Chapter 5 Technological Innovation in Malaysia's Wooden Furniture Industry

5.1 Introduction

This chapter analyses the primary data obtained through the technological innovation survey among innovating SMEs in the wooden furniture industry, with the main objective of answering the research questions determined in Chapter 1 of the study. The presentation of this chapter is in two parts. The first part provides descriptive statistics on the profile of the responding enterprises, as well as their trends in conducting technological innovation activities which is presented according to the following themes: types of innovation activities, innovation co-operation, sources of innovation, drivers of innovation, barriers to innovation, and intellectual property protection. The second part of this chapter will examine the significant association among some of the selected variables used in the survey by using the non-parametric tests. A short summary of the overall finding of the analysis is provided at the end of this chapter.

5.2 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 percent. Of these, 70 firms were active in terms of technological innovation during

the period 2006-2008 and can be categorised as SMEs. This meant that they matched the study criteria.

Knowing the background and main characteristics of the respondents is important as it provides a better understanding of the survey findings, and is helpful in mapping out strategies for technological capabilities development of the sector. Based on this standpoint, this section presents a brief profile of the respondents who indicated that they were technologically innovation active during the survey period. The profile of the innovating respondents is drawn from the first part of the questionnaire. The profile includes years of establishment (*AGE*), ownership structure (*OWN*), annual sales turnover (*TURNOVER*), market structure (*MARKET*), number of fulltime employees (*EMPLOYEE*), and percentage of employees educated to at least degree level in science and engineering subjects (*DEGREE*). Level of measurement used for these variables was scale data.

Table 5:1 details the descriptive statistics for the profile of innovating respondents. As data must be tested for normality before analysing them statistically, the distribution of the data on the respondents' profiles was examined through statistical analyses and graphically. In this regard, statistical analyses for normality tests were carried out through Kolmogorov-Smirnov test (KS-test) and Shapiro-Wilk test. Additionally, Normal Q-Q Plots were used to examine the normality distribution of the data graphically.

The KS-test and Shapiro-Wilk test compare the set of scores in the sample to a complete normally distributed set of scores with the same mean and standard deviation. If a significant value from the KS-test or Shapiro-Wilk test is greater than 0.05, it tells us that the distribution of the sample is not significantly different from a normal distribution - it is probably normal. In contrast, if the value is smaller than 0.05, then the distribution of the sample is significantly different from a complete normal distribution - the sample is non-normal distributed. The outcome of the normality tests will lead to the selection of type of statistical test, as asserted by Field (2000):

> A deviation from normality such as this tells us that we cannot use a parametric test, because the assumption of normality is not tenable. In these circumstances we can sometimes turn to non-parametric tests as a means of testing the hypothesis of interest (pp. 48-49).

The results of the KS-test and Shapiro-Wilk tests on the respondents' profile variables are shown in Table 5:2. It is important to note that the significant values for these variables were smaller than 0.05. This indicates that the distributions of *AGE*, *OWN*, *TURNOVER*, *MARKET*, *EMPLOYEE* and *DEGREE* were significantly different from a normal distribution. In conclusion, all these variables are thus not normally distributed. The above results were confirmed by the normal Q-Q plots as shown in Figure 5:1. In the Normal Q-Q plots for these variables, the graphs do not show a linear relationship between the observed values and expected values from a normal distribution. This shows that these variables are not normally distributed. As these variables were not normally distributed, non-parametric tests were used as statistical analyses for these variables.

Table 5:1 Profile of respondents

Variables	*n*	Minimum	Maximum	Mean	Std. deviation	Skewness		Kurtosis	
						Statistic	Std. Error	Statistic	Std. Error
Years of establishment (*AGE*)	66	1	42	15.94	10.510	.593	.295	-.613	.582
% of local ownership (*OWN*)	67	0	100	87.69	27.652	-2.230	.293	3.837	.578
Turnover in 2008 (RM million) (*TURNOVER*)	44	.20	42.00	12.6432	12.43010	.877	.357	355	.702
% turnover derived from export (*MARKET*)	55	0	100	66.51	32.069	-.596	.322	-.870	.634
No. of fulltime employees (*EMPLOYEE*)	69	3	150	66.26	49.848	0.430	.289	-1.230	.570
% of employees educated to degree level in science & engineering (*DEGREE*)	58	0	50	11.46	15.663	1.364	.314	.639	.618
Valid N (listwise)	32								

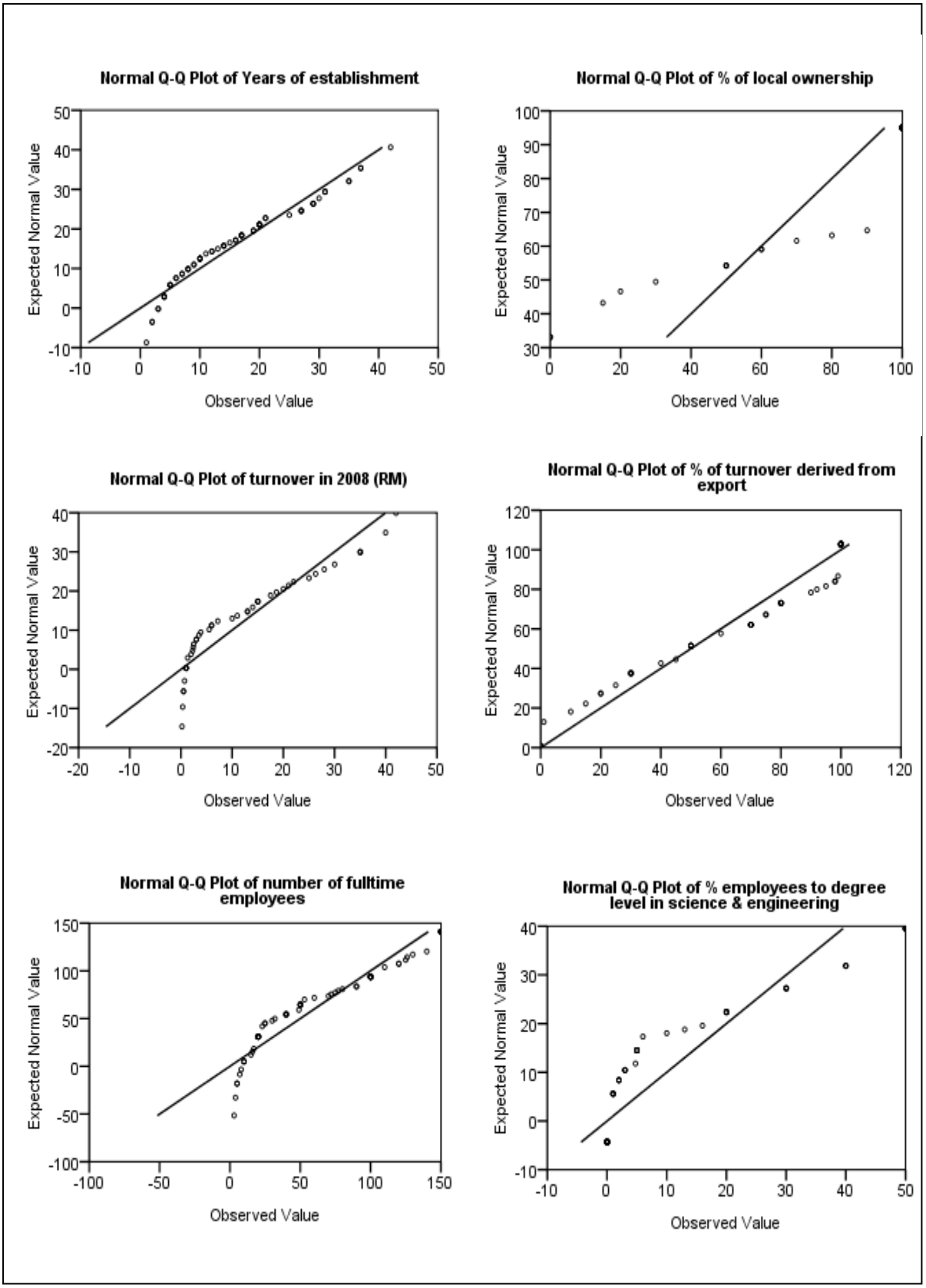
Note: n = the values vary due to missing values for certain respondents.
Source: Author's survey (2006-2008)

Table 5:2 Tests of normality for respondents' profile variables

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Years of establishment (*AGE*)	.232	32	.000	.900	32	.006
% of local ownership (*OWN*)	.444	32	.000	.495	32	.000
Turnover in 2008 (RM million) (*TURNOVER*)	.165	32	.026	.862	32	.001
% turnover derived from export (*MARKET*)	.163	32	.031	.896	32	.005
No. of fulltime employees (*EMPLOYEE*)	.189	32	.005	.865	32	.001
% of employees educated to degree level in science & engineering (*DEGREE*)	.355	32	.000	.658	58	.000

a. Lilliefors Significance Correction
Source: Author's survey (2006-2008)

Figure 5:1 Normal Q-Q Plot for variables of innovators' profile



Source: Author's survey (2006-2008)

Detailed accounts of the profile of the respondents are provided in the following part of this section.

5.2.1 Years of Establishment

The mean age of responding innovating enterprises was 15.9 years. As shown in stem-and-leaf plot in Figure 5:2, more than half (51.5 percent) of the enterprises were found to be below 15 years, and about 35.9 percent were in the range of 15 to 29 years. Only 13.6 percent have been established for thirty years or more. A distribution with a positive skewed indicates that the younger firms show a greater likelihood of innovation than those in the higher age group.

Figure 5:2 Years of establishment Stem-and-Leaf Plot

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Frequency    Stem & Leaf

    9.00        0 .  122334444
   13.00        0 .  5555667788899
   12.00        1 .  000001223444
    9.00        1 .  566777799
    7.00        2 .  0000011
    7.00        2 .  5777999
    4.00        3 .  0111
    4.00        3 .  5577
    1.00        4 .  2

Stem width:      10
Each leaf:       1 case(s)
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Source: Author's survey (2006-2008)

5.2.2 Ownership

Table 5:1 shows that 86.6 percent of the enterprises were majority owned by Malaysians, while the other remaining 13.4 percent were majority owned by foreigners. This resulted in the distribution of the sample being highly negatively skewed. Also, it is interesting to note that, as shown in Figure 5:3, 79.1 percent of the innovating enterprises were fully owned by Malaysians. This shows that most of them are home-grown enterprises, and the influence of Foreign Direct Investments (FDIs) is not significant in the industry.

Figure 5:3 Local ownership Stem-and-Leaf Plot

```
Frequency    Stem &  Leaf

    3.00        0 .  123
    1.00        1 .  5
    1.00        2 .  0
    1.00        3 .  0
    0.00        4 .
    3.00        5 .  000
    2.00        6 .  00
    1.00        7 .  0
    1.00        8 .  0
    1.00        9 .  0
   53.00        10.  00000000000000000000000000000000000000000000000000000

Stem width:      10
Each leaf:       1 case(s)
```

Source: Author's survey (2006-2008)

5.2.3 Sales Turnover and Export Market

As evidenced from Table 5:1, the mean for annual sales turnover of the innovators was RM12.6 million. As predicted, most of them relied heavily on the export market. The mean percentage of turnover derived from export was 66.5 percent, and the distribution was strongly negatively skewed. It is also interesting to note that the mode for percentage of turnover derived from export, as shown in Figure 5:4, was 100%.

Figure 5:4 Percentage of turnover derived from export Stem-and-Leaf Plot

```
Frequency    Stem &  Leaf

     5.00        0 .  00011
     7.00        0 .  2223333
     9.00        0 .  445555555
     8.00        0 .  67777777
    12.00        0 .  888888999999
    14.00        1 .  00000000000000

 Stem width:      100
 Each leaf:       1 case(s)
```

Source: Author's survey (2006-2008)

5.2.4 Fulltime Employees and Level of Science and Engineering Education

Table 5:1 shows that the mean for the number of fulltime employees among the responding innovating enterprises was 66. However, Figure 5:5 shows that 31.0 percent of the innovators indicated that they have no employee with science and engineering degree. Besides, 34.5 percent of the innovating enterprises have 1 to 10 percent of fulltime employees in this category. The extremely low percent of fulltime employees

with science and engineering degree can be seen in the mean value of the sample, which is only 11.5 percent.

Figure 5:5 Percentage of employees educated to at least degree level in science and engineering subjects Stem-and-Leaf Plot

```
Frequency    Stem &  Leaf

   38.00        0 .  00000000000000000011111222333455555556
    3.00        1 .  036
    6.00        2 .  000000
    4.00        3 .  0000
    3.00        4 .  000
    4.00        5 .  0000

Stem width:      10
Each leaf:       1 case(s)
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Source: Author's survey (2006-2008)

5.2.5 Size of Innovating Respondents

The size of the innovators was determined based on the annual sales turnover (*SME_TURNOVER*), and the number of fulltime employees (*SME_EMPLOYEE*). In terms of annual sales turnover, the results shown in Table 5:3 indicates that the majority (61.1 percent) of the innovators had an annual sales turnover between RM250,000 and RM10 million, and were thus classified as small enterprises according to the SME's definitions. A relatively lower proportion (36.1 percent) was medium-sized, with sales turnover between RM 10 million and RM 25 million. The other 2.8 percent were micro-sized with a turnover of less than RM 25,000.

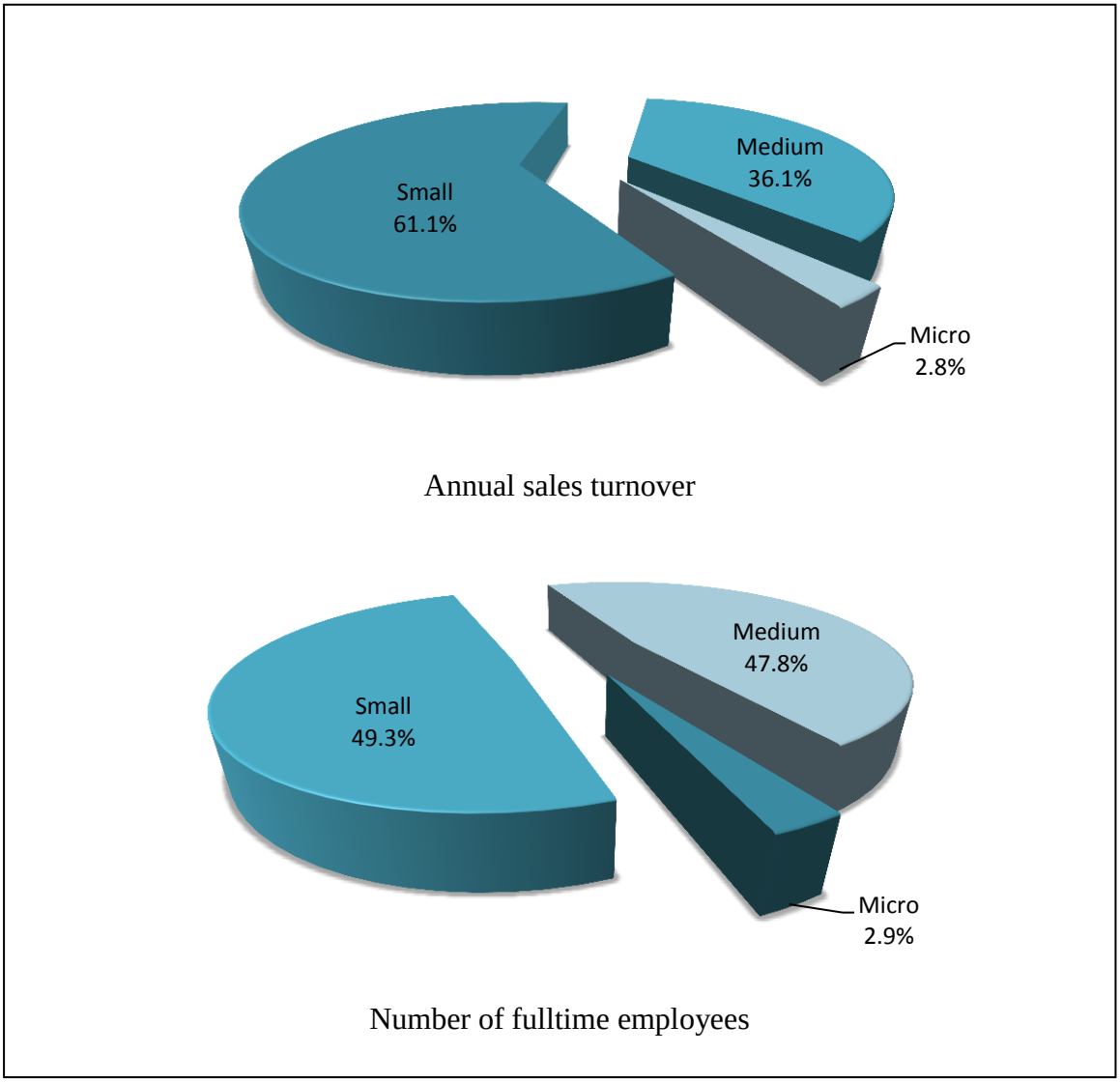
A similar trend can be observed in number of fulltime employees. Table 5:3 shows that 49.3 percent of the responding innovating enterprises were small-sized with between 5 to 50 fulltime employees, and 47.8 percent were medium-sized with 51 to 150 fulltime employees. The remaining 2.9 percent were micro-sized with less than 5 fulltime employees. Figure 5:6 shows the classification of the technological innovating respondents in terms of annual sales turnover and number of fulltime employee.

Table 5:3 Size of innovators

Variable	Size of innovators	%
Size according to annual sales turnover (*SME_TURNOVER)*	- micro (less than RM 0.25 million)	2.8
	- small (between RM 0.25 million and < RM 10 million)	61.1
	- medium (between RM 10 million and RM 25 million)	36.1
Size according to number of full-time employees *SME_EMPLOYEE*	- micro (less than 5)	2.9
	- small (between 5 and 50)	49.3
	- medium (between 51 and 150)	47.8

Source: Author's survey (2006-2008)

Figure 5:6 Size of innovators according to annual sales turnover and fulltime employees



Source: Author's survey (2006-2008)

5.3 Patterns of Technological Innovation

The data on the patterns of innovation activities was derived based on information provided by SMEs on the following themes: types of innovation activities, innovation co-operation, sources of innovation, drivers of innovation, barriers to innovation, and intellectual property protection.

5.3.1 Type of Technological Innovation Activities

Table 5:4 provides an overview of the characteristics of technological innovation activities among the innovating SMEs in terms of involvement in technological innovation, innovation developer, status of innovation, and innovation activities.

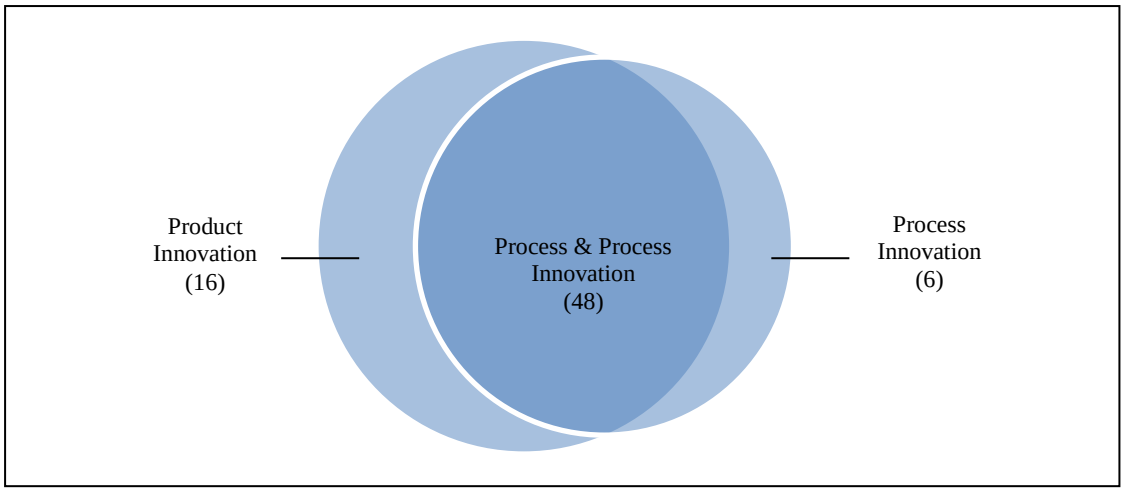
As for the type of technological innovation, about two-thirds of the innovators (68.6 percent) were active in both product and process innovation. The number of innovators active in only product innovation (22.9 percent) or only process innovation (8.6 percent) was relatively small compared to those 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 percent) rather than process innovation (77.1 percent). This is clearly observable in Figure 5:7.

Table 5:4 Characteristics of technological innovation activities among innovators

	Frequency	Valid Percent
a) Involvement in technological innovation (*TECHINO*) *(n=70)*		
- Both technological product & process innovation active	48	68.6
- Only technological product innovation active	16	22.9
- Only technological process innovation active	6	8.6
- Technological product innovation active	64	91.4
- Technological process innovation active	54	77.1
b) Innovation developer: Product innovation (*PRODUCT_DEV*) *(n=64):*		
- mainly by the enterprise	54	89.1
- in co-operation with other enterprises	4	6.2
- mainly by other enterprises	3	4.7
Process innovation (*PROCESS-DEV*) *(n=54):*		
- mainly by the enterprise	44	81.5
- in co-operation with other enterprises	7	13.0
- mainly by other enterprises	3	5.6
c) Status of innovation *(n=70)*		
- Project not yet completed but on time (*PROJ_ONTIME*)	22	31.4
- Project not yet completed but seriously delayed (*PROJ_DELAY*)	12	17.1
- Project abandoned (*PROJ_ABAND*)	8	11.4
- Project not even started (*PROJ_NOSTART*)	12	17.1
d) Innovation activities *(n=70)*		
- In-house R&D (*ACT_INRND*)	57	81.4
- continuously	47	82.5
- occasionally	10	17.5
- Acquisition of external R&D (*ACT_EXRND*)	7	10.0
- Purchase of external knowledge (*ACT_PURKNOW*)	9	12.9
- Acquisition of machinery, equipment & software (*ACT_MACHINE*)	31	44.3
- All design functions (*ACT_DESIGN*)	33	47.1
- Marketing preparation (*ACT_MARKET*)	43	61.4
- Training (*ACT_TRAIN*)	36	51.4

Note: *n= the values vary due to missing values for certain respondents.*
Source: Author's survey (2006-2008)

Figure 5:7 Type of technological innovation activities among innovators

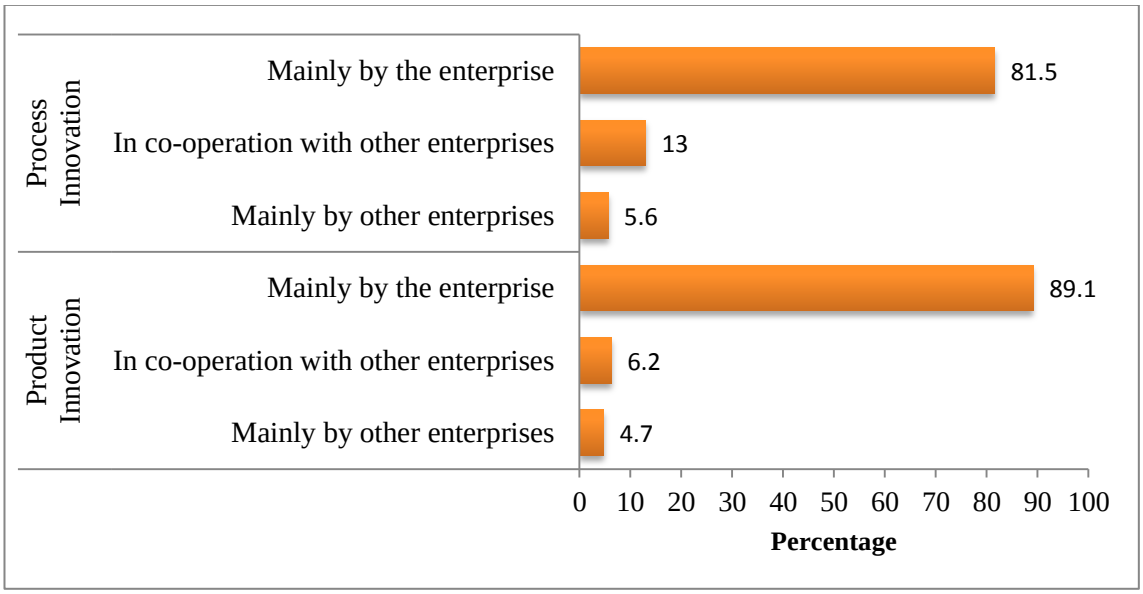


Note: Number in parenthesis refers to the number of enterprises

Source: Author's survey (2006-2008)

It was found that 89.1 percent of the product innovators and 81.5 percent of the process innovators indicated that they themselves were the main developer of innovation respectively. Figure 5:8 illustrates the main developer for both technological product and process innovation activities.

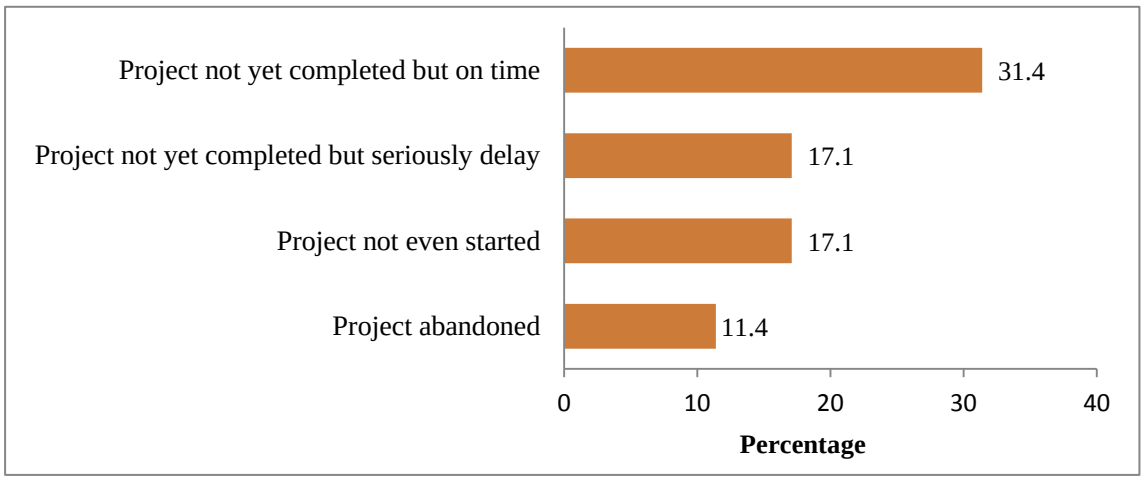
Figure 5:8 Main developer for technological innovation among innovators



Source: Author's survey (2006-2008)

In terms of the status of the innovation projects, 31.4 percent of the innovating enterprises 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 percent of them had projects which were not yet completed and were seriously delayed, or projects which had not even started. In addition, only 11.4 percent of them had abandoned projects. Figure 5:9 demonstrates the status of innovation among the innovators.

Figure 5:9 Status of innovation among innovators

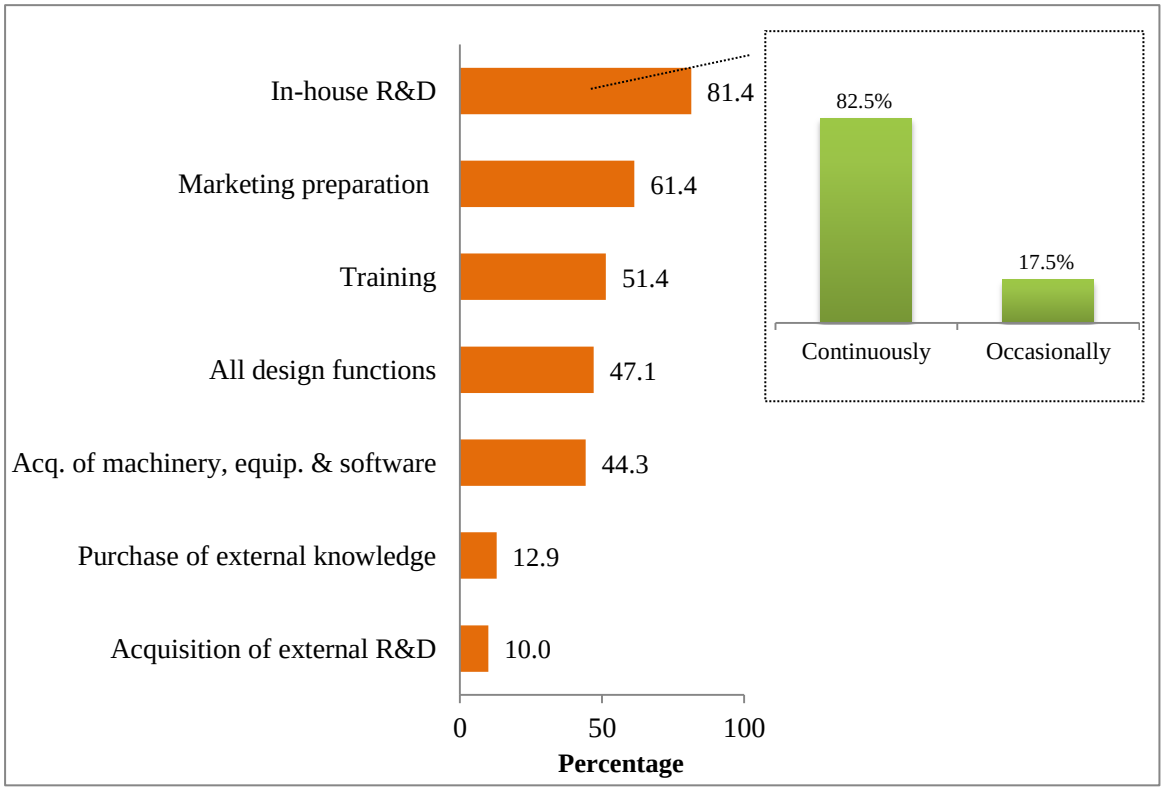


Source: Author's survey (2006-2008)

In terms of types of innovation activities, as shown in Table 5:4, it can be clearly observed that the highest percentage (81.4 percent) of innovating enterprises undertook in-house R&D activities. Of these, 82.5 percent indicated that the in-house R&D activities were carried out continuously, and 17.5 percent indicated that the activities were conducted occasionally. Marketing preparation (such as market research and

market launch 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 percent and 51.4 percent 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 percent), and the acquisition of machinery, equipment and software in connection with product and process innovation (44.3 percent). In contrast, a very little effort was made to acquire external R&D (10.0 percent), or to purchase or license patents and non-patented innovations or other types of external knowledge from other companies or organisations (12.9 percent). Figure 5:10 illustrates the main innovation activities carried out.

Figure 5:10 Main technological innovation activities among innovators



Source: Author's survey (2006-2008)

5.3.2 Innovation Co-operation

In order to gain an insight into the innovation activities of SMEs in the wooden furniture manufacturing sector, it is essential to examine the extent to which co-operation is undertaken for innovation. In this survey, the respondents were asked to identify the main partner for their co-operation efforts, and to rate the significance of such co-operation to their innovation based on a 4 point Likert scale, namely “not used”, “low”, “medium”, and “high”. Data values for these four attributes were determined at: “not used = 0”, “low=1”, “medium=2”, and “high=3”.

Table 5:5 provides an overview of the patterns of innovation co-operation among the innovators. 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. 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 institutions (HEIs), the government and PRIs, commercial laboratories and private R&D institutes. As shown in Figure 5:11, 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.

Table 5:5 Innovators' perception of the importance of the different types of partners in innovation co-operation

Type	Co-operation partners	*n*	Relative importance (%)				Ranking* (Medium or highly importance)
			Not used	Low	Medium	High	
External market & commercial	Suppliers (*PARTN_SUPPLIER*)	70	28.6	7.1	28.6	35.7	2
	Clients or customers (*PARTN_CLIENT*)	70	20.0	8.6	30.0	41.4	1
	Competitors (*PARTN_COMPET*)	70	45.7	15.7	22.9	15.7	4
	Consultants (*PARTN_CONSUL*)	70	44.3	11.4	30.0	14.3	3
	Commercial laboratories & private R&D institutes (*PARTN_COMME*)	70	62.9	12.9	18.6	5.7	6
Internal	Other enterprises within enterprise group (*PARTN_OTHER*)	70	54.3	12.9	21.4	11.4	5
Public sector	Universities or HEIs (*PARTN_UNI*)	70	68.6	18.6	11.4	1.4	8
	Government or PRIs (*PARTN_GOV*)	70	60.0	15.7	14.3	10.0	6

Notes: * *The ranking is determined based on percentage of respondents that have selected the reference partner as "medium importance" and "highly important" to their innovation co-operation.*

Source: Author's survey (2006-2008)

Figure 5:11 The relative significance of the different types of partners in innovation co-operation

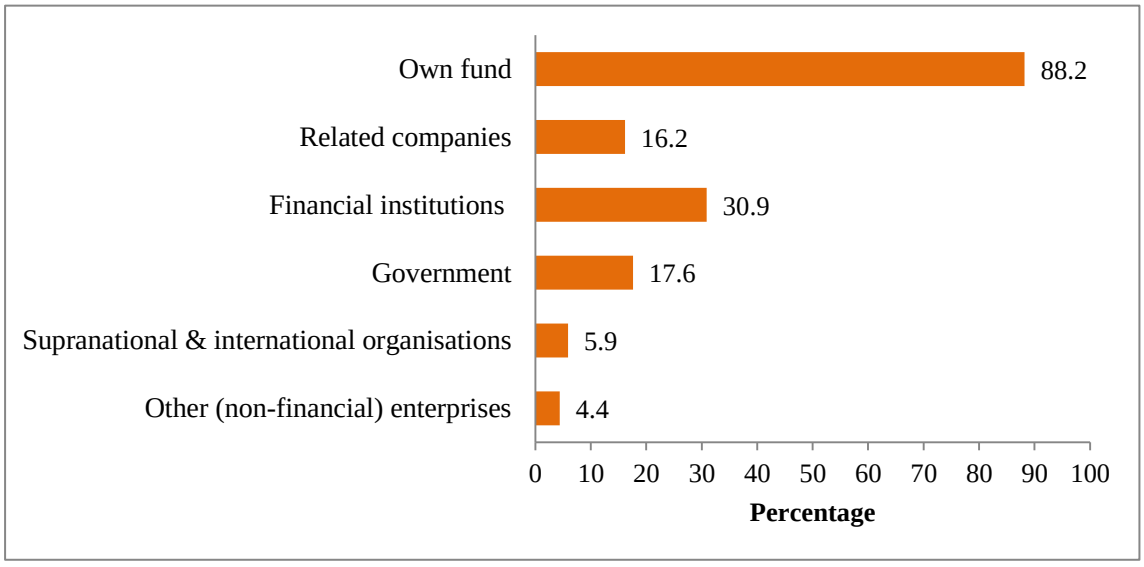
	Public sector	**Internal**	**External market & commercial**
Sources Importance (Greater Importance ↕ Lesser Importance)	○ Government or PRIs ○ Universities or HEIs	○ Other enterprises within enterprise group	○ Clients or customers ○ Suppliers ○ Consultants ○ Competitors ○ Commercial laboratories & private R&D institutes
Lesser Importance ↔ Greater Importance			
Sources Category Importance			

Source: Author's survey (2006-2008)

5.3.3 Sources of Innovation

This study examined sources of innovation from two perspectives, namely sources of funding, and sources of knowledge and technology. Figure 5:12 shows the sources of funding used by the innovators during the reference period 2006-2008. The findings indicate that most of respondents (88.2 percent) 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 percent). Government funds (17.6 percent), funds from related companies (16.2 percent), supranational funds (5.9 percent), and funds from other non-financial enterprises (4.4 percent) 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.

Figure 5:12 Source of innovation funding among innovators



Source: Author's survey (2006-2008)

Apart from the source of funding for the process of innovation, sources of knowledge and technology are crucial to innovators. Knowledge and technology can be acquired from a variety of sources. In this regard, innovators were asked to identify their sources of knowledge and technology as well as indicate their level of significance. A 4 point Likert scale, namely "not used", "low", "medium", and "high" was used. Data values of these four attributes were determined at: "not used = 0", "low=1", "medium=2", and "high=3".

Table 5:6 shows the significance attributed to various sources of knowledge and information. Innovators clearly consider internal knowledge and technology as the most important for their innovation activities. This is followed by clients or customers, fairs and exhibitions, suppliers of equipment, materials, components, etc, competitors and consultants. On the contrary, government or PRIs, universities and other HEIs, patent disclosures, and private non-profit research institutions were evaluated as less important sources of knowledge and technology.

Figure 5:13 is an attempt to provide a synthesis of the responses in terms of the relative significance of the different sources. The result shows 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 showed 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, rather than other formal sources such as patent disclosures and standards. This is similar to the observation made in Section 5.3.2 above in terms of co-operation for the purposes of innovation.

Table 5:6 Innovators' perception of the importance of the different sources of knowledge and technology for innovation

Type	Sources of knowledge and technology	*n*	Relative importance (%)				Ranking* (Medium or highly importance)
			No used	Low	Medium	High	
Internal	Within the enterprise	65	3.1	3.1	32.3	61.5	1
	Other enterprises within the enterprise group	60	45.0	10.0	25.0	20.0	9
External market & commercial	Competitors	63	33.3	12.7	31.7	22.2	5
	Other enterprises in the industry	60	31.7	16.7	30.0	21.7	7
	Clients or customers	60	6.7	5.0	26.7	61.7	2
	Consultants	60	31.7	15.0	35.0	18.3	6
	Suppliers of equipment, materials, components, etc.	60	21.7	18.3	25.0	35.0	4
	Commercial laboratories	60	53.3	16.7	18.3	11.7	14
Education & research institutions	Universities and other HEIs	60	58.3	21.7	15.0	5.0	16
	Government or PRIs	61	54.1	18.0	19.7	8.2	15
	Private non-profit research institutions	60	65.0	18.3	13.3	3.3	18
General information	Patent disclosures	60	55.0	25.0	16.7	3.3	16
	Professional conferences, meetings or journals	60	40.0	16.7	28.3	15.0	11
	Fairs and exhibitions	62	17.7	8.1	21.0	53.2	3
	Professional association, trade unions	60	41.7	21.7	30.0	6.7	13
	Informal contacts or networks	61	29.5	23.0	29.5	18.0	8
	Standards or standardisation agencies	61	39.3	16.4	26.2	18.0	10
	Public regulations (i.e. environment, security)	59	39.0	18.6	28.8	13.6	12

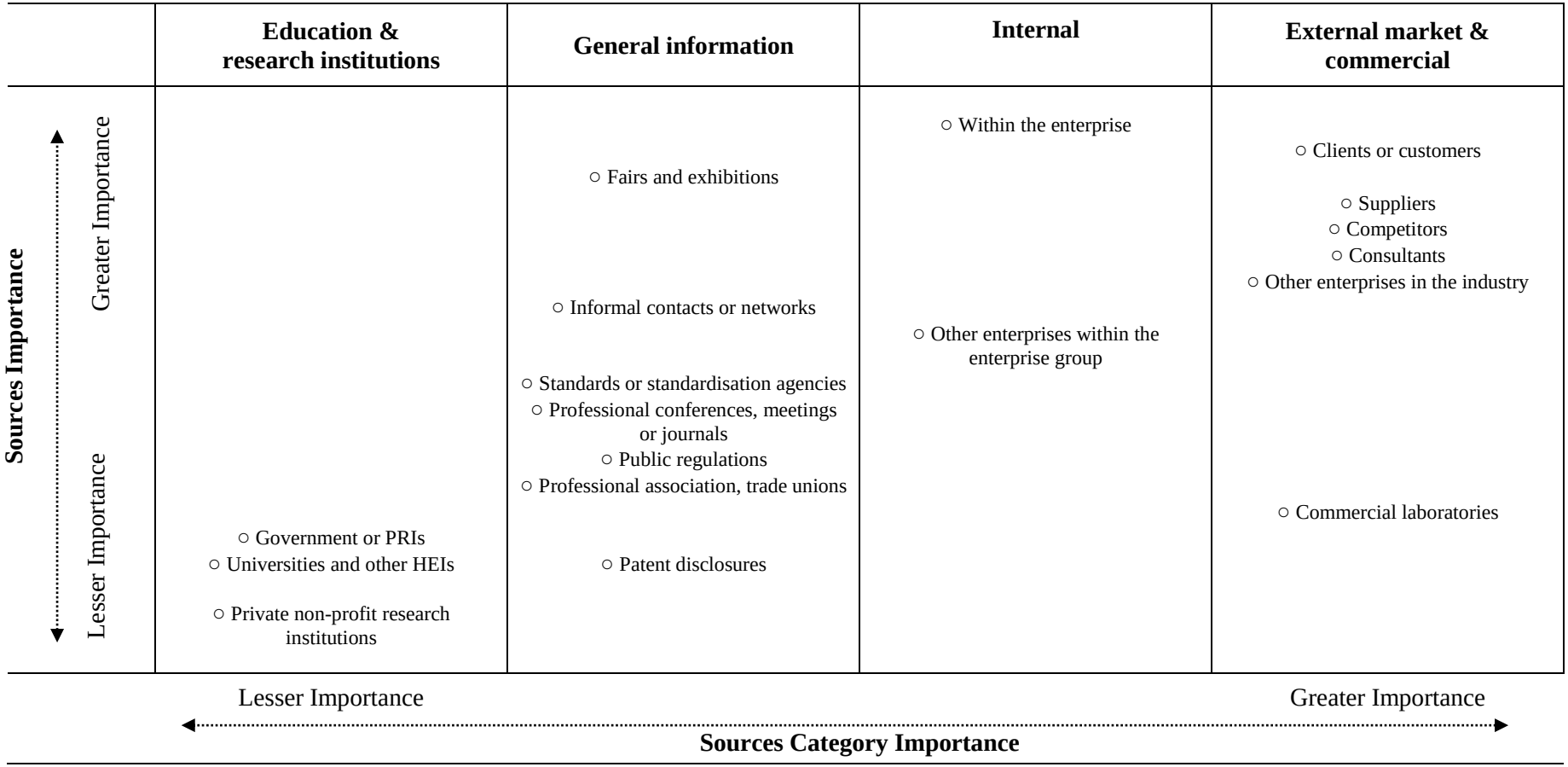
Notes:

n= the values vary due to missing values for certain respondents.

** The ranking is determined based on percentage of respondents that have selected the reference partner as "medium importance" and "highly important" to their innovation co-operation.*

Source: Author's survey (2006-2008)

Figure 5:13 The relative significance of different sources of knowledge and technology for innovation



Source: Author's survey (2006-2008)

5.3.4 Drivers of Innovation

The motivation for innovation constitutes an important component in any innovation survey as this feedback can be used to guide appropriate policy responses. In this survey, four broad sets of drivers for innovation were considered: (a) competition, (b) demand and market, (c) product and delivery, and (d) others. In measuring the relevance of the various drivers and their importance to the innovating enterprises, the same scheme used in the measurement of knowledge and technology source was adopted.

On the list of different drivers, as reported in Table 5:7, the most significant reason given was to "improve quality of goods and services". This is followed by "increase range of goods and services", "enter new market", "improve working conditions", and "increase and maintain market share". On the other hand, drivers such as "replace products being phased out" and "reduce environmental impacts or improve safety" were least significant. Figure 5:14 illustrates the relative significance of each category of innovation drivers. The results show that the objective to improve the product and delivery were the main driver of innovation.

Table 5:7 Innovators' perception of the importance of the different types of drivers of innovation

Type	Objectives	*n*	Relative importance (%)				Ranking* (Medium or highly importance)
			Not relevant	Low	Medium	High	
Competition, demand & markets	Replace products being phased out	68	33.8	7.4	33.8	25.0	13
	Increase range of goods & services	68	10.3	1.5	25.0	63.2	2
	Develop environment-friendly products	68	16.2	8.8	33.8	41.2	8
	Increase & maintain market share	68	16.2	2.9	30.9	50.0	5
	Enter new markets	68	10.3	2.9	19.1	67.6	3
Product & delivery	Improve quality of goods & services	68	2.9	0.0	20.6	76.5	1
	Improve flexibility of production /services provision	68	14.7	4.4	22.1	58.8	6
	Reduce costs (labour, operating, design)	68	17.6	13.2	25.0	44.1	11
	Increase efficiency of delivery goods & services	68	17.6	4.4	19.1	58.8	7
	Achieve industry technical standards	68	20.6	10.3	22.1	47.1	10
Others	Reduce environmental impacts / improve safety	68	17.6	13.2	23.5	45.6	11
	Meet regulatory requirements	67	22.4	4.5	31.3	41.8	9
	Improve working conditions	68	13.2	4.4	36.8	45.6	4

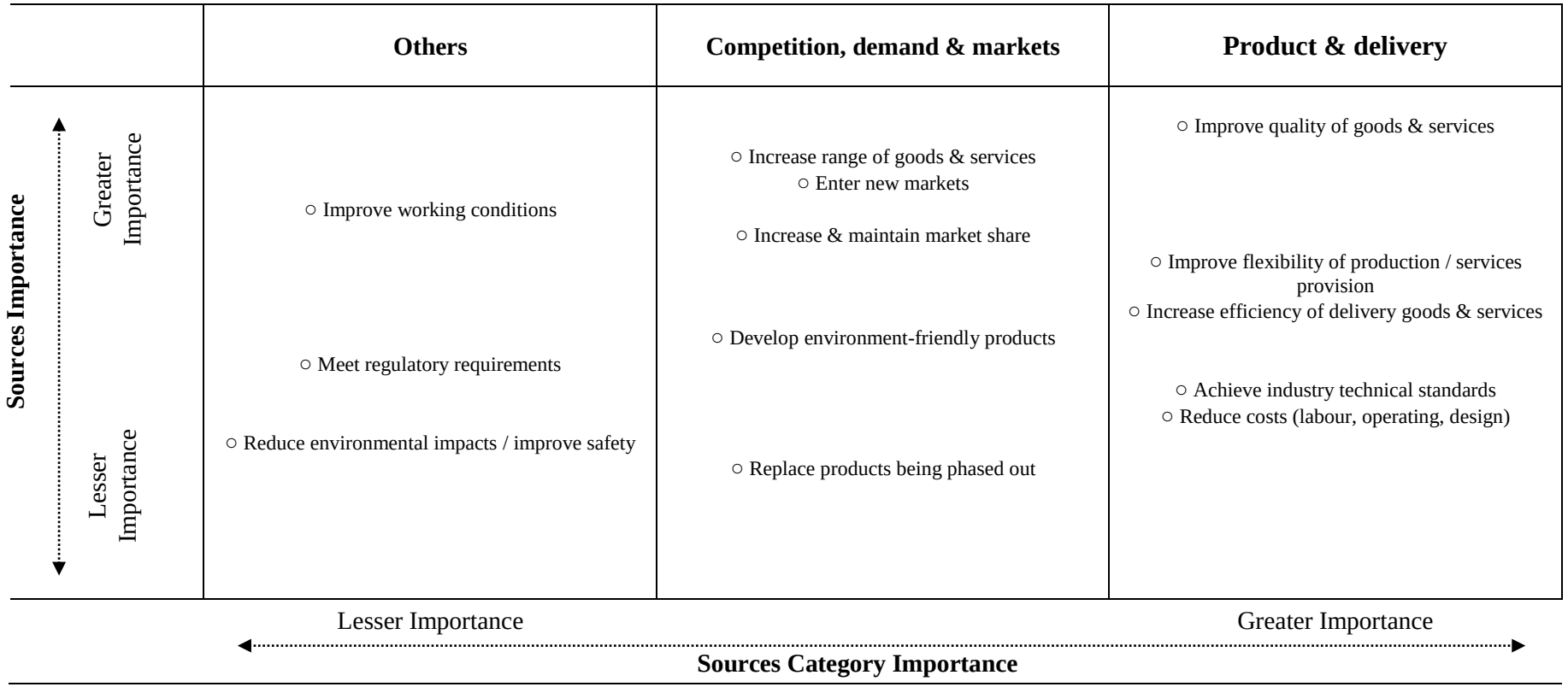
Notes:

n= the values vary due to missing values for certain respondents.

** The ranking is determined based on percentage of respondents that have selected the reference partner as "medium importance" and "highly important" to their innovation co-operation.*

Source: Author's survey (2006-2008)

Figure 5:14 The relative significance of different types of innovation drivers



Source: Author's survey (2006-2008)

5.3.5 Barriers to Innovation

In the survey, the responding innovative enterprises were asked to indicate the significance of various factors in terms of hindering the realisation of technological innovation in their business over the reference period 2006-2008. These factors were categorised into five main categories, namely cost, knowledge, market, institutional, and others.

The overall results of the findings are summarised in Table 5:8. Overall, “cost too high”, “excessive economic risks” and “lack of qualified personnel” seemed to be the first three factors hampering innovation activities. Factors associated with the knowledge base of innovators, such as “lack of information on technology”, “staff were burdened with production requirement”, “lack of information on market”, “difficulty in finding co-operation partners”, and “insufficient innovation potential” were also highly ranked as impediments. Figure 5:15 illustrates the relative significance of each category of innovation barriers. The results show that the barriers belonging to the category of “cost” were the main factors that hindered the realisation of innovation. Market factors were ranked second, followed by knowledge-related factors, institutional factors, and other factors.

Table 5:8 Innovators' perception of the importance of the different types of barriers to innovation

Type	Factors hampering innovation	*n*	Relative importance (%)				Ranking* (Medium or highly importance)
			Not relevant	Low	Medium	High	
Cost factors	Excessive perceived economic risks	64	10.9	10.9	34.4	43.8	2
	Cost too high	64	9.4	6.2	37.5	46.9	1
	Lack of funds within the enterprise	65	24.6	10.8	33.8	30.8	6
	Lack of external financial resources	65	26.2	15.4	27.7	30.8	7
Knowledge factors	Innovation potential (R&D, design) insufficient	62	29.0	16.1	38.7	16.1	11
	Lack of qualified personnel	64	20.3	9.4	48.4	21.9	3
	Lack of information on technology	64	18.8	12.5	45.3	23.4	5
	Lack of information on markets	65	15.4	20.0	43.1	21.5	9
	Difficulty in finding co-operation partners	63	27.0	14.3	47.6	11.1	10
	Inflexibility within the enterprise	60	31.7	20.0	43.3	5.0	13
	Staff were burdened with production requirement	62	27.4	16.1	46.8	9.7	8
Market factors	Uncertain demand for innovative goods / services	64	17.2	14.1	43.8	25.0	4
	Market dominated by established enterprises	62	25.8	19.4	29.0	25.8	12
Institutional factors	Lack of infrastructure	63	28.6	27.0	38.1	6.3	17
	Weakness of property rights	61	37.7	14.8	34.4	13.1	14
	Legislation, regulations, standards, taxation	63	33.3	20.6	31.7	14.3	16
Other factors	No need for innovate due to earlier innovation	61	37.7	24.6	29.5	8.2	18
	No need because of lack of demand for innovation	61	29.5	23.0	39.3	8.2	14

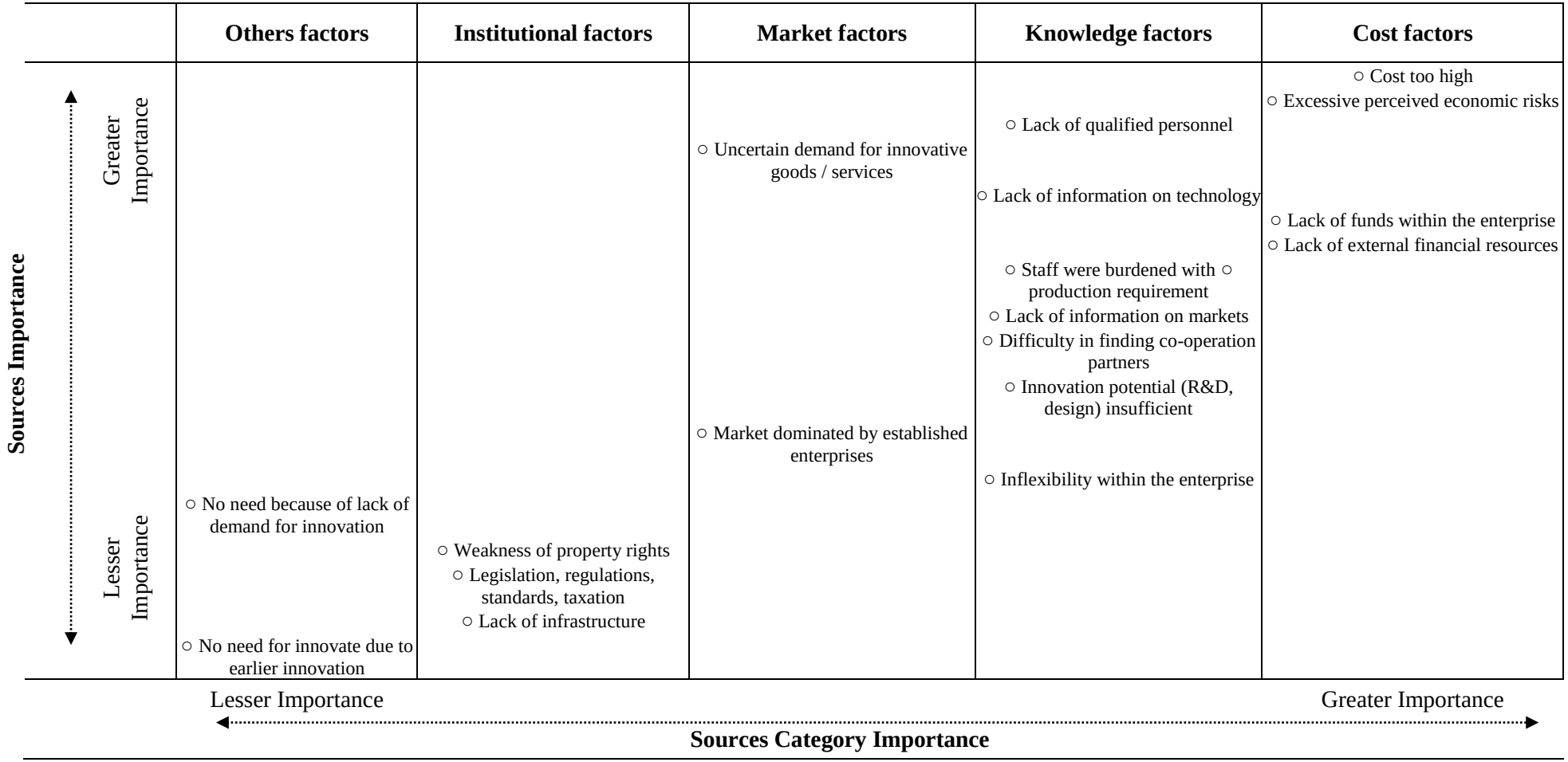
Notes:

n= the values vary due to missing values for certain respondents.

** The ranking is determined based on percentage of respondents that have selected the reference partner as "medium importance" and "highly important" to their innovation co-operation.*

Source: Author's survey (2006-2008)

Figure 5:15 The relative significance of different types of barriers to innovation



Source: Author's survey (2006-2008)

5.3.6 Protection of Intellectual Property

Innovators were also asked for information regarding their use of formal and strategic methods for protecting their intellectual property, and then to rate the importance of the different intellectual property protection mechanisms using a 4 point Likert scale. The findings as depicted in Table 5:9 and Figure 5:16 show that most of the innovators felt that confidential agreement and trade secrecy were the most relevant to them. These were followed by trademarks, the registration of design, patents, and copyrights.

Table 5:9 Innovators' perception of the importance of the different types of formal and strategic methods of protecting intellectual property

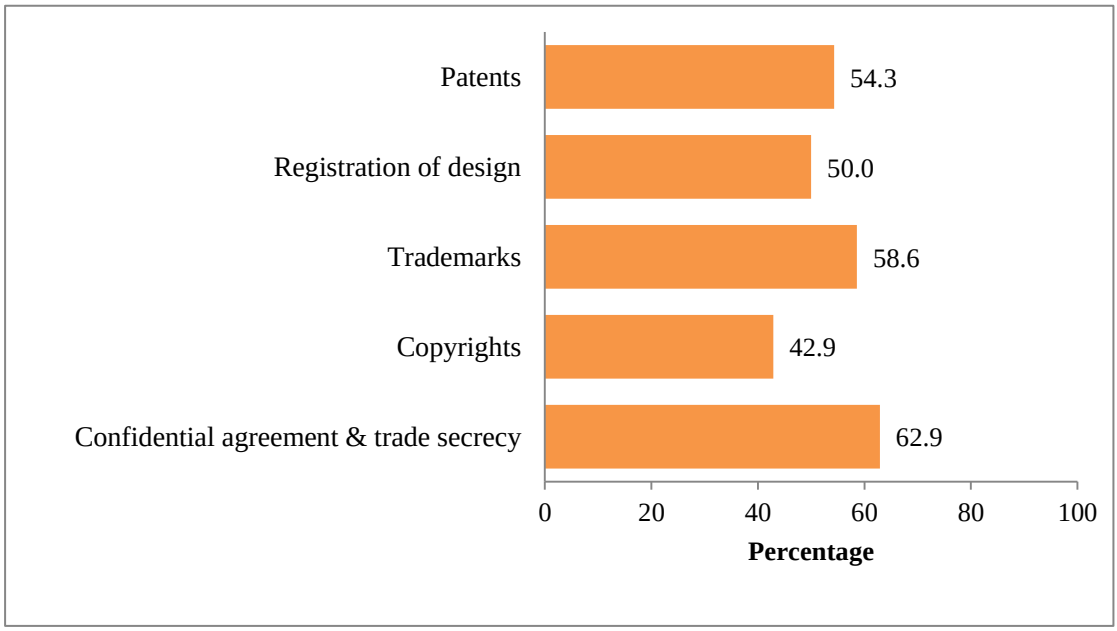
Methods of protecting intellectual property	*n*	Relative importance (%)				Ranking* (Medium or highly importance)
		Not used	Low	Medium	High	
Patents	70	45.7	11.4	14.3	28.6	4
Registration of design	70	50.0	14.3	11.4	24.3	3
Trademarks	70	41.4	11.4	17.1	30.0	2
Copyrights	70	57.1	12.9	11.4	18.6	5
Confidential agreement & trade secrecy	70	37.1	5.7	22.9	34.3	1

Notes:

** The ranking is determined based on percentage of respondents that have selected the reference partner as "medium importance" and "highly important" to their innovation co-operation.*

Source: Author's survey (2006-2008)

Figure 5:16 Use of formal and strategic methods for protecting intellectual property



Source: Author's survey (2006-2008)

5.4 Correlation Analysis of Variables

The following part of this chapter will explore the correlation coefficient and differences among selected key variables in this study. The presentation of the tests results are structured according to the following themes:

a) Profile of innovators and innovation activities diversity

b) Innovation co-operation, sourcing and funding diversity

Variables used for the analysis, namely innovation activities diversity (*IAD*), innovation co-operation diversity (*CD*), knowledge and technology sourcing diversity (*SD*) and innovation funding diversity (*FD*) are also specified before the statistical tests were conducted.

5.4.1 Profile of Innovators and Innovation Activities Diversity[36]

As highlighted in section 5.2 in this chapter, the profile of responding enterprises were captured by six variables, namely *AGE*, *OWN*, *TURNOVER*, *MARKET*, *EMPLOYEE*, and *DEGREE*. In any innovation survey, efforts to identify if there was any significant correlation between these variables and types of innovative activities carried out by the respondents are always an important task. In the case of this study, the innovation activities diversity (*IAD*), or the capability of innovators to perform various types of innovation activities, was measured as:

$$\text{IAD} = \sum \text{score of all innovation activities} / 7$$

Since these profile's variables for innovators were not normally distributed, Spearman's correlation coefficient test was conducted to identify the correlation between these variables and *IAD*. The test results are presented in Table 5:10.

[36] These innovation activities were: in-house R&D, acquisition of external R&D, purchase of external knowledge, acquisition of machinery, equipment and software, all design functions, market preparation, and training. The higher *IAD* score indicates that the innovators were more active in innovation.

Table 5:10 Test for correlation between profile's variables and *IAD*

			Year of establishment	% of local ownership	Turnover in 2008 (RM)
Spearman's rho	Innovation activities diversity (*IAD*)	Correlation Coefficient	.121	.255*	.051
		Sig. (2-tailed)	.333	.037	.744
		N	66	67	44

% of turnover derived from export	Number of fulltime employees	% of employees educated to degree level in science & engineering
-.019	-.010	-.142
.889	.935	.287
55	69	58

As shown in the *p* values of the test results, i.e. $p > .05$, all the profile's variables, except the ownership structure, had no significant correlations with *IAD*. This indicates that the age, annual sales turnover, market structure, number of fulltime employees, and percentage of science and engineering staff for the innovators did not establish significant correlation with their innovation activities. In terms of ownership structure, the Spearman's Rho [r (n=67) =.255, p <.05] indicates that there was a positive correlation between the ownership structure with their innovation activities. However, as shown by the r value is in the range of 0.01 – 0.30, this indicates that the correlation was very weak. In summary, types of innovation activities carried out by the innovators were not significantly correlated to their profile. If there was any, the significance level would be very low.

In order to ascertain the test results above, Mann-Whitney U tests were carried out to determine if there is any significant difference between the *IAD* with the size of innovators (categorised into small and medium-sized),[37] and the market structure (categorised into mainly local market and mainly export market oriented). The Mann-Whitney U test evaluates whether the medians on a test variable differ significantly between two groups. If a significant value from the Mann-Whitney U test, the *p* value, is smaller than 0.05, it shows that there is a significant difference between the two variables. The two tests results are shown in Table 5:11. As shown in the column of asymptotic significance, all the *p* values were greater than 0.05. The results confirmed the previous correlation tests, in which there is no significant difference between the innovation activities carried out by the respondents and their profiles.

Table 5:11 Test of differences between IAD with size of firms and market structure

	Size of firms (small, n_1=34; medium, n_2 =33)				Market structure (mainly local market, n_1=21; mainly export market, n_2 =34)			
	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)	Mann-Whitney U	Wilcoxon W	Z	Asymp. Sig. (2-tailed)
Innovation activity diversity (*IAD*)	543.500	1138.500	-.223	.824	306.000	901.000	-.898	.369

[37] As mentioned in Chapter 1, Section 1.5, the size of firms is classified based on two criteria, namely the annual sales turnover, and number of fulltime employees. In the case of this test, the classification firm's size based on number of fulltime employees was adopted because it has less missing values. In the data obtained through the survey, there was only 1 missing value for number of fulltime employees. However, for annual sales turnover, there were 26 missing values.

5.4.2 Innovation Co-operation, Sourcing and Funding Diversity

In the survey, the respondents were asked to rate from not used to highly important (0 – 3) on the importance of eight possible partners for their innovation co-operation activities, namely suppliers, clients or customers, competitors, consultants, other enterprises within the enterprise group, universities or other HEIs, government or PRIs, commercial laboratories and private R&D institutes. Innovation co-operation diversity (*CD*) for respondents in this study, therefore, was measured as:

$$CD = \sum \text{score of all partners} / 8$$

On the other hand, the ability to secure knowledge and technology from various sources is also a key success factor for innovators. In the survey, respondents were asked to rate from not used to highly important (0 – 3) on the importance of 18 possible sources of knowledge and technology for their innovation co-operation activities. These sources were categorised into four main groups, namely internal, external market and commercial, public sector, and general information. Based on the score gained by all the sources, the innovation sourcing diversity (*SD*) in this study was measured as:

$$SD = \sum \text{score of all sources} / 18$$

Also, the respondents were asked to identify the importance of five sources of innovation expenditure, namely own fund, related companies, financial institutions, government, supranational and international organisations. Hence, the innovation funding diversity (*FD*) for respondents in this study was determined as:

$$FD = \sum \text{score of all sources} / 5$$

Prior to the correlation tests of *CD*, *SD* and *FD*, a normality test was conducted in order to examine the distribution of these variables. The result of the normality test is presented in Table 5:12. The Kolmogorov-Smirnov test results show that the significant values, *p* for *CD* and *FD* are 0.200, which is greater than 0.05. This indicates that *CD* and *SD* are normally distributed. However, the *p* value for *FD* is smaller than 0.05, which indicates that *FD* is not normally distributed. Hence, Pearson's correlation coefficient test was employed to identify the correlation between *CD* and *FD*. On the other hand, Spearman's correlation coefficient test was employed to identify if there is a significant correlation between *FD* and *CD*, and *FD* and *SD*.

Table 5:12 Tests of normality for *CD*, *SD* and *FD*

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
co-operation diversity (*CD*)	.090	53	.200*	.967	53	.145
knowledge and technology sourcing diversity (*SD*)	.082	53	.200*	.974	53	.313
funding diversity (*FD*)	.349	53	.000	.723	53	.000

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Results for the correlation coefficient tests are presented in Table 5:13 and Table 5:14. Table 5:13 shows that there is a significant positive correlation between *CD* and *SD*, [$r_{(n=53)} = .733$, $p < .05$]. This means the higher innovation co-operation diversity, an innovator has higher technology and knowledge sourcing diversity. On the other hand, Table 5:14 shows that there is no significant correlation between the funding diversity and co-operation diversity, and between funding diversity and technology and knowledge sourcing diversity.

Table 5:13 Pearson's correlation coefficient test between *CD* and *SD*

		co-operation diversity (*CD*)	knowledge and technology sourcing diversity (*SD*)
co-operation diversity (*CD*)	Pearson Correlation	1.000	.733**
	Sig. (2-tailed)		.000
	N	70.000	53
knowledge and technology sourcing diversity (*SD*)	Pearson Correlation	.733**	1.000
	Sig. (2-tailed)	.000	
	N	53	53.000

***. Correlation is significant at the 0.01 level (2-tailed).*

Table 5:14 Spearman's correlation coefficient test between *FD* and *CD*, and *FD* and *SD*

			funding diversity (*FD*)	co-operation diversity (*CD*)	Knowledge and technology sourcing diversity (SD)
Spearman's rho	funding diversity (*FD*)	Correlation Coefficient	1.000	.116	-.016
		Sig. (2-tailed)	.	.340	.908
		N	70	70	53

5.5 Summary and Discussions on Survey Findings

This section provides the summary and discussions on the key survey findings. It is divided into five parts as follow: (a) characteristics of innovators; (b) factors assisting and hampering innovation; (c) knowledge and technology development; (d) partnership for co-operation and linkages, and (e) institutions.

5.5.1 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 percent of the innovative enterprises were micro-sized. However, further investigation shows that there was no significant difference between size of innovative enterprises (*SIZE*) with innovation activity diversity (*IAD*) (see Table 5:11). In other words, among the innovating SMEs in the wooden furniture manufacturing sector, there was no clear difference in terms of patterns and process of technological innovation activities.

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. This is observable in Figure

5:4 where 74 percent of the innovative enterprises indicated that they mainly serve the export market. Like size of innovating enterprises (*SIZE*), the investigation on the market structure (*MARKET*) and innovation activity diversity (*IAD*) shows that there was no significant difference between the two variables (see Table 5:11). This indicates that whether the innovative enterprises mainly served the domestic or export market, they commonly shared similar types of innovative activities.

Most of the innovative enterprises were mainly home grown. In fact, about 80 percent 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 FDIs from the MNCs. FDIs are 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 were 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 research intensive 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.

5.5.2 Factors Assisting and Hampering Innovation

The survey findings revealed that improving products and the delivery process e.g. 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 increase 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.

5.5.3 Knowledge and Technology Development

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 relatively 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, government agencies etc. 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 projects 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[38]. 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 ODM. 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.

5.5.4 Partnership 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 HEIs, the government and PRIs were seen as less significant.

[38] However, it is important to note that most of the innovators in this LMT industry do very little if any "R&D" strictly defined (e.g. science based research) but instead of other knowledge creation activities (e.g. design and application in advance of new markets).

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 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.

5.5.5 Institutions

In terms of sources of funding, the big majority of the innovating firms depend heavily on their own funding in pursuing innovation development. Since most SMEs have limited financial resources it might be interesting to examine policy options for overcoming these financial limitations. However, the fact that they exist within 'Woolgars' SME centric universe seems to suggest government policies are out of touch with SMEs in this sector. In the case of external funding, it was mostly secured from

financial institutions such as commercial banks indicating that the local commercial banks in general, have confidence in the furniture industry provided the track record of the loan applicants is good. Besides, almost all of the funding was secured locally, thus confirming the earlier contention that the industry was mainly driven by Malaysians. The contribution of FDI in the industry is not significant in investment terms. However, foreign firms are well be a source of income, forward investment justification (via large orders – banks will lend usually is there is evidence of forward order books), and design and market intelligence.

The innovating enterprises have to a certain extent employed some formal and strategic methods of protecting their intellectual property. In this regard, confidential agreements and trade secret were the most frequently used methods. This is followed by trademarks, patents, registration of design, and copyright.

5.6 Summary

The findings from this study support Woolgar, et al.'s (1998) so-called SME-centric universe, as shown in Figure 2:5 in Chapter 2 of this thesis. 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.

The next chapter provides insights into the technological innovation trends and activities in Muar furniture sector from the perspective of SIS. Explorations and descriptions are focused towards the knowledge and technology development, and main actors of innovation and the existing linkages among these actors. The roles of small and medium scale wooden furniture manufacturers are also given serious attention throughout the analysis.