product and delivery (e.g. improve quality of goods and services, improve flexibility of production or service provision, reduce unit labour costs, reduce consumption of materials and energy, reduce product design costs, etc.)
	Factors hampering innovation activities	Cost factors (e.g. excessive perceived risks, cost too high, lack of funds, etc.); knowledge factors (e.g. lack of qualified personnel, lack of information on technology, etc.); market factors (e.g. uncertain demand for innovative goods or service, etc.); and institutional factors (e.g. lack of infrastructure, weakness of property rights, legislation, regulations, taxation, etc.)
	Methods to protect innovation	Patents, registration of design, trademarks, copyrights, confidentiality agreement and trade secrecy

Source: Adapted from OECD (1997, 2005).

terms of technological innovation during the period 2006-2008, and can be categorized as SMEs. Tables 2 and 3 provide the profiles of the innovators and their sizes respectively.

5.2 Types of Technological Innovation Activities

Table 4 provides an overview of the characteristics of the technological innovation activities carried out by the respondents during the survey period of 2006-2008 in terms of their: (a) involvement in technological innovation; (b) innovation development; (c) innovation status; and (d) innovation activities.

Table 2: Profile of Innovators

Variables	n	Minimum	Maximum	Mean	Std. deviation
Year of establishment	66	1	42	15.94	10.510
% of local ownership	67	0	100	87.69	27.652
Turnover in 2008 (RM million)	44	.20	42.00	12.6432	12.43010
% turnover derived from export	55	0	100	66.51	32.069
No. of full-time employees	69	3	150	66.26	49.848
% of employees educated to degree level in science and engineering	58	0	50	11.46	15.663
Valid N (list-wise)	32				

Note: Value of n varies due to missing respondents.
Source: Authors' survey (2010).

Table 3: Size of Innovators

Variable	Size of innovators	%
Size according to annual sales turnover	– micro (less than RM0.25 million)	2.8
	– small (between RM0.25 million and <RM10 million)	61.1
	– medium (between RM10 million and RM25 million)	36.1
Size according to number of full-time employees	– micro (less than 5)	2.9
	– small (between 5 and 50)	49.3
	– medium (between 51 and 150)	47.8

Source: Authors' survey (2010).

a) Types of technological innovation: about two-thirds of the innovators (68.6 per cent) were active in both product and process innovation. The number of innovators active in only product innovation (22.9 per cent) or only process innovation (8.6 per cent) was relatively small compared to those who were active in both product and process innovation. On the whole, it was found that there were more enterprises engaged in product (91.4 per cent) rather than process innovation (77.1 per cent).
b) Innovation development: it was found that 89.1 per cent of the product innovators and 81.5 per cent of the process innovators indicated that they themselves were the main developer of innovation.
c) Status of the innovation project: of the innovating enterprises, 31.4 per cent indicated that they had an on-going project which was not yet complete but was running on time. This is a good sign. Moreover, not many of them were facing serious problems during the reference period. For instance, only 17.1 per cent of the enterprises had projects which were not yet completed and were seriously delayed, or projects which had not even started. In addition, only 11.4 per cent of them had abandoned projects.
d) Types of innovation activities: the highest percentage (81.4 per cent) of innovating enterprises carried out in-house R&D activities. Of these, 82.5 per cent indicated that the in-house R&D activities were carried out continuously, and 17.5 per cent indicated that the activities were conducted occasionally. Marketing preparation (such as market research and launch advertising for new or significantly improved products and training for personnel directly related to innovation activities) were the two other main activities among the innovators, which accounted for 61.4 per cent and 51.4 per cent of the enterprises' involvement respectively. Other common activities were design functions which include industrial, product, process and service design and specification for production or delivery (47.1 per cent), and the acquisition of machinery, equipment and software in connection with product and process innovation (44.3 per cent). In contrast, very little effort was made to acquire external R&D (10.0 per cent), or to purchase or license patents and non-patented innovations or other types of external knowledge from other companies or organizations (12.9 per cent).

5.3 Innovation Co-operation

The partners for co-operation can generally be divided into three categories: internal, external market and commercial, and the public sector. The findings show that the innovators considered clients or customers to be the most important in generating knowledge and technology for their innovation.

Table 4: Characteristics of Technological Innovation Activities among Innovators

	Frequency	Valid per cent
a) Involvement in technological innovation (n=70)		
– Active in both technological product and process innovation	48	68.6
– Active in only technological product innovation	16	22.9
– Active in only technological process innovation	6	8.6
– Active in technological product innovation	64	91.4
– Active in technological process innovation	54	77.1
b) Innovation developer:		
Product innovation (n=64):		
– mainly by the enterprise	54	89.1
– in co-operation with other enterprise	4	6.2
– mainly by other enterprise	3	4.7
Process innovation (n=54):		
– mainly by the enterprise	44	81.5
– in co-operation with other enterprise	7	13.0
– mainly by other enterprise	3	5.6
c) Status of innovation (n=70):		
– Project completed and on time	22	31.4
– Project completed but seriously delayed	12	17.1
– Project abandoned	8	11.4
– Project not even started	12	17.1
d) Innovation activities (n=70):		
– In-house R&D	57	81.4
– continuously	47	82.5
– occasionally	10	17.5
– Acquisition of external R&D	7	10.0
– Purchase of external knowledge	9	12.9
– Acquisition of machinery, equipment and software	31	44.3
– All design functions	33	47.1
– Marketing preparation	43	61.4
– Training	36	51.4

Note: Value of n varies due to missing respondents.
Source: Authors' survey (2010).

Interaction with suppliers, consultants, competitors and other enterprises within the enterprise group was also listed as an important source of knowledge and technology. Conversely, they put less emphasis on universities and higher education institutes, the government and Public Research Institutes (PRIs), commercial laboratories and private R&D institutes. As noted in Figure 1, partnership arrangements in the category of external markets and commercial were the most preferred, followed by internal sources. The role of the public sector as a source of knowledge and technology was viewed as the least significant among the innovators.

Figure 1: The Relative Significance of the Different Types of Partners in Co-operation for the Purposes of Innovation

	Public sector	Internal	External markets and commercial
Importance of sources (Greater importance ↑ / Lesser importance ↓)	• Government or PRIs • Universities or higher education institutes	• Other enterprises within enterprise group	• Clients or customers • Suppliers • Consultants • Competitors • Commercial laboratories and private R&D institutes

Lesser importance ⟷ Greater importance

The importance of each category of sources

Source: Authors.

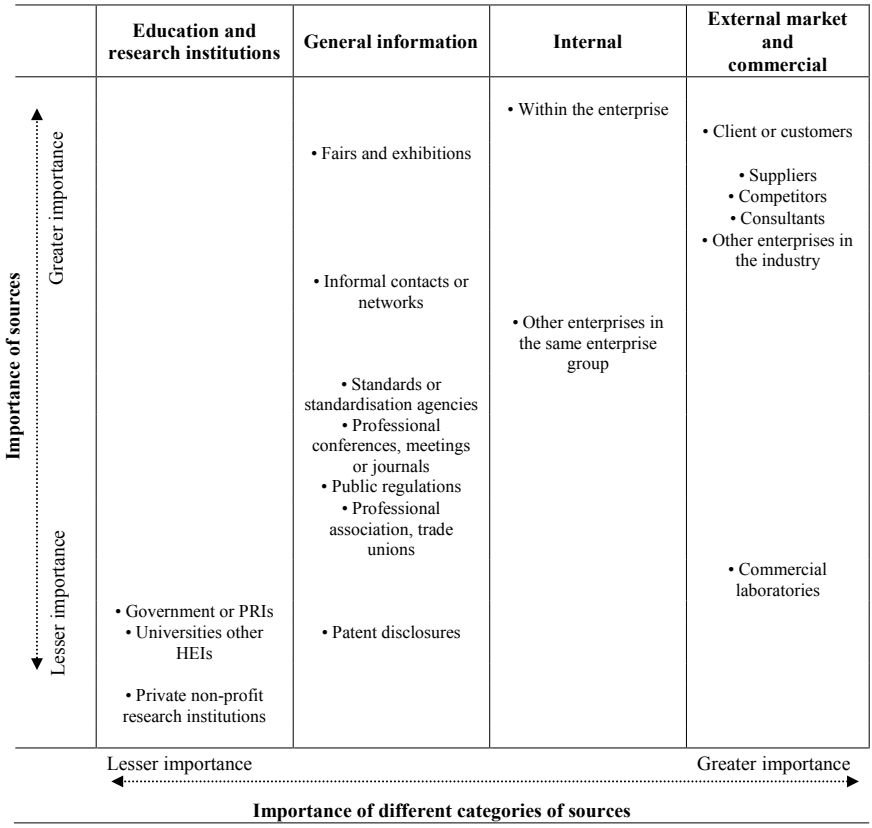
5.4 Sources of Innovation

This study examined sources of innovation from two perspectives, that is, sources of funding and sources of knowledge and technology. The findings indicate that most of the respondents (88.2 per cent) relied heavily upon their own internal funds. In terms of external sources, the most prevalent type of funding was funds from financial institutions (30.9 per cent). Government funds (17.6 per cent), funds from related companies (16.2 per cent), supranational funds (5.9 per cent), and funds from other non-financial enterprises (4.4 per cent) did not seem to play a significant role in assisting the innovators. Another important observation is that almost all of the funding was secured from local sources.

Apart from the source of funding for the process of innovation, sources of knowledge and technology are crucial to innovators. Figure 2 is an attempt to provide a synthesis of the responses in terms of the relative significance

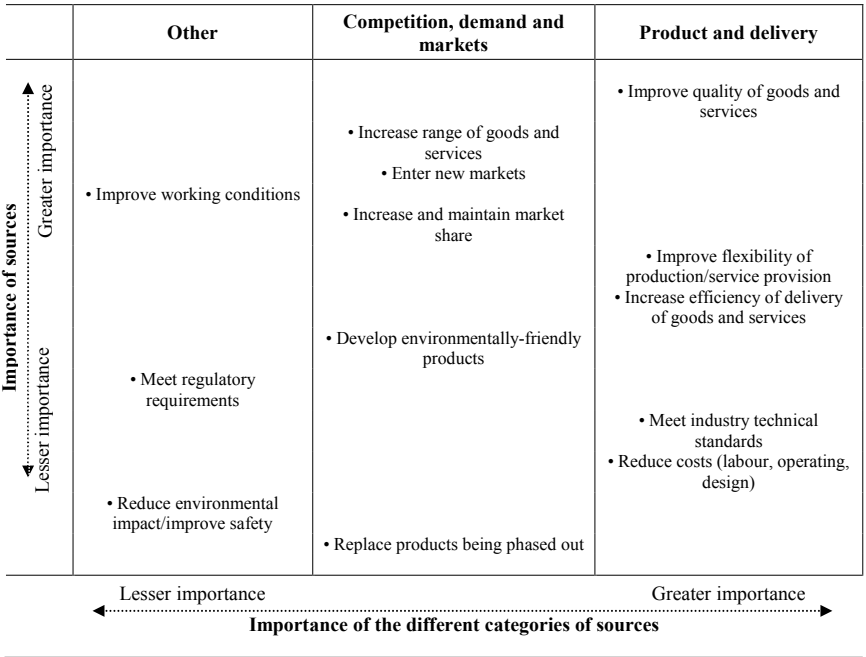
of the different sources. The results show that the external market and commercial sources and internal sources, were the two greatest sources of knowledge and technology. This was followed by knowledge and technology sourced from general information. The responses show that education and research institutions were the least important. The overall results of the survey clearly indicate that innovators work closely with their immediate business environment such as clients and customers, suppliers and, to a slightly lesser extent, with their competitors in order to obtain external knowledge and technology for their innovation activities. The public sector, such as universities, PRIs and the government, fell well outside their focus of attention. In addition, the preferred channels for the transfer of knowledge for these enterprises were fairs, exhibitions, informal contacts and networks,

Figure 2: The Relative Significance of Different Sources of Knowledge and Technology



Source: Authors.

Figure 3: The Relative Significance of Different Types of Drivers for Innovation



Source: Authors.

rather than other formal sources such as patent disclosures and standards. This result is similar to what has been observed in Section 5.3 above in terms of co-operation for the purposes of innovation.

5.5 Drivers of Innovation

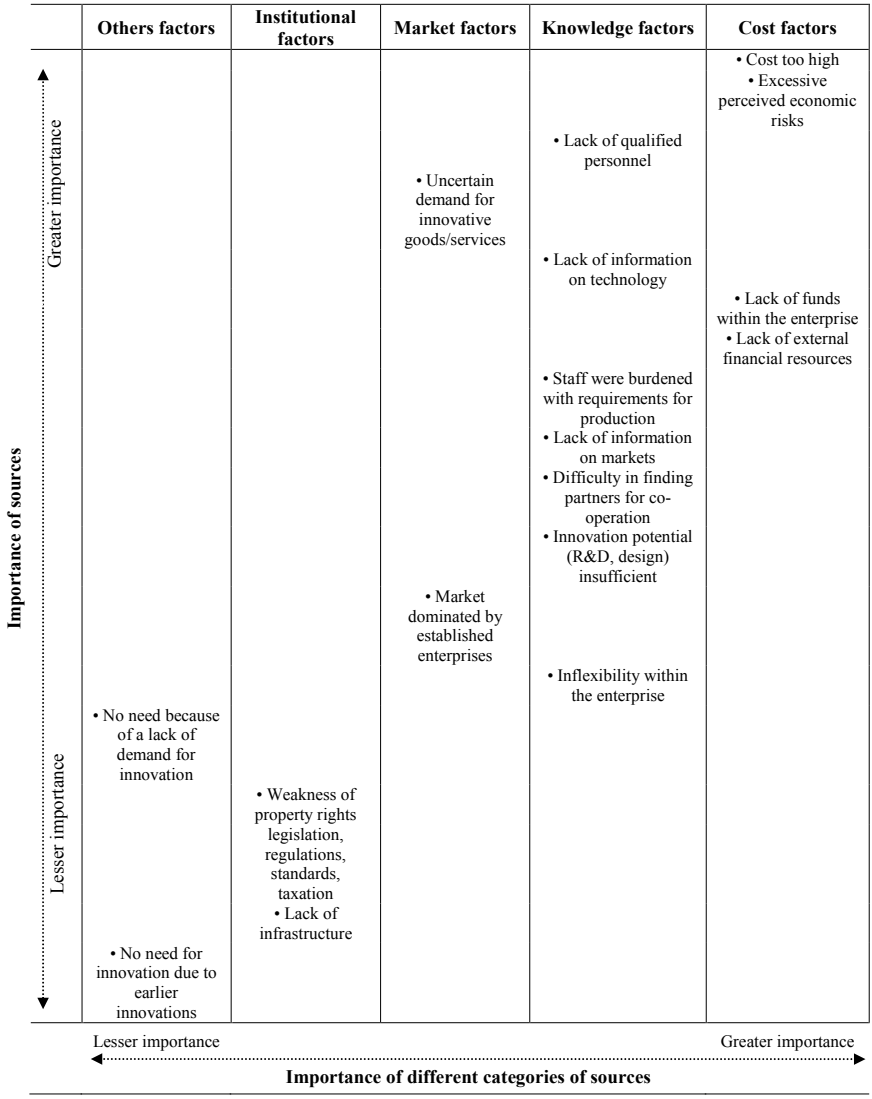
In this survey, four broad sets of drivers for innovation were considered: (a) competition; (b) demand and market; (c) products and delivery; and (d) other. Figure 3 illustrates the relative significance of each category of drivers for innovation. The results show that objectives belonging to the category of "improves the product and delivery" were the main driver of innovation. The category of "increasing competition, demand and markets" was ranked second, followed by the category "other".

5.6 Barriers to Innovation

In the survey, the responding innovative enterprises were asked to indicate the significance of various factors in terms of hindering the realization of

technological innovation in their business over the reference period 2006-2008. These factors were categorized into five main categories, namely cost, knowledge, market, institutional and other. Figure 4 illustrates the relative significance of each category of barriers to innovation. The results show that the barriers belonging to the category of "cost" were the main factors that

Figure 4: The Relative Significance of Different Types of Barriers to Innovation



Source: Authors.

hindered the realization of innovation amongst the innovators. Market factors were ranked second, followed by knowledge-related factors, institutional factors, and other factors.

5.7 Protection of Intellectual Property

Innovators were also asked for information regarding their use of formal and strategic methods for protecting their intellectual property. Confidentiality agreements and trade secrecy (62.9 per cent) were the most commonly used method among the innovators. These were followed by trademarks (58.6 per cent), patents (54.3 per cent), the registration of designs (50.0 per cent), and copyrights (42.9 per cent).

6. Discussion

The SIS framework suggests that the dynamics of innovation differs significantly across sectors in terms of characteristics, sources, actors, linkages and so on. In tandem with the survey findings, this section presents discussions on the dynamics of technological innovation in Malaysia's wooden furniture industry from four perspectives *viz*., characteristics of innovators; factors assisting and hampering innovation; the development of knowledge and technology; and partnerships for co-operation and linkages.

6.1 Characteristics of Innovators

Overall, this survey on SMEs who are active in the field of technological innovation in the wooden furniture manufacturing sector shows that the majority of them are small-sized, both in terms of the number of full-time employees or annual sales turnover. This was followed by medium-sized companies. Less than 3 per cent of the innovative enterprises were micro-sized. As the local market is limited and close to saturation, exploring the global market is becoming an important business strategy for the sustainability of innovative enterprises. In addition, Malaysia has been one of the largest exporters of furniture since the last decade. This is clearly observable in the findings of this survey, as most of the innovative enterprises relied heavily on the export market.

Most of the innovative enterprises were mainly home grown. In fact, about 80 per cent of them were fully owned by Malaysians. Having full control of the industry might be seen as a great achievement for local industry players. However, sustaining the competency and development of the industry would be difficult if the sector was not able to attract Foreign Direct Investments (FDIs) from the Multinational Corporations (MNCs).

FDI is important in the sense that it expedites the transfer of state-of-the-art technology, design and management practices to the local recipients, which could eventually foster the overall competencies and development of the furniture industry in the country.

Another interesting feature of the innovative enterprises was that the younger SMEs were more likely to engage in innovative practices compared to the older establishments. This might be due to the fact that the younger SMEs were more open and ready to face the uncertainty and risks pertaining to innovative activities. In addition, the results indicate that there was an extremely low percentage of full-time employees with science and engineering degrees amongst the innovative enterprises. This result is not in line with the common perception that an innovative enterprise requires a greater number of full-time employees with science and engineering degrees. One possible explanation is that furniture manufacturing is a labour intensive industry. It does not involve the use of sophisticated high-technology equipment or scientific procedures like other science and technology-based industries such as biotechnology, electronics, electrical goods, etc. Therefore, there is no need for a large number of personnel who are highly qualified in science and engineering in the furniture industry.

6.2 Factors Assisting and Hampering Innovation

The survey findings revealed that improving products and the delivery process for example, by improving the quality of goods and services and improving the flexibility of product or service provision was the first concern of the innovative enterprises. Other significant drivers in the category of competition, demand and market development, such as entering new markets and increasing the range of goods and services available, were also significant in driving the innovation agenda. There were, however, a number of factors that hindered the innovative efforts of the enterprises. The most cited factors were the high cost of innovation, perceived economic risks, a lack of information on markets, uncertainty regarding the demand for innovative goods or services, and a lack of information on technology. In general, cost and market-related factors were the two main factors that hampered innovation. They were followed by knowledge-based factors, institutional factors and other factors.

6.3 The Development of Knowledge and Technology

About two-thirds of the innovating enterprises were active in terms of both product and process innovation. Further investigation showed that product innovation was preferable to process innovation. This can be understood because the lifecycle of the style and design of furniture is short. In addition,

it is relatively easy to imitate the designs of others, because there are many international furniture exhibitions and, in the case of Malaysia itself, there are two such exhibitions which are held annually.

The majority of the innovating enterprises indicated that they were the main developers of innovations. There are two possible interpretations of this finding. From a positive point of view, these enterprises have sufficient capabilities to execute their innovative projects. Conversely, we could also interpret this finding as indicating that the innovative enterprises generally worked on their own because their linkages with other enterprises, universities and government agencies were weak.

One of the encouraging findings from the survey was that only a small number of these innovative enterprises were facing serious problems in the process of pursuing innovation. Most of them indicated that they were currently engaged in some on-going project and, more importantly, that the progress of these on-going projects seemed to be on track. Second, an overwhelming majority of these enterprises were continuously carrying out in-house R&D, which is the core activity of an innovation system because it sustains the learning process of the enterprise. In addition, market preparation, including market research and launch advertising for new or improved products and training for personnel directly related to innovation activity, were also viewed as key activities in pursuing innovation. The involvement of firms in design functions, including industrial, product, process and service design and specifications for production or delivery, was moderate. This indicates that these firms are still not the main players in terms of original design manufacturers. In addition, less of an effort was made to acquire external R&D, and to purchase or license patents and non-patented innovations, know-how and other types of external knowledge from other companies or organisations. This is justifiable in the case of SMEs, because the cost involved is rather high, and the nature of knowledge makes it difficult to transfer to other firms.

6.4 Partnerships for Co-operation and Linkages

The innovating firms most frequently co-operated with their clients, customers, suppliers and consultants. In contrast, there were limited partnerships between these firms and government or PRIs, commercial laboratories and private R&D institutes and universities or higher education institutes. This trend was also reflected in terms of the degree of importance of each type of partnership. Hence, partnerships with clients or customers, suppliers and consultants were perceived to be the most important, whereas partnerships with universities or higher education institutes, the government and PRIs were seen as less significant.

In terms of sources of knowledge, most of the innovative enterprises relied on their internal resources for knowledge and information. For external sources of knowledge and information, the most important source was clients or customers. Other important sources of knowledge and information were trade fairs and exhibitions, suppliers and informal contacts or networks. The less important sources of knowledge and information were private non-profit research institutions, universities, patent disclosures, the government or Public Research Institutes (PRIs) and commercial laboratories.

In summary, the majority of the innovative enterprises have an active network involving their clients or customers, and this is also the most important network in developing their technological capabilities. This is followed by suppliers, consultants and competitors. Generally speaking, the respondents had not established a close network with the government and PRIs, commercial laboratories and universities. For them, the contributions of these actors were not significant to the development of their competitiveness. The findings from this study support Woolgar *et al.*'s (1998) so-called SME-centric universe. The SME-centric universe suggests that SMEs relate most intensively with those in their immediate business environment, such as customers and suppliers, and, to a slightly lesser extent, with their competitors. Universities, PRIs and the government fall well outside their focus of attention. In addition, these networks are likely to be local. However, an interesting observation here was that, although the linkages with such formal organisations and agencies are weak in the wooden furniture industry, these businesses have the ability to go into global business and to survive without much support from formal institutions.

7. Conclusion

The technological innovation performance of an enterprise is served by various actors in the industry, and the ability to effectively engage and link with these actors will be a driver for the enterprise in gaining a competitive edge. For SMEs, which have long been recognized as the backbone of sustainable economic development and as a spawning ground for the birth of potential entrepreneurs, the ability to form these linkages must certainly be developed and sustained. Furthermore, for SMEs in the low-technology sector, the ability to secure external sources of technical information is a key strategy in terms of technological leapfrogging. In this regard, SMEs in the furniture industry in Malaysia constitute an interesting case study. Very few Malaysian low-technology indigenous industries have successfully continued to enhance their capabilities in improving quality production and innovative design. Despite the growing competition both regionally and internationally,

the Malaysian furniture industry is able to position itself as one of the largest exporters of furniture in the world.

To conclude, the results of this study show that the trend for technological innovation among Malaysian small and medium-sized wooden furniture manufacturers is centred on business-driven activities. Their immediate business partners, such as clients, customers and suppliers, become the key partners for co-operation in innovation, as well as sources of technology and knowledge. This is in line with studies by Pavitt (1984) and Malerba and Orsenigo (1997), who have argued that the pattern of innovation activity in the furniture industry is mainly generated by the entrepreneurial activity and creativity of small, new firms. There were only limited linkages between the industry and government machinery, PRIs and universities. The development of such linkages with government machinery has not been helped by perceptions of unwieldy procedures and rules that characterize such collaborations. Thus, the challenge for policymakers is to redefine the existing programmes for industrial linkages between SMEs in the furniture industry and government machinery, PRIs and universities by addressing the deficiencies as described in this study.

Notes

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1. CSIL is an independent economic research and consulting company. It was founded in Milan in 1980 and it specializes in applied economic research, SMEs economics and providing evaluations and technical assistance to development projects and programmes.
2. On the 9th of June 2005, Malaysia's National SME Development Council approved for adoption the following definition of Malaysian SMEs in manufacturing sectors: (a) micro-enterprise: sales turnover of less than RM250,000, or fewer than five full-time employees; (b) small-enterprise: sales turnover between RM250,000 and less than RM10 million, or between five and 50 full-time employees; and (c) medium-enterprise: sales turnover between RM10 million and RM25 million, or between 51 and 150 full-time employees.
3. However, various types of innovation have been proposed by different scholars. For instance, Schumpeter (1934) suggests that there are five types of innovation, namely the introduction of a new product or a qualitative change in an existing product; process innovation which is new to an industry; the opening of a new market; development of new sources of supply for raw materials or other inputs; and changes in industrial organization. According to the OECD (2005), innovation can be categorized into four types, that is, innovation in terms of product, process, the market and organization.
4. According to Stoneman (1995), it is common to separate product innovation and process innovation, and the distinction between product and process innovation

is a useful one. However, the evidence would tend to suggest that product and process innovation in the real world go hand-in-hand. Moreover, Chiesa (2007) states that an innovation cannot be defined as a product or process in absolute terms. An innovation is a product innovation when it concerns the output of a firm's activity, whereas it is a process innovation when it concerns the means of production used to make the firm's product.

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