An investigation of the potential for enhancing innovation within the Taiwanese Woodworking Industry.

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DECLARATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this thesis, that the original work is my own except as specified by acknowledgments or in footnotes, and that neither the thesis not the original work contained therein has been submitted to this or any other institution for a higher degree.

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Abstract

An investigation of the potential for enhancing innovation within the TWMMI

Due to political, economic, social and technological changes, traditional manufacturers of the TWMMI are facing a fight for survival. An effective strategy is urgently required to help manufacturers to turn these threats into opportunities. One strategy is increasing scope in order to compete with international rivals through creativity, combined with increasing productivity through technology in order to create competitive advantage.

This study investigates how SMEs within the TWMMI can improve their competitive advantage. It examines the impact on company performance of creativity and ICT based manufacturing technology.

A semi-structured questionnaire with open-ended and closed-ended questions was designed based on a SWOT assessment and literature review to find a positive correlation between creativity and ICT based manufacturing technology and improved business performance. Thus the questionnaire investigates how the TWMMI are dealing with the fact that they are no longer competing effectively in the woodworking machinery market as identified in the SWOT and whether they have implemented any strategic solutions, which are classified in the literature review to solve the problem.

From interviews with 30 respondent companies and 18 international customers conducted, results show that:

(1) Companies that implement of a high level of creative function achieve a greater level of creative success.

(2) It is not always the case that implementing a higher level of FMS combined with ICT is necessary to gain a greater level of improved business performance. Competitive advantage can be gained through outsourcing manufacturing of component parts to suppliers.

(3) The implementation of a higher level of creative function combined with some level of FMS and ICT or outsourcing may allow the TWMMI to achieve a greater level of improved business performance

The strategy recommended to follow includes individual companies co-operating together by investing capital in research and development promoting creativity. Furthermore, promotion of innovation in creativity and ICT based manufacturing technology is also required along with strategic promotion of creative skills in education and society to facilitate creativity in the business environment within Taiwan as a whole.

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Background to the research

Before this study, the author (Chai-yun Huang) was a General Manager in Machinery Tool Industry in Taiwan. She received her master's degree in Design Management at De Montford University.

My interest for this study first arose through the work experience I've had in this field whilst working in Taiwan. Having established a company with my brother in 1988, I was very much thrown into the world of the Taiwanese Woodworking machinery industry. Our company produced component parts for the TWMMI, thus through client interviewing and general business practice, I had a lot of contact with the owner managers of each firm and gradually developed an interest for this field.

Having moved to England, I was able to attain a more international point of view and was able to critically evaluate Taiwan in terms of its global position and compare it to other countries in the West. Most significant for me was the way businesses and industries differed between Taiwan and the Western Countries and how I discovered that in many industries, Taiwan was far inferior. I was pleasantly surprised, however, to discover that the TWMMI' market position as third in the global market. This filled me with a feeling of pride and I immediately became interested in furthering my knowledge of this area. Through further research, however, I discovered that there were in fact many weaknesses with the industry and in fact many of the owner managers were having difficult in developing adequate competitive strategies which would allow them to retain their market footing. I was thus intrigued into what could be done to alleviate the threats and weaknesses of the TWMMI at present and how the industry could build on its strengths not only to maintain their market position but, if possible, to become one of the market leaders in the international market of woodworking machinery industry.

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Chapter one Introduction

1.1 Summary

Chapter 1 – introduction

This section will provide contextual information concerning the historical development of the TWMMI. I will identify the challenges that the TWMMI now faces in order to survive. I will examine competition from its German and Italian competitors in terms of product innovation, and assess the competition it faces from cheaper product costs from the Chinese and South-East Asian markets. The section concludes with a SWOT analysis to identify strengths, weaknesses, threats and opportunities for the TWMMI. This identifies the key issues for the industry, including their inability to compete with China and South-East Asia due to higher labour costs and the inability to compete with Europe due to a lack of innovation. There are inherent contradictions within the SWOT analysis owing to the dual nature of small, family owned businesses and their underlying tensions but these will be resolved in chapter 6 of this thesis.

Chapter 2 - Literature Review

In Chapter 1 is SWOT analysis, I identified that the TWMMI can no longer compete effectively in the low-tech woodworking machinery. In order to survive in the long term and increase their market position in the international market, I believe that the TWMMI should utilise their strengths to innovate their products. Innovative products have helped the market leaders not only to build a good reputation in the global market but also own three times more market share than the TWMMI. Therefore, this empirical

study reviewed a wide range of literature related to innovation theories, defined the key concept and then explored possible strategic innovation solutions available to the TWMMI. The clarified solutions will be used as variables to develop the research framework for the TWMMI, described in the next Chapter.

Chapter 3 – Developing a model to increase the TWMMI's competitiveness

Chapter 3 will introduce the development of this empirical research model and three working hypotheses. Three working hypotheses are developed based on four variables: a creative function, FMS combined with ICT, increased creative success and improved business performances which are clarified in the subsequent literature review. The four working hypotheses underpin the research presented in Chapter 4 and 5. Hypothesis 1: the higher the level of creative function, the greater the level of increased creative success in TWMMI. Hypothesis 2: the higher the level of FMS and ICT, the greater the level of the improved business performance in TWMMI. Hypothesis 3: the higher the level of creative function, FMS combined with ICT, the greater the level of the improved business performance in TWMMI. Interviews were conducted during this empirical study to answer the three research questions, the outcome of which is presented in Chapter 4 and the correlation between innovation activities and their effectiveness on improved business performance are discussed in detail in Chapter 6.

Chapter 4 – Data analysis

This Chapter presents the results of the analysis of the data collected from the semi-structured questionnaire with open-ended and close-ended questions. The section begins with an analysis of a creative function and FMS combined with ICT, which are

undertaken by the TWMMI to improve business performance. A creative function involves funds, internal idea generation, external idea stimulation and creativity integration. FMS combined with ICT includes machining centres, conveyor system, robotics, design-manufacturing technology, administrative software technology and e-commerce. Increased creative success involves patent registering, diversification and government awards and improved business performance includes developing new product ability, developing new product speed, manufacturing lead time, delivery time, customers' response, geographical coverage and customers' satisfaction. The results of the questionnaires are examined to assess whether or not the TWMMI had implemented the creative function and FMS combined with ICT to improve their business performance. The analysis of results investigated in this section is then used in Chapter 5 to examine the correlation between innovation activities and their effects on improved business performance.

Chapter 5 – Discussions

This section provides a detailed analysis and discussion of the correlation between a higher level of creative function and a higher level of FMS combined with ICT and a greater level of improved business performance. The results of thirty companies were correlated on a quadrant graph to examine whether there is a greater level of improved business performance when there is a higher level of creative function and a higher level of FMS combined with ICT. From this conclusions were developed to test hypothesis 1, 2 and 3.

Chapter 6 – Impact on TWMMI

Chapter 6 is an analysis of how current TWMMI practice fits against the three hypotheses (testing how TWMMI's current working practices map onto the three hypotheses and show where there are strengths and weaknesses – gap analysis - in their current working practices). This empirical study in Chapter 4 and 5 show that one of the key areas of failure for the TWMMI is a lack of investment across all three key areas identified in the hypotheses. The reason why the TWMMI cannot produce breakthrough products is that the investment in creativity is too widely distributed throughout the TWMMI network and production capacity is limited. At present, individual companies do not have sufficient resources to effectively invest in creativity. Therefore the key recommendation from this analysis is that at micro level, the TWMMI would benefit from investing in creativity and manufacturing technology by a corporative approach to future market expansion and sustainability i.e. individual companies pool their resources to provide sufficient investment in creativity to benefit all the companies in Taiwan and allow them to compete effectively with the market leaders. The key recommendation from this study at macro level is that Taiwan would benefit from the Taiwanese government, society and industry (ie in this study the TWMMI) working together as a whole to increase competitiveness in order to compete with their international rivals.

Chapter 7 – Conclusions

This section is a summary of the earlier work. It introduces briefly the background of the TWMMI. The initial remit was to investigate the relevance of e-commerce and the impact on competitiveness for the TWMMI because the TWMMI believed their

problems with competition were based on their inability to communicate effectively in their marketing of products on the global market. However, following initial investigations and the construction of the SWOT analysis it became clear that the problems with competitiveness relate to the positioning of their products in a low cost market which is no longer viable following the entry into the market of China with lower cost structures. Hence there is a need for the TWMMI to reposition its products in order to be able to compete effectively. This section stresses that the key reason of this empirical study is whether and why innovation is important to the TWMMI. Three critical questions are answered in this section. These are (1) Does implementing a higher level of a creative function mean that the Taiwanese woodworking machinery manufacturers have a greater level of increased creative success? (2) Does implementing a higher level of Flexible Manufacturing Systems combined with Information Communication Technology mean that the Taiwanese woodworking machinery manufacturers have a greater level of improved business performance? (3) Does implementing a higher level of a creative function, Flexible Manufacturing Systems combined with Information Communication Technology mean that the Taiwanese woodworking machinery manufacturers have a greater level of improved business performance? The contribution of this empirical study is clearly demonstrated in this section and it further clarifies the limitations of the study as well as opportunities for future research.

1.2 Historical Context

The woodworking machinery industry manufactures a range of woodworking machines for furniture companies to produce wooden furniture. The Taiwanese woodworking machinery manufacturers tend to produce low-tech products targeting the Asian and U.S.

DIY market. However, after joining the WTO in January 2002, Taiwan encountered intensive competition from high precision German and Italian producers and lower costing South-East Asian and Chinese producers. This thesis aims to explore the possible options Taiwanese Woodworking Machinery Manufacturers can adopt to compete with their market rivals.

1.3 Woodworking processes and machinery

The primary function of woodworking machines is to process logs into wood of various shapes which can be assembled into different items. There are 3 stages for processing the raw materials, i.e. converting the log into the finished product. The first stage involves splitting the log into a number of horizontal bands, (usually four), carried out by the splitting & sawing machines, and then drying the timbers using specialised drying machines. The second stage of processing involves filing and compressing the timber into identical shapes, size and density which can then be moulded into the desired shapes. This is done first by a moulding machine and then the woodworking lathes. The sanding machines then polish the moulded wood to smooth out rough edges and surfaces. A bending machine is used to trim the edges of wood into different angles or shapes, and then various holes are punched into the polished wood for assembly. The third and final stage is done by painting the wood different colours with a roller coater or UV flow coater then drying it with UV curing machines. In this particular industry, individual manufacturers are specialised in the type of woodworking machine (planning/sawing/milling/moulding/bending) they wish to produce. This means they can concentrate on their particular speciality hence, more are able to compete internationally.

1.4 History of the Woodworking Machinery Industry in Taiwan

The Woodwork Machinery Industry in Taiwan has been shaped by the political, economical and culture history of the nation. Taiwan was occupied by the Japanese for 50 years between 1895 and 1945. During that period, the Japanese government exploited many of Taiwan's natural resources; especially gold and wood. In order to remove the wood, it was necessary to import woodworking machines from Japan. Subsequently, following the Second World War, the Taiwanese economy deteriorated, prompting the Taiwanese government to impose limitations on imports. One such import was woodworking machines and the new limitations allowed only publicly owned businesses to have free importation of these machines. Privately owned businesses had to rely on the second hand machines left during the Japanese occupation.

Owners of old Japanese machines found that frequent repairs were necessary. These repairs allowed the workers to discover how the machines were made and operated. This new skill allowed them to reproduce copies of the Japanese machines and to improve modified ones. The first Taiwanese Woodworking machine was produced in 1954 by the Sheng Feng Company. Wun-Zen Chang who made this machine was, at that time, working as a production manager of the Sheng Feng Company. He saw a future in the woodworking machinery industry and so branched out and established his own company, called Champ Fond Machinery Company in 1964. This split led to the development of two factions in the Taiwanese Woodworking Machinery Industry; one with the Sheng Feng Company based on producing simple sawing and hand jointer

machines, the other was with the Champ Fond Company producing simple drilling, and boring machines.

In 1974 further product modifications took place as employees from these companies branched out and established companies of their own. These new companies redesigned the existing products, for example, a modified one-side planner to a two-side planner, subsequently introducing them into the market. In actual fact, these new companies were not able to design a two-side planner by themselves. They imported two-side planners from American companies and then took them apart to imitate the function of the American products. During this time, most of the products such as milling or moulding machines were sold in the domestic market. Only a few were exported to America. This imitation strategy allowed new companies to make considerable profits and as a result, Taiwanese woodworking machinery companies established the norm of imitating products from developed countries such as Japan, Germany and U.S.A.

From 1974 to 1984, many more companies were established. The rapid increase stemmed from a typically Taiwanese desire to be one's own boss, which was helped by the cheaper land and labour available at that time. New products produced during this period were sanding and coating machines but the majority of these products were imitated from the Japanese and then exported to China. In the late 1980s, due to a labour shortage, environmental protection movements as well as the pressure of globalisation, many furniture manufacturers were striving to internationalise their operations and moved their production lines to different countries, such as North America, South East Asia and China, (Cohen 1997).

During the 1990s, Japanese national policies focused on car and electronic industries thus ignoring the woodworking machinery industry, giving the TWMMI an opportunity to replace the Japanese position in the international market. With the help of American technology and Japanese expertise in R&D, as well as the imitation of high quality products from European countries, the TWMMI was, towards the end of 1990s, in third place in terms of export and in the fourth place in terms of productivity in the international market (Taiwantrade 2003).

By 2000 approximately 10.9 percent of Taiwan-made woodworking machines were sold to domestic buyers, (Taiwantrade 2003). The percentage of domestic sales has continued to decline each year since 1994. This demonstrates that Taiwanese woodworking manufacturers were moving towards export-orientated industries. After joining the WTO in January 2002, Taiwanese enterprises encountered intensive competition from foreign competitors in the domestic market due to the non-imposition of tariffs on international trading activities. Consequently, Taiwan's Woodworking Machinery manufacturers are not only facing competition in the domestic market and from high precision German and Italian products but also from lower costing South-East Asian and Chinese products(News 2000).

For the future, to overcome the fierce competition, TWMMI must develop effective strategies to compete with their international rivals successfully. Future success will come from matching opportunity with capability, as emphasised by Newman, Logan, and Hegarty (1985), who conceptualised a framework to help companies visualise their position in their marketplace. This framework may assist the TWMMI to evaluate areas

in which they can exploit strengths, minimise weaknesses, capitalise on opportunities and reduce threats. To assess the value of such a framework this thesis will explore the options of the TWMMI. This assessment begins with the strengths of the TWMMI, weaknesses, threats and opportunities of the TWMMI.

1.5 SWOT analysis of the TWMMI international market performance

A SWOT assessment identifies that the TWMMI have three strengths: proximity to suppliers' resources support, position as third in the international market and formed as small, family owned businesses (flexible management).

The TWMMI have two weaknesses: companies have been formed as small, family owned businesses and there is insufficient level of foreign language capability.

The TWMMI have six threats: the market leaders competing with high- tech products penetrating Asian market, new rivals competing with low price, political issues, currency problems, shortage of wood and an increased price of raw materials.

Finally, the TWMMI have two opportunities: government education and training programs to cultivate skilled workers, and diversify into semi-conductor industry.

The next section assesses in more detail business activities and the market position of the TWMMI at the present time.

1.5.1 Strengths

A major strength within the TWMMI is that their suppliers are close by and can be easily and conveniently contacted. This not only saves on transportation costs but also allows orders to be modified quickly and efficiently. More importantly, the suppliers have close relationships with the TWMMI, thus providing an extra channel of idea source, assisting TWMMI in the technical development of their new products.

A further strength of the TWMMI is its market position as third in the world, as a consequence it has sufficient standing to compete with its international rivals.

Furthermore, the majority of the companies are small, family owned businesses (Cohen 1997). This enables quick decision making and allows new competitive strategies to be implemented more easily, allowing the TWMMI to react to market changes quickly and efficiently, avoiding the dangers of the Asian economic crisis suffered by other Asian countries in 1997.

1.5.2 Weaknesses

Although the size of the TWMMI companies has been seen as strength above, in many instances this aspect of the TWMMI can also be deemed a weakness. It is through Taiwan's unstable history, involving conquests from Portugal, the Dutch, China and Japan, (Yeh 1998) that many business enterprises have become wary at investing much

capital into expanding their businesses, resulting in the majority of the TWMMI being small, family owned businesses. Being small, family owned businesses may prevent the TWMMI from developing and manufacturing new products. As Acimall Asia (1998) pointed out, TWMA, the Taiwanese Woodworking Machinery Manufacturers' Association encompasses 260 companies, and of these 260 companies only seven companies had either the size or ability to compete with Italian and German producers. Acimall Asia stated that Italian Woodworking Machinery Manufacturers' Association had about 153 companies on its list while, the VDMA, the German Woodworking Machinery Manufacturers' Association had about 150 companies listed. The size of the firms means that the TWMMI often have insufficient capital to invest in business activities such as innovation.

An insufficient level of foreign language skills also prevents the TWMMI from selling their products worldwide. According to Taiwantrade (2003), in 2000 only about 10% of the Taiwan-made machines were sold in the domestic market, 90 % of them were exported. This means that the sales force play an important role in this industry. Salespeople not only need to have selling techniques but also the ability to speak a foreign language, particularly English because it is the world business language. However, most of the owners or sales people of this industry graduated with vocational degrees, which focused on engineering qualifications with little knowledge of foreign languages. Therefore most of them have difficulties in using foreign languages particularly as regards to oral communication to take orders from foreign customers.

1.5.3 Threats

The Taiwanese Woodworking Machinery manufacturers are unable to develop and manufacture the high-tech machines that the German and Italian producers are able to create. This evidence can be seen in table 1 (pp: 20), taken from the (2002) Annual report of the Italian Woodworking Machinery Industry. Taiwanese producers only covered 11 items with almost 40 % of sales generated by exporting sawing machines. This type of product requires only low technology to manufacture, enabling the TWMMI to produce them relatively easily. Due to the low-tech nature of the TWMMI's products, they are unable to demand premium prices from customers as the market leaders are able to do.

Taiwantrade (2003) states that in order to minimise production costs, Taiwanese manufacturers emphasise low-tech products to compete with their international rivals. The low-tech products will attract new rivals at the outset because it does not require manufacturers to invest heavily in high level of innovation. Taiwanheadlines (2003) reported that new rivals, e.g. the South-East Asian and the Chinese producers, with government support and low labour cost are able to produce the low-tech products with relative ease and can manufacture and market them at significantly lower prices than the TWMMI. The TWMMI's profitability will be threatened by the South-East Asian and the Chinese producers' price strategy because the TWMMI's market strategy aims to produce low-tech products at low prices to compete with international rivals.

As can be seen in Table 1 (over page), taken from the 2002 Annual report of the Italian Woodworking Machinery Industry, 14 main products were produced and exported by German manufacturers in 2002. In order to maintain market leadership in this industry, German producers seemed to focus on new product development. This is because 23.15 % of its sales in total were generated by exporting new products, (machines that can carry out different types of machining operations without tool changing between operations) hence it contributes to the biggest sales in the product category for German producers. These machines were produced only by German and Italian companies, which demonstrated how these two countries emphasise the importance of new product development.

Although the Italian manufacturers are able to produce machines which can carry out different types of machine operations without tool changing between operations, it only contributes 4.25 % to their total revenue. This shows that much of the market share in this sector is still dominated by the Germans. According to the annual report, the Italian Woodworking Machinery Industry 2002, Table 1.1 (over page) illustrates that approximately 35 % of the Italian producers' revenue was created from other machine-tools handling. These products involve handling tools, which assists the main products' operation functionality.

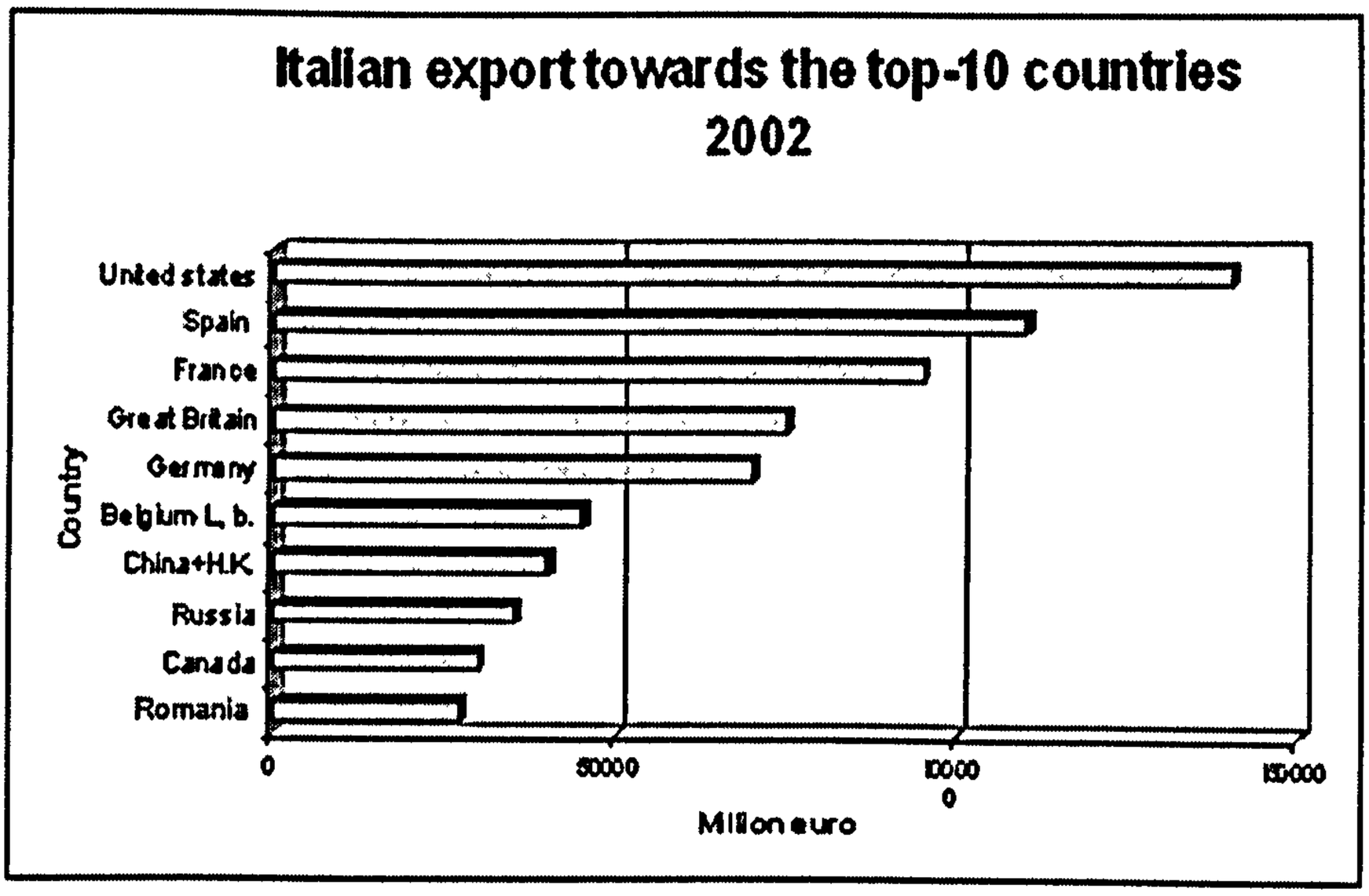
Table 1.1 The main three exports' sales in products' category in 2002

Items	Product's description	Germany	%	Italy	%	Taiwan	%
1	Machines can carry out different types of machining operations with tool changing between operations	30983	2.13	71891	5.78	3303	0.40
2	Machines can carry out different types of machining operations without tool changing between operations	336194	23.15	52891	4.25		
3	Sawing machines	196564	13.53	132859	10.68	328,594	39.84
4	Planning, milling or moulding(by cutting) machines	189267	13.03	65955	5.30	74456	9.03
5	Grinding, sanding or polishing machines	38150	2.63	51953	4.18	76997	9.33
6	Bending, or assembling machines, presses included	96455	6.64	24990	2.01	11134	1.35
7	Boring and mortising machines	84140	5.79	138584	11.14	33854	4.10
8	Splitting, slicing or parting machines	62826	4.33	31355	2.52	16984	2.06
9	Woodworking lathes	3588	0.25	7939	0.64	9053	1.10
10	Other machine-tools handling the main machines	55223	3.80	423318	34.04	188983	22.91
11	Presses for the manufacturers of particle or MDF board-3010	169196	11.65	29668	2.39	676	0.08
12	Presses for the manufacturers of particle or MDF board-3090	14808	1.02	94014	7.56		
13	Parts and accessories of machines of heading the main machines-9220	23334	1.61	8220	0.66	80804	9.80
14	Parts and accessories of machines of heading the main machines-9280	151678	10.44	109961	8.85		
Total		**1452370**	**100**	**1243635**	**100**	**824838**	**100**

The German and Italian producers are not only able to develop and manufacturer high-tech new products but are also able to bring them into a wider market range. This evidence can be seen from figure 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6.

In order to minimise their risks in the global market, the Italian producers sold their products into their main markets relatively evenly, (figure 1.1). Figure 1.1 shows Italian export towards the top10 countries.

Figure 1.1 Italian exports towards the top-10 countries



In 2003, Italian producers seem to have shifted their concentration from Western European countries to Eastern European countries (Figure 1.2 and 1.3). Figure 1.2 (pp: 22) and 1.3 (pp: 22) show Italian export by geographical area. Since East European countries 'opened their doors' to attract investments from foreign countries, it has facilitated their economic growth. As a result, they may have more resources and demand for the woodworking machinery to assist their infrastructure construction.

Figure 1.2 Italian Woodworking Machines export by geographic area in 2002

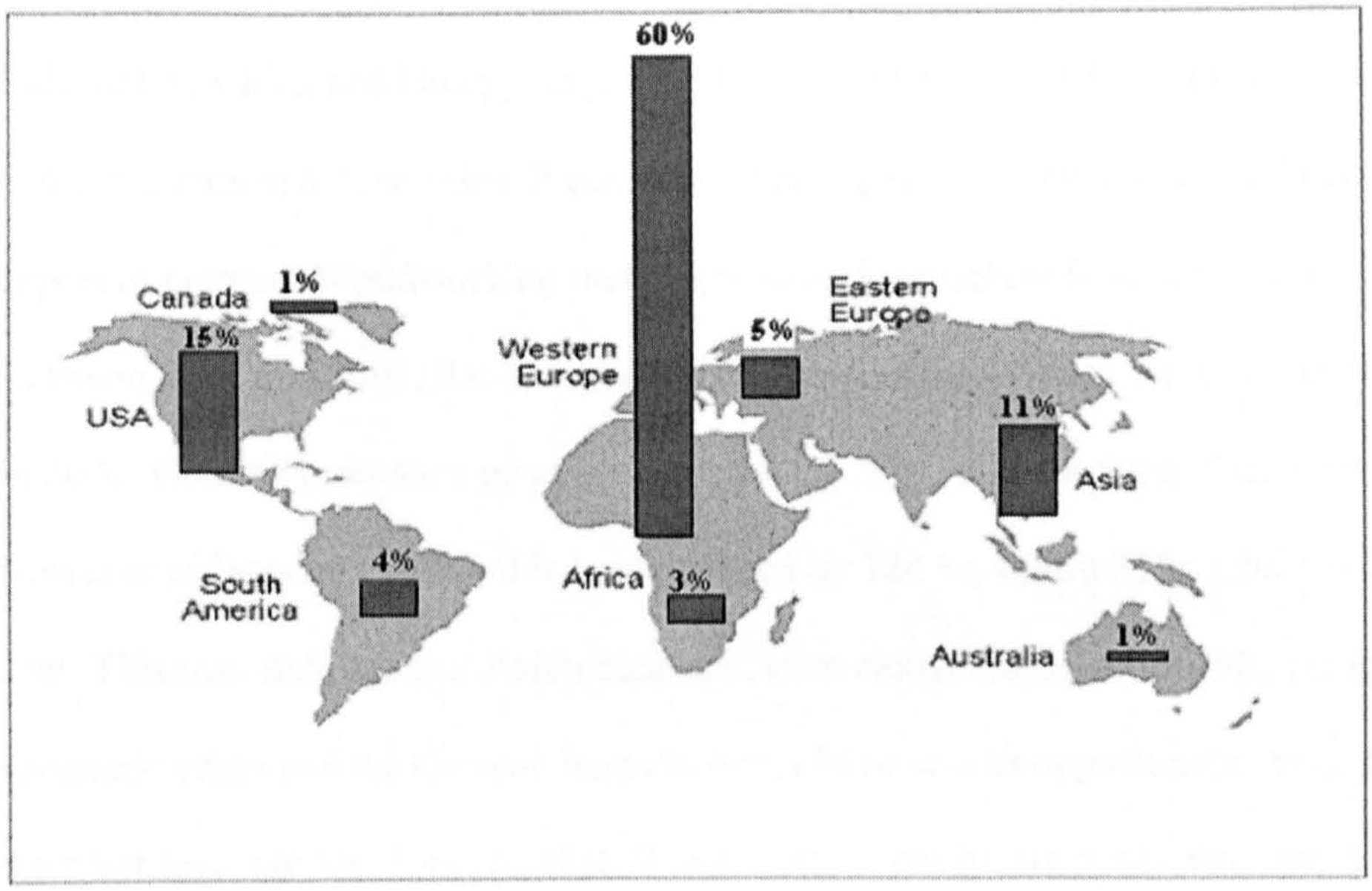
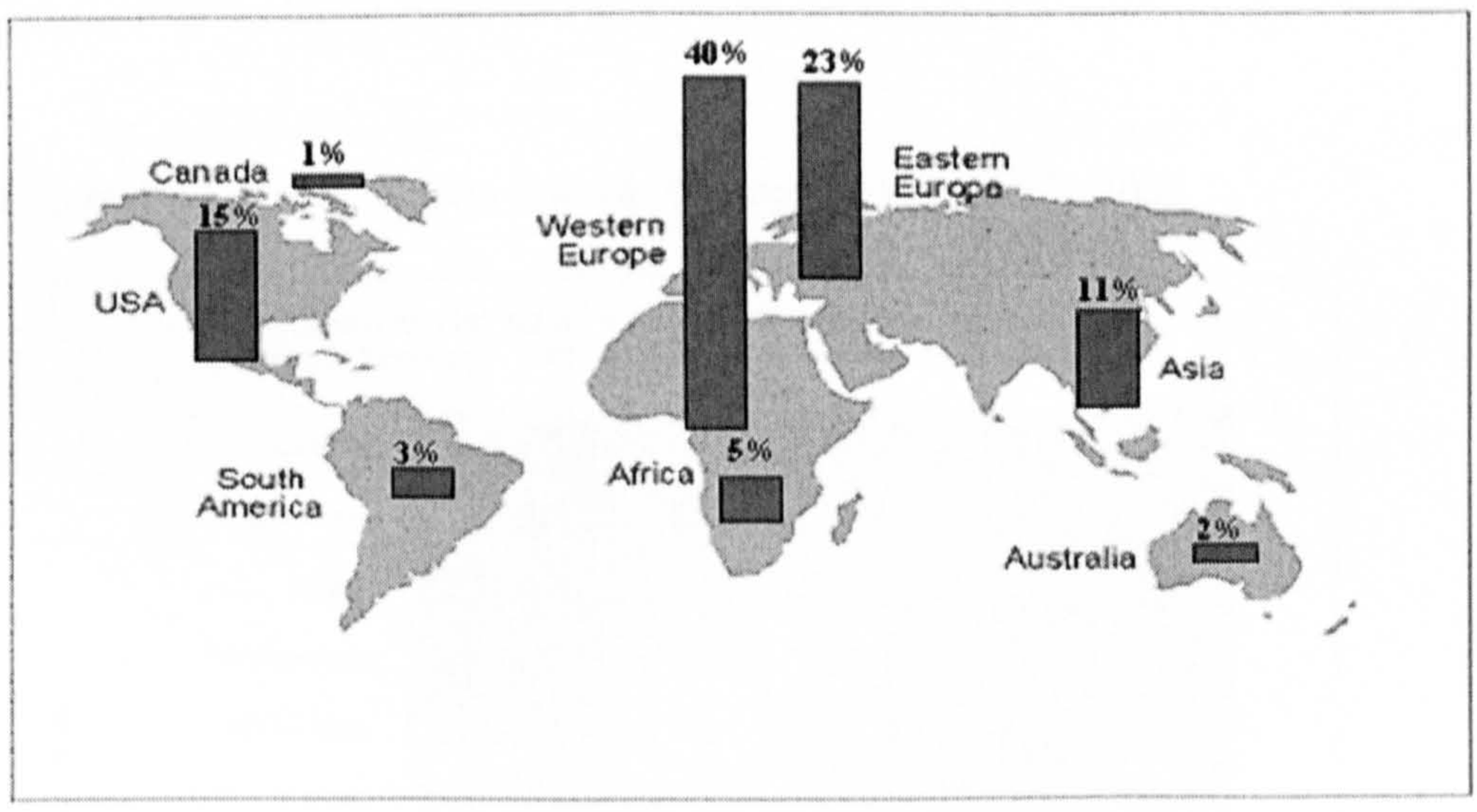


Figure 1.3 Italian Woodworking Machines export by geographic area in 2003



In order to increase their market share, the market leader has penetrated into the Asian market, in particular Thailand. This evidence can be seen in figure 1.4, 1.5 and 1.6.

Figure 1.4 represents German exports to the top 10 countries in 2002, (VDMA 2004) The U.S. was the biggest market for German producers and created 10 % of sales, followed by China and Hong Kong, which generated close to 8 % and France which generated almost 6 % of sales. Figure 1.5 (over page) shows the major markets for the export of German Woodworking machinery to major markets from Jan.-Sept. 2003. Between 2002 and 2003, the Thai market has entered into the top ten German export list. In 2002, German producers generated less than 5 % of sales from the Thai market. However in Jan.-Sept. 2003, this has increased by 724 %, followed by China with 9 per cent. This may indicate that Asian countries have recovered from the 1997 Asian economic crisis and the German manufacturers have sought opportunities to expand their territory into the Asian market. When German producers penetrated into this market, the TWMMI would lose their market share to the market leaders. Consequently, the TWMMI's profitability would decrease.

Figure 1.4 German exports towards the top-10 countries in 2002

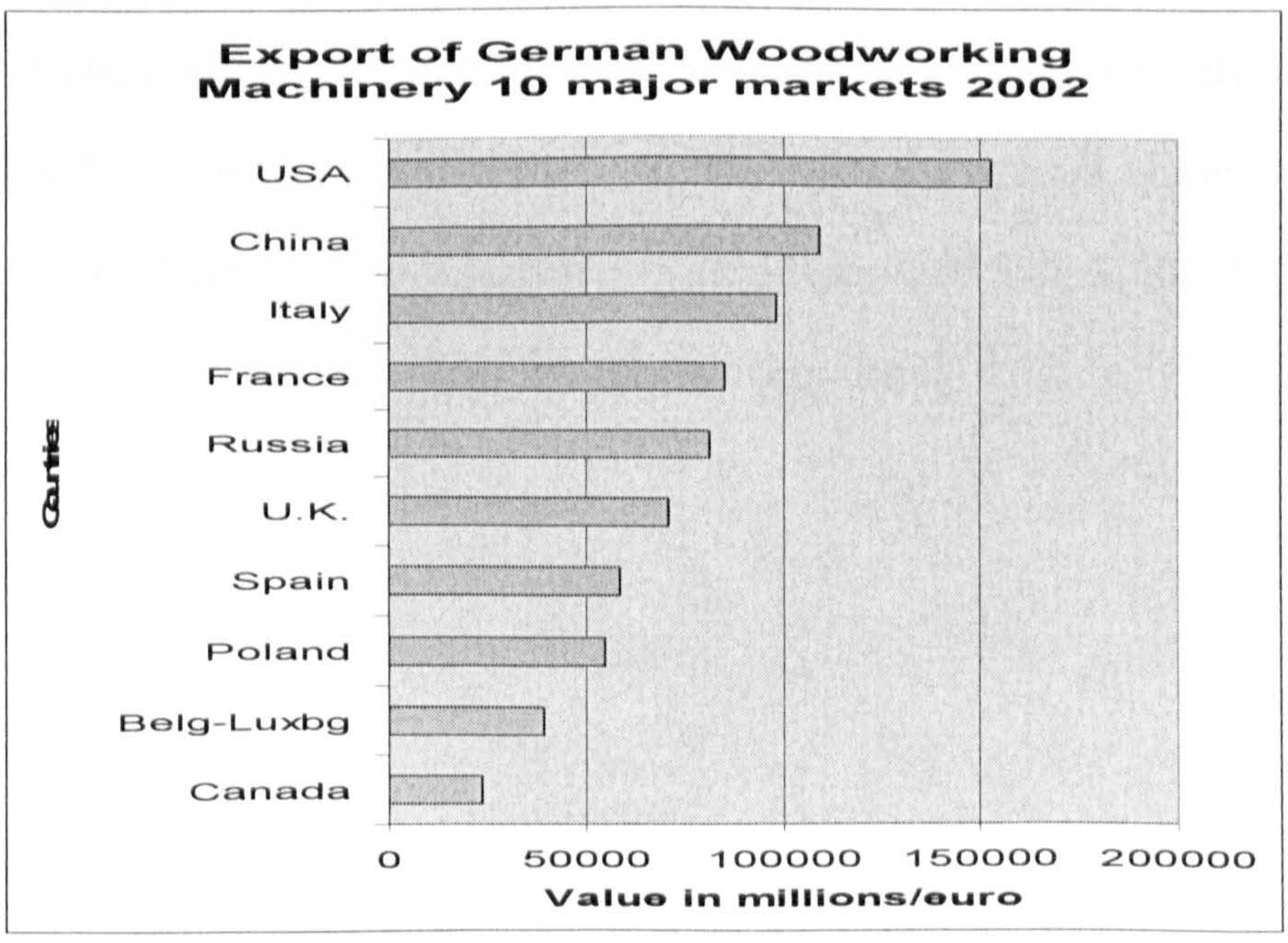


Figure 1.5 German exports towards the top-10 countries in Jan.-Sept 2003

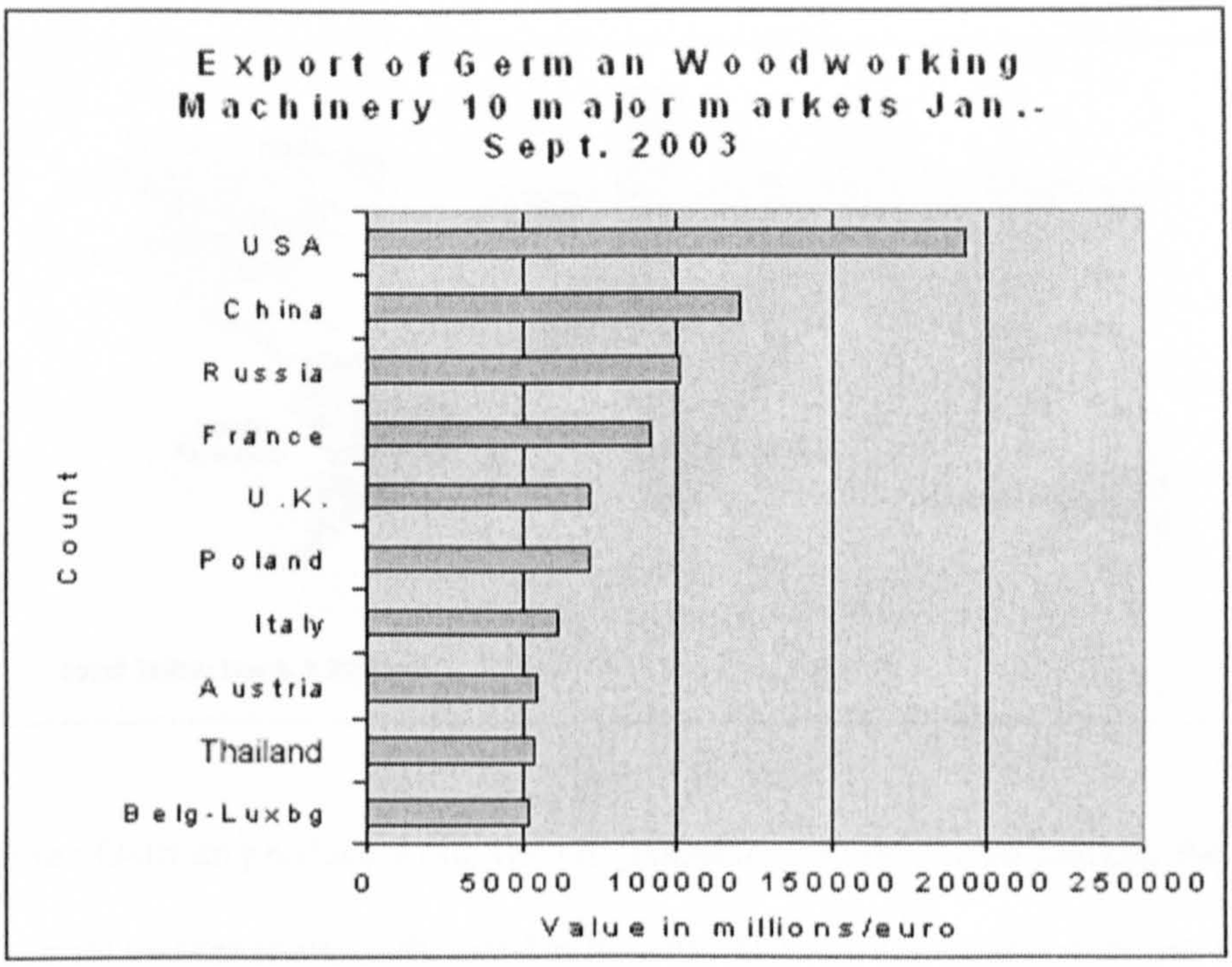
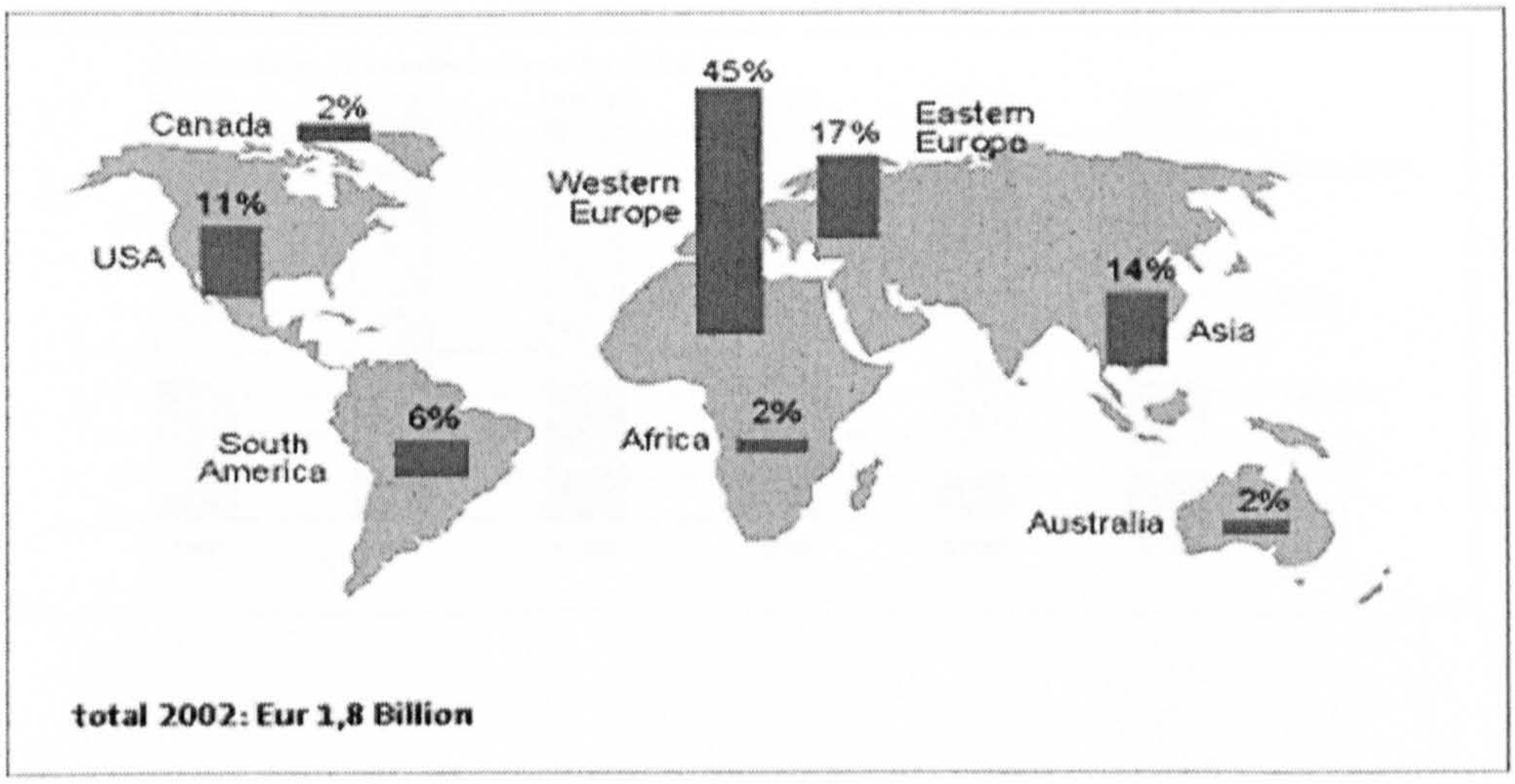


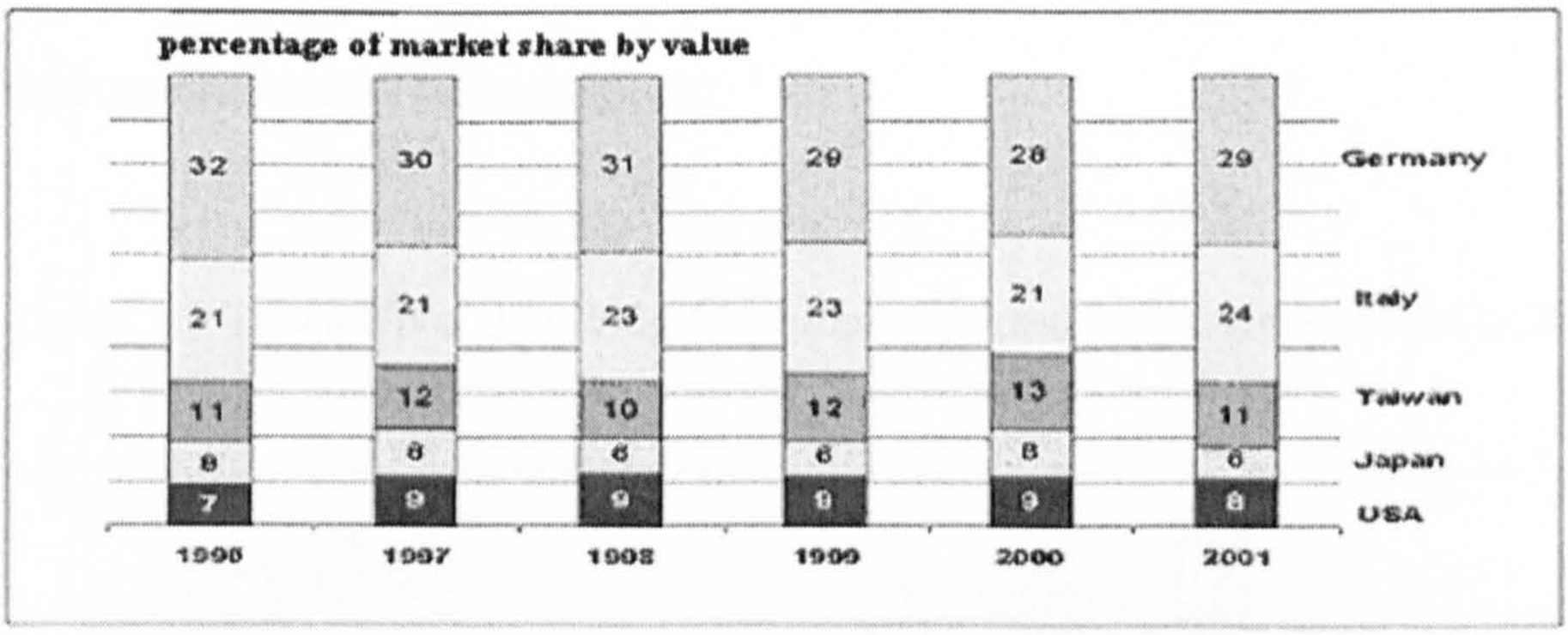
Figure 1.6 (over page) provides the details of exports of German Woodworking Machines: Worldwide in 2002. As can be seen in the diagram, the market leader focused their market share on European countries with a total of 62 %, while less attention was paid to South America, Africa and Australia, which only obtained 6, 2, and 2 % of market shares respectively. The German producers, however, believe that Asia is a potentially large market for future expansion. As a result, 14 % of market share in this region was owned by German exporters.

Figure 1.6 German Woodworking Machines exported by geographic area in 2002



If the German producers continue to penetrate into the Asian market, the TWMMI will lose its market share to the market leaders. The market leaders may use their economies of scale (the more the product produced, the lower the cost would be) to compete with the TWMMI. As a result, the TWMMI's profit margin will be threatened by the market leader. As can be seen in Figure 1.7 (over page), although the TWMMI was the third largest producer of woodworking machinery in terms of value, German Manufacturers (the market leader) owned almost three times the market shares than that of Taiwanese producers. Italian producers (the market challenger) also possess more than twice the market share than that of Taiwanese manufacturers.

Figure 1.7 World Trade of Woodworking Machinery from 1996 to 2001



Taiwanese woodworking manufacturers did not seem to be aware that these threats are still developing and that they were manufacturing low-tech products and bringing them into a narrowed market. This evidence can be seen from Figures 1.8, 1.9 and 1.10.

Figure 1.8 (over page) shows Taiwanese Woodworking Machinery export by geographical coverage in 2002, (VDMA 2004) Taiwanese manufacturers owned 32 % of the market shares in the Asian market. However, if this market share excluded exports to China, the number would be a mere 22 %. This figure indicates that the Chinese market plays an important role for this industry because it amounts to nearly 10% of the market shares in Asia. Almost 30 % of market shares for the TWMMI are produced from the African region. This may be because Africa is a less economically developed continent (LEDC), which requires the machines to build up their infrastructure. Thus, the price issue may be a major concern for African countries. The TWMMI created 26 % of market shares from the U.S. whereas only a small amount of market shares was produced from Western European countries. This may be due to the fact the European countries, being more economically developed countries (MEDC),

demand more advanced woodworking machines for their production. Their proximity to the leading competitors in the market, Italy and Germany, may have also decreased their purchase of Taiwanese goods.

Figure 1.8 Taiwan Woodworking Machines exported by geographic area in 2002

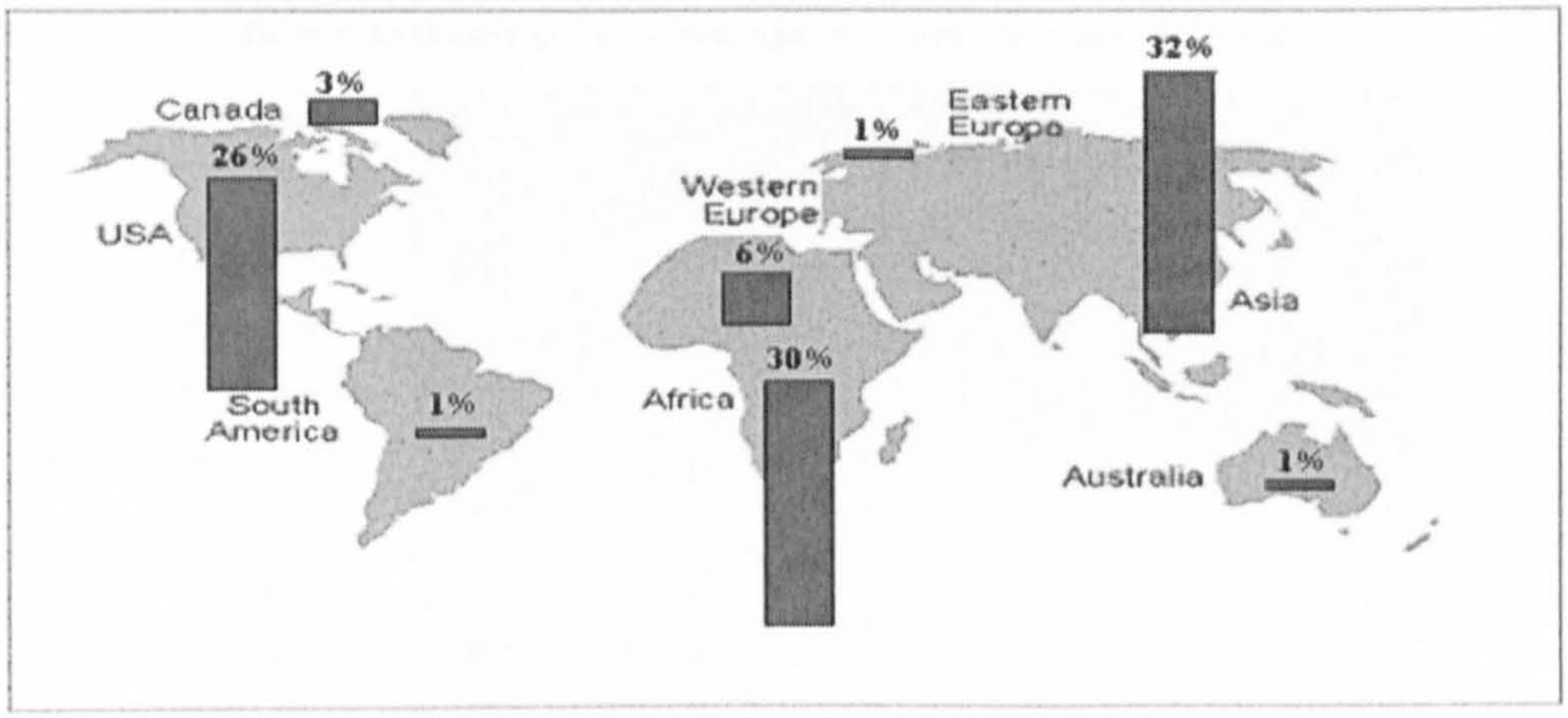


Figure 1.9 (over page) and 1.10 (pp: 29) represent the exports of Taiwan Woodworking Machinery in 2002 and 2003, (TWMA 2004). There were no changes to the TWMMI's market concentrations between 2002 and 2003 which related to no change in the TWMMI market strategy. TWMMI's sales still relied heavily on the U.S. market. These reports showed the Taiwanese manufacturers concentrated only on the U.S., Chinese and Canadian markets. The United States was Taiwan's biggest export market accounting for 50 % of the country's exports. Following the United States was China, with almost 20 % of the total export followed by Canada, Vietnam, Malaysia, Indonesia and Thailand, etc. South-East Asian countries remain a key market for Taiwanese producers due to its plentiful resources of wood and similar culture as well as business ties with Taiwan. This immense reliance of over 50 % on the US market can be quite

risky. For instance, the September 11th, terrorist attack on the U.S. in 2001 significantly affected this industry's business performance. Sales value dropped by 34% in 2001 compared with 2000, (see Figure 1.11pp: 29).

Figure 1.9 Taiwan exports towards the top-10 countries in 2002

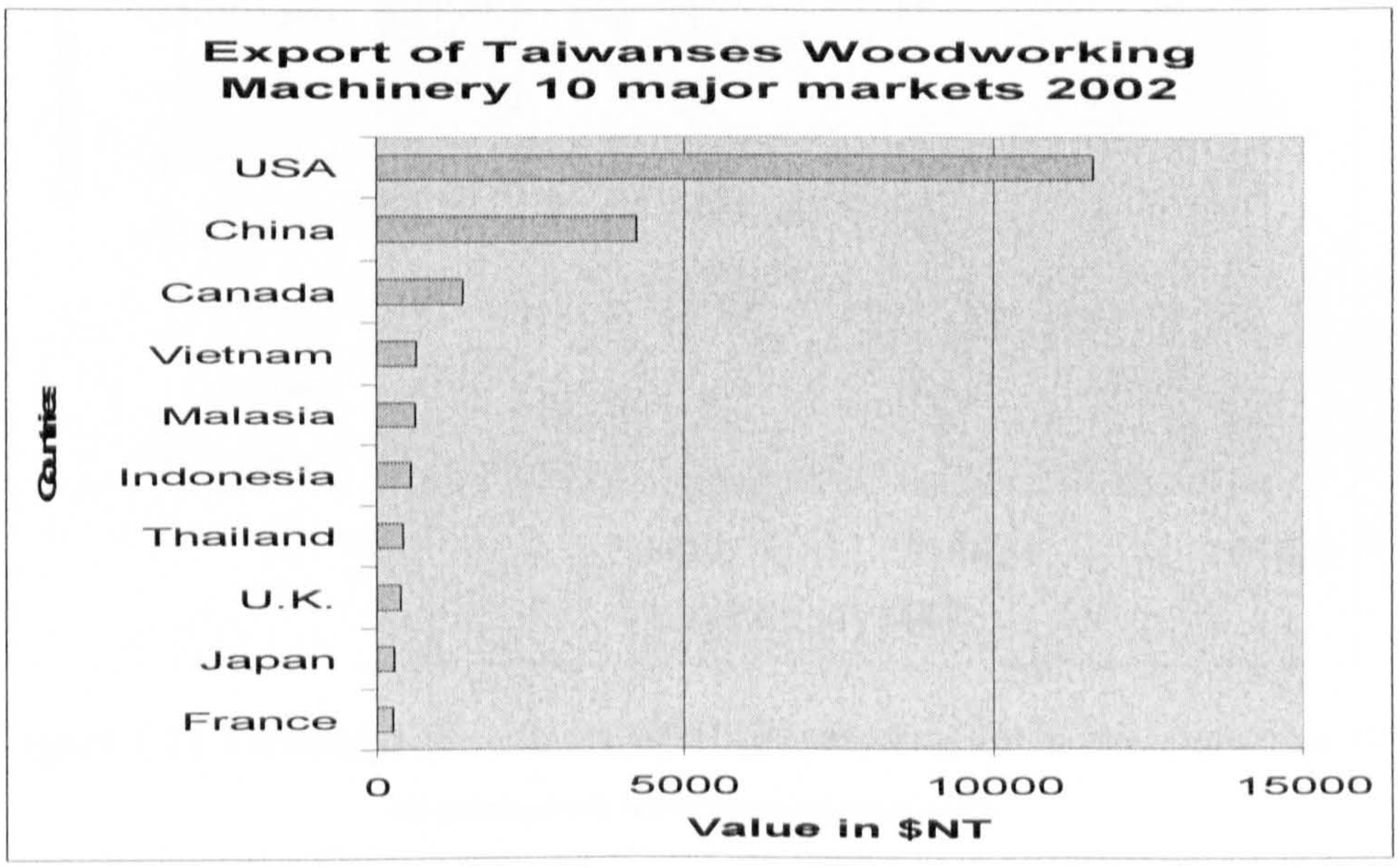


Figure 1.10 Taiwan exports towards the top-10 countries in 2003

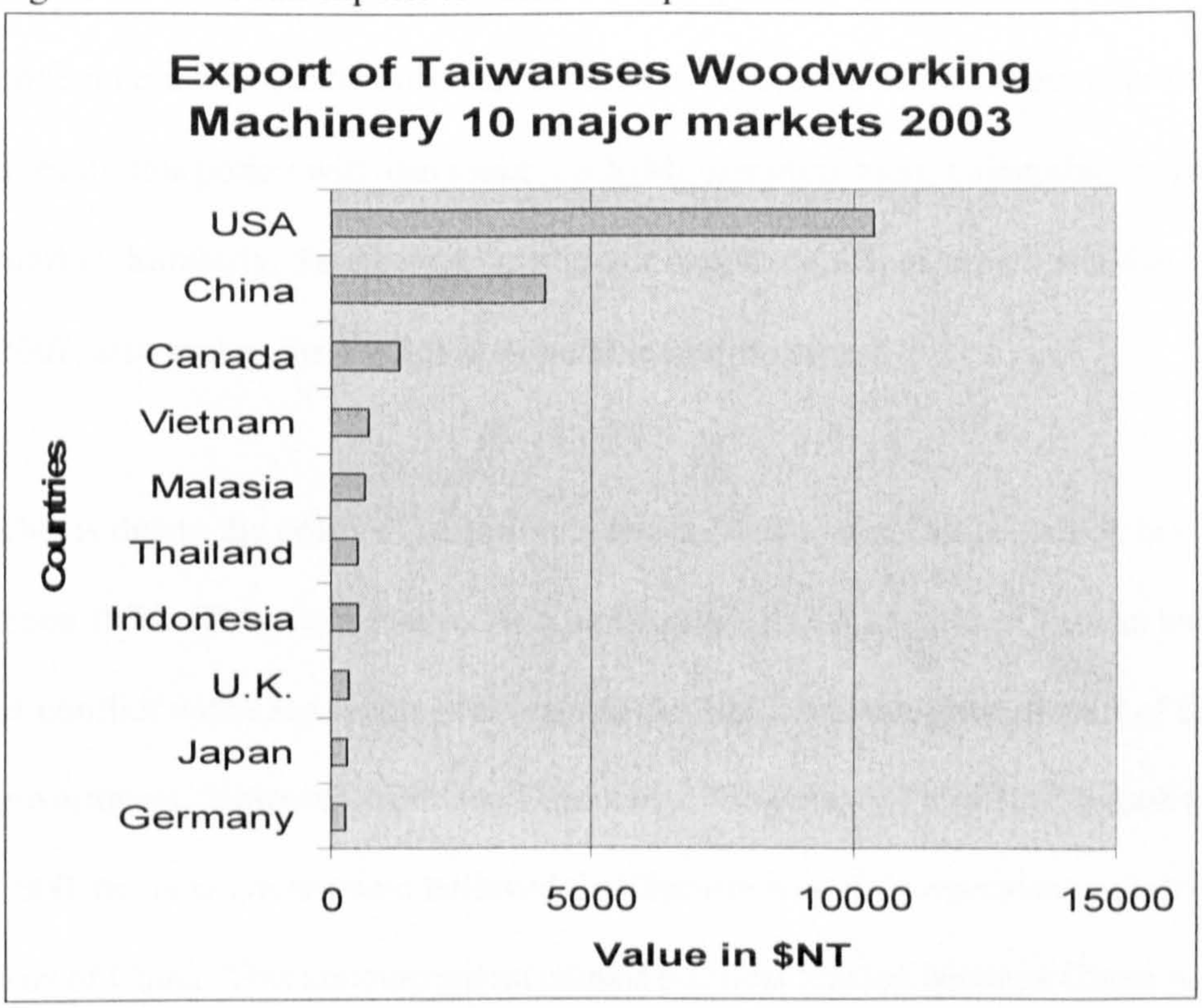


Figure 1.11 Taiwanese Woodworking Machinery exports in terms of value 1994-2002

In addition, in order to continue make U.S. exports more competitive, the American government wanted the dollar to continue to depreciate in the future, (Garten 2004). As a result, this policy will also make TWMMI exporters more vulnerable in the U. S. market. Similarly, Taiwan's proportion of exports to China, which stood at 19.34 % in 2002, also makes the TWMMI vulnerable in this respect.

This is due to the political intension between Taiwan and China , which has existed since 1970 . This was because the Kuomintang (KMT) regime of Taiwan had a history of conflict with China who believed that the KMT was a legitimate part of the Chinese government. However, since the Democratic Progressive Party (DPP) took power in 2000, the new government believed that Taiwan was an independent country and not part of China. This announcement caused political tension between China and Taiwan. President Chen has persuaded his enterprises not to focus too much of their businesses on China and that it is time to move on to other countries such as Europe, Latin America and India, (Glosseman 2003). The DPP party won the general election on 20 March 2004 and the government still emphasises the fact that Taiwan is an independent country and persuades all Taiwanese to vote for their independent rights. This action has attracted not only the attention of the Chinese government but has also made the American government nervous.

In the future the TWMMI will also face a shortage of wood and increased problems with the supply of raw materials. There will be a shortage of wood in the future, due to global warming, acid rain and government regulation that has been drawn up to protect tropical rainforests. The main product of the TWMMI is woodworking machines, which

are for furniture companies to make wooden furniture. If forests are diminishing and at the same time government policy is continually being introduced to protect forests, the future of the TWMMI will be in danger.

Due to the gradual increase in the price of steel between 2000 and 2005 (the period during which the research has been conducted), the profit margin of manufacturers has dropped significantly, and this situation continued until 2006 , China is now able to produce steel domestically, (Chiles 2005) and it is anticipated that the price of steel for TWMMI is likely to fall from 2006. Steel is one of the main components of the TWMMI to produce its machines. Because the cost of steel was continuously increasing between 2000 and 2005, the profit margin of the TWMMI was affected heavily. In the future the decreasing price of steel is likely to favourably affect TWMMI's profit margins.

1.5.4 Opportunities

As the manufacturing sector in Taiwan is the country's sixth largest industry, the Taiwanese government has set several national policies to enhance its manufacturing capability, e.g. education and training, (Investintaiwan 2003).

The government encourages educational institutions to work closely together with the manufacturing sector in order to produce more skilled workers. For example, some specialist apprentice schools design their curriculum based on industrial theories and applications. The government believes that once students have graduated from these schools, they will have appropriate technical and vocational knowledge to contribute to

the workforce. It is expected that they will be able to learn practical skills from experienced workers. For workers in previous generations, they learnt by experience and working alongside Japanese technicians. Because most woodworking machines in the early years in Taiwan were imported from Japan, the Japanese had an obligation to teach the key techniques to the Taiwanese workers. In turn, the experienced older generation are able to contribute by teaching their skills to the younger generation.

Career training centres have also been established. The training centres are situated around the major cities of Taiwan- Taipei, Taichung and Kaoshong, etc. People who are willing to be trained with experts in this sector are able to apply for government subsidies. With government and institutional support, an increasing number of skilled workers will be available for the manufacturing sector. The TWMMI will benefit from these initiatives.

Taiwan is one of the major clients in the world for demanding semi-conductor processing equipment. However, Taiwanese manufacturing equipment firms only supply 5% to 10% of high-tech equipment for the domestic semi-conductor industry (TWMA2005). Nearly 95 % of high-tech machinery is imported from overseas. This clearly indicates that the semi-conductor industry offers the TWMMI an opportunity to be one of the supply chains to supply processing equipment to the domestic market.

1.6 Conclusions

The SWOT analysis has identified that one of the main strengths of the TWMMI is the proximity of its suppliers as they provide the TWMMI with technical help and support

as well as being an extra source for the manufacture of products. In addition, the flexibility of the TWMMI as small, family owned companies is a further strength as this allows for timely decision making and allows strategies to be changed quickly and efficiently.

The size of the companies, however, can also be seen as a weakness as there is often insufficient capital to invest in expanding the companies and producing high-tech products.

A major threat for the TWMMI is its continuous trend in producing low-tech products and bringing them into a narrow market. These low- tech products are easier for competitors to imitate as they do not contain novel ideas and technology. High-tech products are more difficult to imitate as the company will need to invest more in research and development to gain the knowledge and ability to produce these products.

The size of the TWMMI and its lack of capital further prevent the TWMMI from investing sufficient resource in business activities such as innovation. This limits the TWMMI's opportunities to compete with the market leaders in terms of technology and quality of products. Furthermore, the limited language capability of the TWMMI severely limits the TWMMI from expanding into European markets.

These weaknesses augment the threats that the profit margin of the TWMMI is facing competition from all fronts, with new rivals entering with lower prices and existing competitors with high-tech products cutting their prices.

There are two options for the TWMMI to alleviate the weaknesses and threats they currently face from their competitors. The TWMMI may either produce low cost, low priced products to compete with South-East Asian and Chinese rivals and/or produce innovative products to compete with the German and Italian producers.

In order to produce low priced products, three methods are available. Firstly, the TWMMI could use low cost labour to produce low cost products. However, it is practically impossible to beat South-East Asia and China in this respect for they have significantly cheaper labour than that in Taiwan. The second method is for the TWMMI to expand their markets as, with a larger market and more demand for their products, the TWMMI could cut the price of their goods. The TWMMI's weakness with foreign languages may seriously hinder success of this option. Lastly, the TWMMI can opt to increase production using advanced technology. However, these new technologies may be costly and the TWMMI's small, family owned firms may have insufficient capital to invest in new technologies.

The main method for the TWMMI to produce high-tech products can be product innovation because it allows the TWMMI to differentiate their products from the international rivals. To produce high-tech products, the TWMMI need to invest in product innovation. Currently, the opportunities provided by the government's education and industrial schemes can help in this respect. However, the TWMMI may again have insufficient capital to invest in product innovation. The following literature review will discuss the best methods of adopting innovation activities and how they can help the TWMMI to reposition in the international market.

Chapter 2 Literature Review

2.1 Introduction

The literature review explores a range of literature on innovation process involving creative cognitive ability, manufacturing technology and ICT. Creative cognitive ability can help the TWMMI to create novel and useful ideas and manufacturing technology and ICT can assist the TWMMI to develop, design and manufacture a variety of customised products and then take them into the global market to compete with international rivals. Once the key concepts have been identified and defined, an explanation of the underlying types of approach to the innovation process will be explored. The issues surrounding the process of creativity will be examined, followed by an assessment of the manufacturing technology and ICT. The influence of globalisation will be highlighted, followed by options the TWMMI can adopt in order to become successful innovators. Once all these facets have been explored, the literature concludes with a number of suggestions for best practice in the adoption of innovation.

2.2 Key concepts and exploration of possible strategic solutions

Innovation, invention and creativity are key concepts that will be explored and defined for the purpose of this empirical study. There are a number of definitions of innovation as well as a variety of related terms that have been used inconsistently by different authors in the context of innovation. This section will examine the similarities and differences between these definitions and then derive a suitable definition that it will use to consider the future direction of TWMMI.

Creativity

Guilford (1950) defines creativity as intellectual traits shown by individuals, who spend a significant amount of time in the act of creativity itself. This school of thought therefore focuses on individual rather than collective or collaborative creativity and is more interested in the internal intellectual process than the external products of creativity.

Roger, C. R. (1954) takes more of a product orientated view, defining "creativity as the emergence of a novel relational product, growing out of the uniqueness of the individual and the circumstances of his/her life". Similarly, Cox (2005) appointed by the U.K Treasury to review the U.K's international competition and states that "creativity is the generation of new ideas – either new ways of looking at existing problems, or seeing new opportunities, perhaps by exploiting emerging new technologies or changes in markets".

Amabile (1988) blends these two views by defining creativity as a process to create novel or useful ideas, and extends the concept to include collaboration by which a group of individuals work together to produce new ideas.

Innovation

New ideas are not the same as commercial products. The process of converting an idea into a commercial and practical application is known as innovation according to Trott (1998) citing US Department of Commerce, 1967). Amabile's (1988) definition of

innovation similarly stresses "implementation' which is to encompass the elements of developing new ideas and then put them into use successfully.

Jones (1997) illustrates the idea of innovation with the example of the Microwave oven. Jones reminds us that although the oven was invented in England in 1947, it has been Japanese electrical companies, such as Sharp and Matsushita and Korean manufacturers, such as Samsung who have used innovation to develop the concept and manufacture high quality, high performance derivate products that are sold all over the world. Jones pointed out that innovation is not only having the imagination to dream up new ideas and the ability to solve identified problems, but also having the knowledge of how to turn the resulting conceptual solutions into well-designed, well-manufactured and well-marketed products worldwide. Cox (2005) supports this view that creativity is generation of new ideas and innovation is the process that carries them through to new products.

Invention

Some authors believe that creative ideas can be transformed into an invention through the process of innovation (e.g. West and Farr 1990, cited by Heunks (1998). These theorists view invention as part of the innovation process by which an organisation adopts technology and manpower to convert new ideas into breakthrough products. Others take the view that innovation is concerned with the commercial and practical application of inventions, in other words invention is separate from and precedes innovation (e.g. Trott 1998 citing US Department of Commerce (1967). According to this view invention is the conception of the idea, whereas innovation is the subsequent

translation of the invention into economic reality. This idea is similar to that of Rogers, E.M. (1983), pp174) who defines invention as the process by which a new idea is discovered and created, and "re-invention" as the degree to which an innovation is changed or modified by the user in the process of its adoption and implementation.

Creativity, invention and innovation

This study adopts the view that creativity is a process that produces ideas and inventions and innovation is the process of converting ideas and inventions into practical, economic reality. The low-tech products that TWMMI currently produce are easily copied by their Chinese competitors who can access raw materials (Chapter 1 pp: 31) and labour more cheaply than TWMMI (Chapter 1 pp: 18), hence TWMMI is no longer able to compete effectively in the low- tech woodworking machinery market. In order to compete, TWMMI must move into the high-tech market which can command higher prices from customers. Therefore, both the generation of creative ideas and the subsequent translation of the ideas into value products are crucial to the TWMMI because without ideas, there will not be breakthrough products.

2.3 Types of approach to the innovation process

The TWMMI's competitiveness will be influenced by strategic choice of the innovation activities. This section will examine a range of theories relating to the innovation process for the TWMMI.

Amabile (1988 citing the work of Saren 1984) whose model is based on stages of innovation process, classifies models of innovation process according to five types: 1) departmental-stage models, 2) activity-stage models, 3) decision stage models, 4) conversion process models, and 5) response model.

Robertson (1974) develops a department-stage mode to illustrate the process of innovation. This model breaks down the process into a series of stages; that is: idea-invention-evaluation-development-design-production model, production-sales, movement from its conception as an idea, and then developments in sequence. It is a linear model of innovation process, where each department is responsible for certain tasks. This model of the innovation process is inappropriate for application to the TWMMI because it concentrates on R&D to discover ideas and neglects market to innovate new products.

The Activity-Stage model identifies particular activities that are performed during innovation, (Amabile 1988). Amabile recommends a good example of an Activity-Stage mode which is proposed by Cummings and O'Connel (1997). The Activity-Stage model begins with: 1) Initiation of the process; search for the source of the problem, 2) generation of alternative innovation proposals; 3) evaluation of alternatives innovation proposals; 4) selection and initiation of an alternative, and finally 5) acceptance and reutilisation. This model of the innovation process is not suitable for application to the TWMMI because it focuses on markets but neglects technological push.

The Stage-Gate model (Decision-Stage) of the innovation process is developed by Cooper (1993). It is a linear innovation process with a well-defined pathway (gate 1 ideation, gate 2 preliminary investigation, gate 3 detailed investigation, gate 4 development, gate 5 testing and validation, and finally gate 6 production and launch), and specific points where rational decisions (1 gathering information to reduce uncertainties, 2 evaluation of information, 3 decision making, and 4 identification of remaining key uncertainties) can be made. As a product moves from idea to launch, the Stage-Gate model achieves two functions: it proves parallel processing of all the elements impacting on the development of the product (cross-functional integration involving internally, e.g. R&D, manufacturing, marketing and externally, e.g. suppliers and customers), while ensuring a gradual increase in the new product development project's success as one moves to a later stage, (Bigwood 2004). This empirical study believes that the Stage-Gate model of the innovation process is appropriate for application to the TWMMI because it describes the major phases in life-span idea implementation as well as the major influences on those phrases. It begins with creating and developing new ideas and then designing as well as manufacturing them into valuable products.

A conversion-process model is developed by Twiss (1992). This author states the innovation process can be seen as a conversion process that transforms inputs, e.g. materials, scientific knowledge, and manpower, into outputs, e.g. new products. Although this model involves markets and technology for the success of innovation activities, it is inappropriate for application to the TWMMI. This is because the TWMMI's inputs are varied and unspecified.

Response models represent innovation as the organisation's "response" to external or internal stimulus: 1) stimulus on individuals in organisations to conceive a new idea; 2) conception of the idea for an innovation; 3) proposals by the investor of a project for development, and 4) the adoption of the innovation, (Amabile 1988). This model of the innovation process is not suitable for application to the TWMMI because it is indirectly related to the basic work activities of organisation and is more directly related to administrative management.

This study is to explore the level of innovation process, which begins with new ideas and results in launch of new products which impacts on improved business performance.

2.3.1 The process of creativity in organisation

Creativity is important to the TWMMI because it is the production of novel and useful ideas for the TWMMI to develop, design and manufacture a variety of products to compete with the market leaders. This section will examine a range of theories relating to creativity and how each would affect TWMMI competitiveness.

Creativity within an organisation is important in looking for individual creative skills in the task domain and in creative thinking, (Amabile 1988). The author further emphasises the individual creativity skills in the task domain can be developed by both information available within the organisation, and by formal training which can be provided by the organisation. One cannot be creative without learning what others know, but one cannot be creative without becoming dissatisfied with the knowledge and

rejecting it, Csikszentmibalyi (1997). Therefore, access to the huge amount of information may enable individuals to be more imaginative or combined with other factors, lead to an increase in creativity. As a result, an organisation needs to establish an organisational function to gather as much as useful information to stimulate employees' creativity.

When coming up with a solution for problem solving, an individual must have knowledge and skills in his/her field. Individuals are required to have the basic knowledge and skills in their domain, (Amabile 1988). As the complexity the domain of the problem increases, a greater amount of domain relevant knowledge and skills are required. Domain relevant knowledge and skills are a person's ability, defined by his/her technical, procedural and intellectual knowledge in that task or problem domain. Such skills are influenced by formal and informal education (Amiable 1983). Basadure, Wakabayashi and Grane (1990) argue that formal education systems and culture do not teach or nurture individual's cognitive skills. The availability of training is critical for developing any kind of talent. Training can provide employees with awareness, understanding and skills in the cognitive technique and process; that is problem-finding, problem-solving and solution implementation, (Amabile 1999). Simonton (2000) suggests that a relatively high level of systematic training and practice would enhance the individual capability for creativity, he believes that even creative geniuses cannot escape a period of apprenticeship.

The individual skills in creativity thinking can be strengthened by the presence of the organisational management such as supervision. Supportive and non-controlling

supervision is an effective informal approach to cultivate employee's creativity, proposed by Cummings and Oldham (1997). In their case studies, they found that when supervisors were supportive, along with instant informational feedback, it facilitated skills development among employees.

However, Corso and Pavesi (2000) argue that companies should use the traditional bottom-up knowledge and skills learning among employees instead of hierarchical management. This means that employees should learn independently and use their spare time to learn from other experience for product innovation. In their case study, previous product experience was discovered to be the best way for employees to learn knowledge and skills on their own. This is because component standardisation design provided by companies allows the transfer of architectural knowledge from one product to another within a product family for employees' knowledge and skills learning. This learning enables employees to define new product content according to the similarities and difference from past and existing products.

Sternberg, O'Hara, and Lubart (1997) conclude that to be creative, a company has to invest in six resources: knowledge, intellectual abilities, thinking styles, motivation, personality and environment.

To sum up, employees' creativity is important to the TWMMI because their creative ideas come from the employees' individual creativity contribution. Therefore, the TWMMI should establish a creative function to provide resources to encourage and cultivate individuals' creative thinking abilities. In addition, the creative function should

also include external sources for idea generation because employees' creative thinking not only comes from internal education and training but also external information dissemination.

The main focus of this study is cognitive skills and cognitive styles rather than motivation and personal traits. The primary research intends to investigate the level of the TWMMI implementing a creative function and the level of its affects on increased creative success.

2.3.1.1 Factors influencing creativity

Taiwanese political, social and culture ideologies is crucial to the TWMMI because they will influence employees' creative thinking within the TWMMI. Creativity is the complex product of a person's behaviour in a given situation. The situation is characterised in terms of the contextual and social influences that either facilitate or inhibit creativity accomplishment. (Woodman, Sawyer and Griffin (1993). Ng (2001) advanced Csikszentmihalyi's (1997) creativity theory to explain how the Asian culture undermines the creative behaviour of individuals (illustrated in Lau, Hui and Ng's (2004) books . Ng emphasises that culture shapes beliefs, values and behaviours and it can have an effects on how individuals express their creativity. He believes that different cultures value different things and these values directly influence the development and expression of creativity. If education is important in a culture, it will be reflected in the decisions that most people make most of the time. For instance, if individuals perceive that investment in creative potential is related to formal education, they will make decisions to invest in formal higher education, which in turn would offer

them higher return on their investment. On the other hand, employers will have higher expectations concerning the effects of the investment on employee productivity.

Education systems are one of the most visible function faces to encourage or inhibit creativity. Barron (1988) states that Western scholars deal with the implicit concepts of creativity. Implicit creativity is associated with brining "something new" or "unique", which is different from the Chinese explicit concepts of creativity derived from teaching of Tao and Confucian, (Lau, Hui and Ng 2004). Tao and Buddhist teaching view creativity as inspired imitation of the forces of nature.

Confucian stressed that one of the most important qualifications to teach anything is to "review the old", so as to find the new. Thus, for Confucians, study of the past was a necessary prerequisite to creativity since the creativity process was perceived as a gradual learning process. The authoritarian nature of learning in the Confucian tradition is a set of dogmas concerning enterprise learning. Education is the acquisition of correct knowledge, not the discovery and generation of new knowledge. Lau, Hui and Ng (2004) criticise this Confucian process of learning, which emphasises hardwork and memorisation. Teachers are the supervisors and their role is to guide, control, and transmit to their students the knowledge accumulated in the past. The students in return are expected to be respectful and be obedient to their teachers under all circumstances. This is because teachers do not allow their authority to be challenged; students are to respect their teachers, instead of asking them provocative questions. Tan (2001) also criticised this education system because the reliance on recitation, instructor-directed work, and memorisation do little to promote creative thinking. Confucian teaching

ideology indeed has heavily influenced on the TWMMI creativity behaviour. It can be seen in Chapter 1 (1.4 pp:13) that traditionally the TWMMI do not perceive creativity as "new" or "unique" instead they imitate the market leaders' products to compete with low-tech producers.

Child-rearing practices are considered as the most influential for the development of creativity, Ng (2001). Confucian influences in the East have created a focus on filial piety child-rearing society. Children are raised to respect, honour, and obey their parents. To focus on filial piety in the East leads towards cognitive conservatism, which causes an individual to adopt a passive, uncritical and uncreative orientation, to learning and stereotyping of beliefs. Filial piety also leads to rigid and close-minded thinking. In contrast, in the West child raising practice aims to raise children who will become independent and confident in their ability to "conquer" the outside world. Western socialisation practices emphasise children's expression of their views and opinions, they become independent and self-reliant and this leads to more creative thinking. Children are the future of the TWMMI's employees. The East child-rearing practices may inhabit the employees' creative thinking within TWMMI.

Simonton (1975) concluded that social variables, e.g. political, economic or cultural conditions may support different kinds of creativity. Creativity may also entail intergenerational processes such as role modelling. The negative impact on presentational creativity on the East results in a negative recruitment process on the areas of creative employees. For instance, scientists are held in high esteem and not artists, therefore future generations would be more inclined towards scientific studies.

Certain political environments affect directly the degree of creativity, in particular, when warfare discourages the output of creative ideas, (Simonton 1980). Simonton (1978 citied by Amabile 1983) believes that during unstable times, young people learn to believe that the world is unpredictable and this belief in unpredictability can be associated with negative creative productivity. For instance, when a person grows up in a time of assassination, coups d'etat, and military mutinies, he or she tends to have a negative creative development. On the other hand, an individual who grows up in a civilised and peaceful environment tends to grasp the potential of the creative development, (Simonton 1975). Political issues may inhabit employees' creativity within TWMMI. Political intension between Taiwan and China since 1970, this instable environment may influence both employees' creativity behaviour and the TWMMI to invest in their employees' creativity.

In short, a creative individual is associated with his/her heritage, social, political and cultural environment. This study will focus primarily on factors influencing individual creativity. The primary research will explore and discuss how Taiwanese society, education, culture and politics influence individual creativity.

2.3.2 The Innovative process of manufacturing technology in organisation

Manufacturing technology is crucial to the TWMMI because it enables them to produce a variety of quality products effectively that can compete with international rivals. This section will assess a range of theories relating to the manufacturing process and how each would impact the competitiveness of the TWMMI.

The product life cycle pattern is a useful tool for manufacturers to understand their new product development, (Hayes and Wheelwright 1979). The product life cycle describes the course of a product's sales and profits over its lifetime. It involves five distinct stages: product development, introduction, growth, maturity and decline. The product life cycle tool offers producers a concept of changes that may take place during the time when their products are on the market. While a product on the market will go through its life cycle: product development, introduction, growth, maturity and decline, the production process which produces that product will also go through its production cycle. A company's market position can be determined by the stage of the product and its choice of production process. The production process evolution begins with a "fluid" process (customised production). The fluid process moves towards higher standardisation, mechanisation, and automation (mass production) when manufacturers want to expand their market share and take advantage of economies of scale. It will become a "systemic process" in that the production is very efficient but a huge amount of money needs to be invested in advanced production equipment and an interrelated working process and hence this leads to less flexibility compared to the original fluid process.

Tayler (1947) formulated the mass production management principle, which was exemplified by the assembly lines of Henry Ford cited by (O'Neill and Sackett 1994). Mass production strategy is characterised by narrow product lines (that is, by producing few methods or just one product type, (Hayes and Wheelwright 1979). Mass manufacturers emphasises producing standard, low variety and high volume products to

achieve economies of scales (the more the products produced, the lower the cost could be). Therefore mass producers use special purpose automated machines to achieve high productivity and cost efficiency within their manufacturing process, (Parish 1990). In a declining environment where demand is decreasing, the large scale mass production becomes disadvantageous and suffers inefficiency in production costs due to excess capacity and the increase in holding cost inventories developed by the large scale manufacturing system, (Harrigan 1980).

The problem of excess capacity could be solved by lean manufacturing systems. The lean manufacturing system enables a reduced inventory because it applies "Just-in-Time"(Parish 1990) (JIT) management principle to the production line, (O'Neill and Sackett (1994). In order to reduce the inventory, a firm can implement Just in Time (JIT) in its production system. This means that once the firm has received orders, it will inform their suppliers about related parts or components but not ask for delivery until all products are ready for assembly. Therefore, this production allows manufacturers to reduce not only "work-in-process" stock but also finished goods stock, because the production process starts with customers' orders entering the business system. Katayama and Bennett (1996) emphasise the main feature of lean production is that fewer resource inputs are required by the manufacturing system, i.e. less material, fewer parts, shorter production operations and less unproductive time is needed for set up etc. On the other hand, there is pressure for high output performance to achieve higher quality and more technical and functional products.

In order to shorten the product life cycle, lean manufactures take advantage of technologies' development, incorporated incrementally in consecutive product

generations, (O'Neill and Sackett (1994). They use the product design stage to reduce the time and to achieve improvements in manufacturing process. This means that they take existing products off the market during the maturation stage and modify them as new products to increase customers' demand. Katayama and Bennett (1996) argue that although lean production has provided a competitive and effective method for Japanese car manufacturers, it is inappropriate to apply this in a recession operational environment. In their studies, the Japanese manufacturing sector was incapable of increasing demand for their products in the recession period using lean production. A weakness of lean production is its inability to accommodate variations or reductions in demand for new products. Katayama and Bennett (1996) suggest that an adaptable production system (FMS) helps firms to improve their ability to produce a mix of products efficiently while retaining more profits than lean manufacturing during period of lower demand in the market.

A Flexible Manufacturing System is capable of producing batches with smaller volume without penalising the economies of scale. It increases machine utilisation and ultimately helps to increase manufacturing efficiency by reducing the cost/time of a manufacturing operation, (Boer 1994). A flexible manufacturing system can increase machine utilisation, flexibility product quality, as well as reduced inventories, time and labour cost Mansfield (1993). Uky (2005) recommends that FMS is a good production method for manufacturers to operate with the lowest total cost and have the ability to provide a variety of products to meet customers' requirements because FMS enables manufactures to produce mass customised products when it connects with ICT manufacturing technology. A Flexible Manufacturing System (FMS) allows the

manufacturing operation to cope with uncertainties in expected demand as well as market conditions without affecting the performance negatively, (Slack 1991). If the new products are not a simple modification of existing products, innovation requires a flexible production technology,(Kraft 1989). This author reported that wages in Germany are high compared with other countries. International success is only possible for German producers if the exported products are manufactured by advanced technology, e.g. FMS.

To summarise, the key concern of manufacturing process within TWMMI, mass manufacturing systems allow the TWMMI to produce larger quantities of good quality products at low cost to customers. However, it requires the TWMMI to invest more capital in automatic production equipment. Lean manufacturing systems may allow the TWMMI to share resources with suppliers. However, these production systems in The TWMMI may not be able to cope with turbulent environments when demand is low because this manufacturing process is characterised by modifying existing products and introducing as new ones into the market. In addition, whilst most component parts are produced by suppliers, it may be difficult for the TWMMI to control the quality of its products. On the other hand, FMS is not only aimed at new product development but also emphasises product quality problems because it enables the TWMMI to group manufacture equipment and technology to produce quality products within their factories. Therefore, FMS is appropriate for application to the TWMMI because FMS allows them to produce a variety of products effectively to compete with the international rivals.

2.3.2.1 Grouping of technology to produce small batches of customised products

Grouping of technology is important to the TWMMI because it allows them to produce a variety of customised products to the global market.

Mansfield (1993) states that FMS consists of production equipment workstations (machine tools) linked by a rationales handling system to more products from one workstation to another, and it operates as an integrated system under full programmes control. However, a more useful definition can by found from Krar and Gill, (2003); and this definition underpins this empirical study: this empirical study favours this definition provided by Krar and Gill (2004) "a FMS consists of a number of CNC machining centres and a material handling system that is controlled by one or more computers. These authors further state that during the 1950's, Numerically-Controlled (NC) machines used the existing technology of paper tapes with regularly spaced holes punches in them to feed numbers into controller machines that were wired to the machine tools. The electro-mechanical nature of controllers allowed digital technologies to be easily incorporated as they were developed. By the late 1960's Numerically-Controlled machines were available for a variety of machinery processes and automatic tool changing. NC technology was the development of the universal NC programming language called APT (Automatically Programmed Tools). APT allowed programmers to develop postprocessors specific to each type of NC tool so that the output from the APT program could be shared among different parties with different manufacturing capabilities. Manufacturers can use CNC technology incorporated with Computer-aided Design (CAD) and Computer-added Manufacturing (CAM) to develop, design and manufacture a variety of products.

The main feature of CAD is to enable designers to work quickly on their problems and find solutions from their computers. The power to produce is in CAM program language, claimed by (Millson and Granham 2001). Automated 3D incorporating CAM allows machine designers to model the object for prototypes. If engineers detect a fault during the manufacturing process, they can send it back to designers for modifying on the CAD files. CAD software is used to design detailed 2D or 3D models of physical objects, in the case of TWMMI the mechanical parts. Computer-aided manufacturing (CAM) is the use of computer-generated 3D models to assist in the development for any particular solid object. This means that CAD is for image creation while CAM is the system for prototyping. Computer and design systems are used for product design and integration of the CAD database with Product Design Management (PDM) to bridge the gap between design and production of products. A PDM system can help manufacturers to compress the time required to bring new products to market, (Gascogine 1995). Althoff (1998) identified that Component Supply Management (CSM) systems can bridge the gap between design and procurement. This is due to the fact that the systems provide decision support software and content database to help design engineers to select optimal parts or materials, and to promote the reuse of design as well as preferred parts. The system also allows procurement staff to manage parts and components with their suppliers. A CSM system is critical to cutting-time-to-make due to the collaboration between the design and purchasing department as well as suppliers. Enterprise Resource Planning (ERP) bridges the gap between manufacturing and procurement. ERP enables the procurement department to provide the correct quantities of components and parts at the correct times to the correct factories.

To sum up, the TWMMI can use the advantages of CAD and CAM incorporated with NC/CNC machining centres to produce a variety of customised products. The Taiwanese manufacturers can utilise 3D's functionality to draw their blueprints instead of by hand, which can save a great amount of time. PDM systems allow the TWMMI to retrieve component parts drawings effectively and efficiently.

The TWMMI can use database systems to store and retrieve customers' on going trading information. This information enables the manufacturers to predict trends for future new product developments. The TWMMI can use CSM systems to manage stock. The level of stock within the TWMMI is very important because the lower the level of the stock, the more efficient the working capital. In addition, they can use CSM to analyse and compare the price of component parts from each supplier in order to reduce the cost of raw materials. ERP systems not only have the functionality of CSM but also of resources planning. The woodworking machinery manufacturers may use ERP to set more accurate budgets for new product development but also manage purchasing and stock more effectively. Thus the TWMMI have two options. One is to buy the cheaper ERP system on the market but with low functionality. The other is to employ technical experts to design and install a high functional system to tailor their business needs. The primary research attempts to investigate the level of the TWMMI implement FMS combined with ICT and the level of its affects on business performance.

2.3.2.2 Utilising ICT e-commerce to promote products to global market

ICT e-commerce is important because it can assist the TWMMI to promote products and expand their geographical territories. This section will highlight relating theories and how they would affect TWMMI business performance.

ICT e-commerce/e-business can provide a new sales channel for businesses to sell products, update information and make transactions, which means businesses will find it easier to gain access to markets previously inaccessible because applying e-commerce/e-business means that geographical location is less important, (Bloch, Pigneur et al. 1996). Customers' relations can also be improved as businesses can provide around the clock customer service and customised products to suit particular customers.

Teo and Pian (2003) emphasise that innovation of new products can be impacted by the internet in three ways. Firstly, by collecting information about customer needs from the website, the company can generate new product ideas to satisfy the customers' requirements. Secondly, the R&D process can be facilitated by cooperation networks within the firm as well as between the firm and its business partners. Thirdly, product distribution can be improved by creating a close relationship among business partners along the supply chain network.

Web systems can be used by manufacturers as a promotion or distribution channel to sell their products to potential and existing customers globally, suggested by Rao (2002). The main functionality of a website is to enable manufacturers to design the web pages according to their objectives. It also provides an immediate international presence for

producers without geographical boundaries and with minimal investment (Ash and Burn 2003).

E-mail is an important push mechanism, in that targeted e-mails are used to announce new products and special offers. Poon and Swatman (1999) also agreed that e-mail is useful in business communication and document transfer because with e-mail one can retrieve ones' message whenever one wants. This saves employees a lot of time. It enables organisations to broadcast their message or promote their products by attachment to their targeted customers. Internet technology also gives manufacturers the opportunity to expand their markets through enhanced international trade via the internet, studied by Moodely (2002). Internet trading exchanges link buyers and sellers to facilitate the sales and distribution of products, particularly for customised products and smaller orders, (Rao 2002).

There are several studies reported on the use of internet, e-commerce by Small Medium Sizes (SMEs). The most recent study was conducted by Poon and Swatman (1997) who carried out a survey study, followed by a case study project, which was to clarify answers in the survey research on the use of the Internet by small businesses in Australia and the UK. They reported that the top five most important factors in Australia which drove small businesses to using the Internet were: 1) direct and indirect advertising, 2) low cost communication, 3) Easy access to potential customers, 4) company image enhancement, and 5) to form and extend business networks. On the other hand, the top five most important factors were found in the UK were: 1) external

e-mail, 2) casual browing for information, 3) search for web pages addresses, 4) information search and 5) advertising/promoting the business.

A survey study in 10 countries: Brazil, China, Demark, France, Germany, Japan, Mexico, Singapore, Taiwan and The United State was conducted by Tan and Wu (2001). They discussed key reasons why participants adopted and used e-commerce. From their discovery the top four issues driving the participants to the use of e-commerce are:1) to expand the market for existing products or services, 2) to improve the coordination of customers and suppliers, 3) to enter new markets and 4) to reduce costs.

Levy and Powell (2003) were questioning whether small firms would progress through a "stages of growth" model in their use of the internet. Thus, twelve SMEs cases in the UK West Midlands were conducted by the authors (2003). Some respondents in their report revealed that when their business strategy is to pursue business growth and to respond to their position in the international marketplace, they would develop more advanced e-technology to compete over their rivals. On the other hand, respondents who did not pursue business growth, would only use e-mail or other means to communicate with their customers. The authors concluded that strategic commitment is more essential than following the stages of the model.

To conclude, e-mail not only helps the TWMMI to announce their new products to target the loyal customers but also provide around the clock service. Websites can assist the TWMMI to promote their products internationally. Web trading systems and Internet network trading exchanges enable Taiwanese manufacturers to distribute their

products worldwide. To grasp the full functionality of internet based technology, it not only requires the TWMMI to invest in a great amount of capital but also technical experts. Therefore, as small, family owned businesses, the woodworking machinery manufactures may have difficulty in implementing ICT e-commerce technology.

The primary research attempts to explore the level of the TWMMI implement ICT e-commerce and the level of it affects on business performance.

2.4 Globalisation

Globalisation is crucial to Taiwan and its manufacturers because globalisation will force them to adopt globalisation of technology such as Information Communication Technology (ICT) to develop and manufacture products in order to compete with the international rivals. This section will explain why and how ICT affects both Taiwan and the TWMMI's competitiveness. Perraton, Goldblatt, and McGrew (1997), defines globalisation as a process of social change and a multi-dimensional phenomenon related to a variety of forms of social action, e.g. economic, political, legal, cultural, military and technological sites of social actions, such as the environment. They can be described and analysed in relation to:

1) Their geographical extent as to how much of the world they intend to cover (economies of scope).

2) The intensity of flows and interactions, not simply the level of international and intercontinental transaction, but how far they have become facilitated with associated social relations with each country, area or locality.
3) The impact of these flows and interactions on the activities and power of local and national actors.
4) The degree to which networks and infrastructures have been established to facilitate these interactions and how far institutions have emerged to regulate them.

Geographical and cultural distances have shortened with the advent of the global network. This global network allows companies to expand their geographical market, purchasing and manufacturing as well as creating ideas around the world. However, advanced technology also creates global competition among countries and individual companies and this intensive competition will impact on a country's economy and social life.

Technological change is a factor in globalisation and it is a fundamental force in shaping the pattern of transformation of a country's manufacturing sector, (Moodley 2003). New technology based on Information communication technology (ICT) is at the heart of economic transformation in both the industries and developing countries such as Taiwan. However, Archibugi, Howells and Michie (1999) argue that nations, (in this case Taiwan) and firms, (in this case TWMMI) are forced to adopt to technological innovation and change in order to become or remain internationally competitive. Firms (in this case TWMMI) will struggle to cope with technological change because to adopt

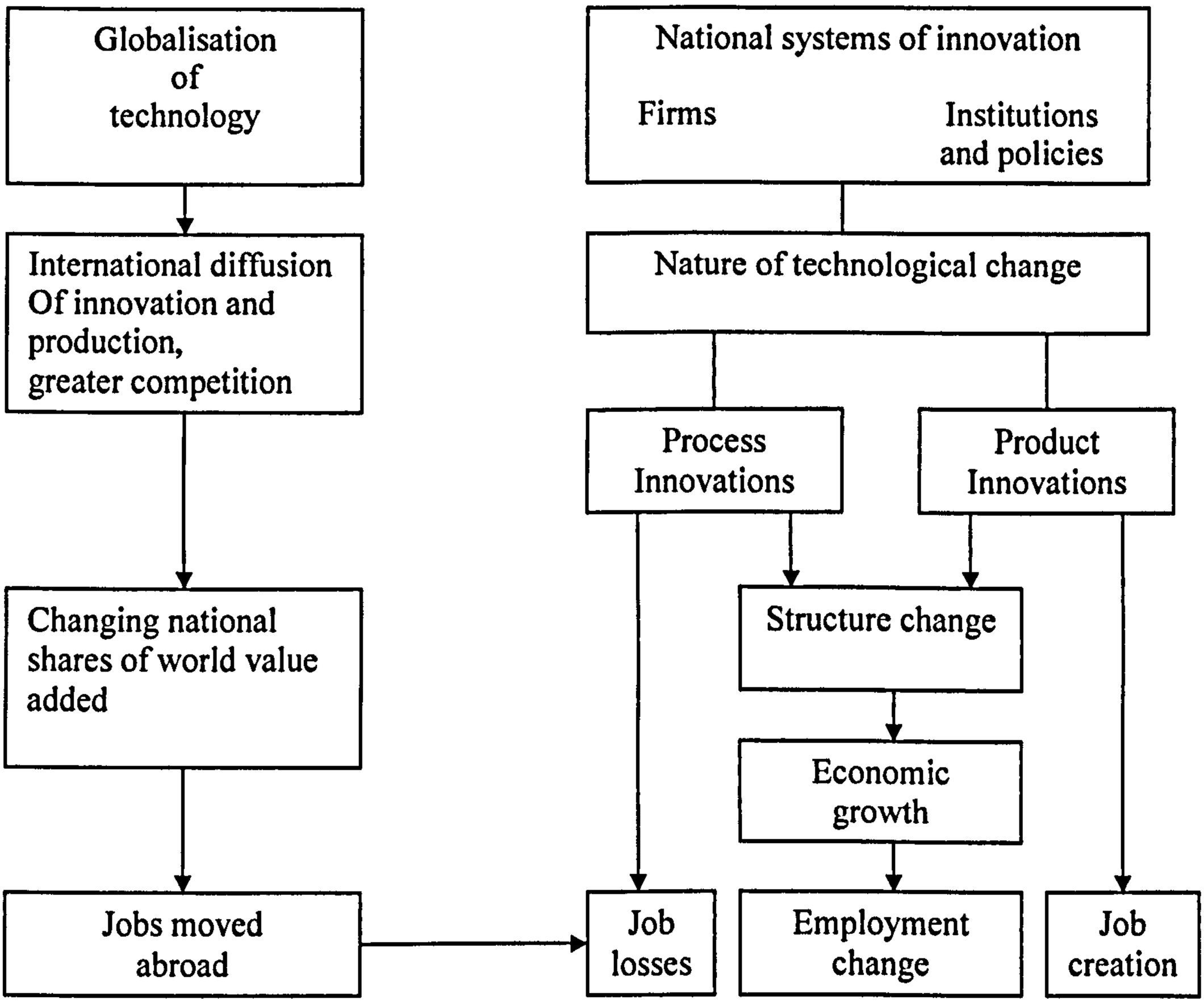
new technology, firms need to restructure their business processes to incorporate this new technology with their overall strategies. A country's employment (in this case Taiwan) will be also influenced by the new technology because the globalisation of technology can erode the production and employment base of advanced countries. The authors used two different ways to describe globalisation. The first is related to global factors in the economy and social life: global factors influence the performance of local and/or national communities.

The second is linked to national government policies. Globalisation is putting new pressures on nation states which lead to negative economic outcomes. To overcome this problem, a mixed policy may be conducted by nation states. Governments (in this case Taiwanese government) may use macroeconomic policies, for instance, by depreciating their currencies to promote exports and lower their interest rates to encourage investment while they may also focus on their industrial policies to achieve their particular objectives such as in the specialised high-tech sector, (in this case Taiwan semi-conductor industry). The Governments' industrial policies and technology policies (for example of the Taiwanese government policy on its industry and technology) have become more important in the 21st century because these policies are not only associated with the abilities of firms (in this case TWMMI) to innovate and produce their products to international markets but are also related to national employment (in this case Taiwan employment) and disposable income.

The concept of "national systems of innovation" is specified in technology demands, defined by Pianta (1995 cited by Archibugi, Howells and Michie (1999). This means

that a country's policy on its technology system would be influenced by the capabilities of its industries with respect to product innovation and process innovation. The authors constructed a web of relationships linking the national systems of innovation with the process of globalisation of technology, leading to specific growth and employment outcomes.

Figure 2.1 Globalisation, national system of innovation and their economic impact



Source: adapted from Daniele Archibugi, Jeremy Howells and Jonathan Michie (1999:52): Policy In global Economy, published by the press syndicate of the University of Cambridge.

First, the national systems of innovation (in this case Taiwan information infrastructure) with the parallel activity of firms (in this case TWMMI), institutions and national policies, form the nature and direction of technological change in terms of product innovations and process innovations. Product innovations are based on R&D activities while process innovations (manufacturing process) are introduced through investments in new equipment, e.g. FMS.

Product innovation means that firms focus on developing new products and then taking them into existing markets. In theory, when new products are introduced into the marketplace, this will facilitate higher demand for those products, which will encourage firms to produce more products to meet those demands. Increasing productivity is needed in order to meet the market demands and, therefore, more workers are recruited into firms' production lines, thus creating more jobs.

On the other hand, in the context of globalisation of production and markets, innovations take place by adopting advanced technology to increase market share. Price competition is a way of expanding market share. This in turn reduces profits and therefore firms may conduct cost leadership to reduce labour costs in order to increase revenues. This is because labour costs have crucial effects on the profit-and-loss-accounts of a company. To reduce labour costs, firms (in this case Taiwan furniture companies or TWMMI) may look for opportunities overseas, where there is an abundance of cheaper labour with acceptable skilled workers. As a result, greater competition reinforces the pressure to increase productivity and this may give advantage

to specialisation industries. This process will lead to the increased pace of structural change resulting in a different sectoral composition of national economies.

To sum up, the Taiwanese economy is influence by globalisation of technology such as ICT, as it creates global competition among countries and their manufacturing sectors. Hence, to increase Taiwan's competitiveness, the Taiwan' government intends to establish information systems to enhance the capability of its industries in order to compete with their international rivals. Once their industries have the ability to develop and manufacture new products, they would contribute to Taiwanese employment and economy.

The primary research intends to investigate the capability of the TWMMI to implement ICT. Therefore it is important to understand how the Taiwanese government promotes ICT to help its industries to create competitiveness. The following section discusses how the Taiwanese government promotes ICT.

2.4.1 Taiwanese information infrastructure and Internet based ICT

A widely available and affordable information infrastructure is an important factor for the success of ICT e-commerce. Taiwan has a high penetration of the Internet service providers and has experienced rapid wireless growth since 1995, (Find 2003).

The Taiwanese government is attempting to invest a large amount of money to project society into a new information era by adopting several plans, (Hu 2003). In order to enhance its semi-conductor industry competitiveness, information communication

infrastructure and its relevant facilities have been put in place by the Taiwanese government. The TWMMI will benefit from this policy because they may need to utilise ICT for their product and process innovation (manufacturing process).

The Ministry of Economic Affairs (MOEA) will budget NT$320 million to train around 30,000 specialists for strategic industries, including semiconductors and digital content, (Hu 2003). The TWMMI may need these specialists to help them to build up their computing systems for business management, (Hu 2003).

In order to build Taiwan into an information society, the government intends to create a fair competition environment for private operators to initiate the broadband network. The Taiwanese government is privatising telecommunications in both basic services and value-added network services. Value-added network service providers are allowed up to 100 percent foreign investment and have widely defined business coverage, including high-speed broadband network services. In addition, the government is liberalising banking and other aspects of the financial industry, as well as promoting electronic commerce, commercial automation, and Internet applications. For example, the largest telecommunications company in Taiwan, Chunghwa Telecom, plans to cut cellular service rates by 20 percent and lower charges on ADSL services by the beginning of July 2003. As a result, the TWMMI will have options to select the best ones to suit their business needs due to a wide range of Internet service providers in Taiwan.

Taiwan is Asia's second largest user of e-commerce after Singapore among Asian member states of the Asia-Pacific Economic Cooperation (APEC) forum, (Find 2003). Taiwan is the world's third leading supplier of personal computers and related products, and hence its industries have become integrated in the global supply chain, particularly in the IT sectors. This indicates that an Information Communication Infrastructure has been established in Taiwan and therefore the TWMMI will be able to manage their business activities with their global customers and suppliers through a global network.

The primary research attempts to explore whether the TWMMI utilise government resources on ICT to help product development and manufacturing process.

2.5 Joint venture strategies for innovation

A joint venture strategy is important to the TWMMI as small, family owned businesses, they may have difficulty to implement innovation activities. In order to successfully implement innovation activities within their organisations, the TWMMI can utilise external capability, e.g. competitors or customers. This section will assess a range of theories relating to the implementation of high levels of innovation successfully.

When there is a mismatch between resources and capabilities, firms can use "merger", "acquisition" and "takeover to create opportunities for their businesses activities, (Sudarsanam 1995). Resources involve marketing, a distribution network, R&D and operation capacity. Capabilities include the firm's management style, reputation and innovation.

"Merger", "acquisition", and "takeover" means that two firms are the coming together to combine and share their resources to achieve common objectives, (Sudarsanam 1995). "Merger", "acquisition", and "takeover" are often interchangeable terminology terms by authors. They are a means of corporate expansion and growth. The characteristics of a Merger, an acquisition or a takeover is when one firm purchases the assets or shares of another, with the acquired firm's shareholders ceasing to be owners of that firm.

A cooperative strategy can offer companies which are lacking competence or resources to enter into a new industry or original sector, particularly in developing countries, (Child and Faulkner 1998). Cooperation with a local firm enables the firm to offer a capability, which the foreign partner does not possess in that market. The "cooperative strategies", "collective strategies", "strategic alliances", and value-added" partnerships are used interchangeably by researchers. Pierre and Garrette (1999) use "strategic alliance" terms to explain how the partner companies pool their resources together in order to produce a global product and distribute it worldwide. These authors classify three different forms of alliances between competitors: complementary, share-supply and quasi-concentration (consortium).

Complementary alliances are formed by only two partner companies and are aimed at marketing & sales. This agreement never includes R&D or design activities. Share-supply alliances may be formed by many partners and involve R&D, design and manufacturing activities. It is aimed at improving efficiency in production and has no impact on the marketing & sales of the final product. Quasi-concentrations may cover

the entire production process and result in the production of a common product/market by all rivals; that is R&D, design, manufacturing and marketing. In addition, Dussauge and Garrette added cross-industry agreements is one of alliances for companies from totally different industries to give leverage to their complementary capabilities to seek to diversify their activities. Cross-industry alliances can provide a way for one of the partners to lean about the other partner's industry and help it diversify into this industry. This alliance raises the issue of the learning ability of the partner entering a new market and, at the time, that of the established partner's ability to maintain a sufficiently rapid pace of technological innovation.

Moreover, a vertical partnership is to take full advantage of a partner's skills and technology to leverage the suppliers and manufacturer's complementary resources, stressed by Dussauge and Garrette. Johnson and Lawrence (1988 cited by Brush and Chaganti (1996) seem to view vertical partnerships as "value-added partnerships" and are defined by these researchers as relationships between companies that work together to manage the flow of goods and services within the value chain. Brush and Chaganti (1996) conclude that cooperative strategies enable companies to link their value chain; that is R&D, production and marketing to those of stronger partners and this provides value to the products for their customers. Dess et al (1995) identifies that cooperating new ventures can specialise in activities where they can add the most value to the product and outsource the remaining activities to partner firms that have built distinctive competencies in those activities. Therefore, cooperative strategies can be crucial to the success of non-high-tech firms. On the other hand, non-high-tech ventures may find it difficult to attract partners because they have few attractive benefits to potential partners.

Brush and Chaganti (1996) investigated six cases to explore what, why, and how cooperative strategies were used in high-tech and non-high-tech companies. The results showed that high-tech and non-high-tech companies used cooperative strategies to reduce the constraints of resources shortages. The results also showed that the key objective in cooperative strategy was the pooling of resources, lowering of costs and the expansion of the customer base, rather than an interest in the immediate contribution to profit.

Strategic alliances are not characterised by any particular legal status, (Pierre and Garrette 1990). An alliance is based on an agreement between the partner firms. Cooperation is thus founded on a contract between the partner firms. From the legal point of view, therefore, an alliance is a contract.

In their book, Pierre and Garrette (1990) compared the organisational characteristics between mergers, acquisition and strategic alliance. Merger/acquisition divests oneself of entire business units whereas the partners companies remain independent entities and continue to pursue their own objectives. Nevertheless, they have to agree on a set of targets, which the alliance has to set up to achieve.

Merger/acquisition decisions are made by senior management and hence speed up the decision making process. In an alliance, however, one of the partners cannot, in theory, force the others to accept any particular solution. The lack of agreement between the partners can paralyse the alliance for considerable lengths of time or lead to an ill-conceived cooperation.

Corporations are owned by their shareholders. Shareholders do not have the power to manage the day-to-day operations of corporation. Instead management power is vested in directors, who are elected by the shareholders. The directors delegate their power to run the day-to-day affairs of the corporation to officers whom the director selected. One of the main advantages of this form of business entity is that shareholders directors and officers generally are not personally liable for the obligations of the corporation. The owners risk only the investment they make in the business to pursue their ownership interests. Another advantage of the corporation form is that because a corporation is an entity apart from its owners and managers, it can continue to exist after the death or resignation of such persons.

Co-ops are a business being owned and managed by its members and each member has his/her own right to vote for his/her opinions, (Bluejay 2005). Co-ops are characterised by legal status. Co-ops are characterised by the Rochdale principle, named after the first successful co-op, which was started in Rochdale, England in the 1840's, (Circlepinescentre 2005). There are eight fundamental principles: 1) Democracy, 2) Open membership, 3) Fixed and limited interest on capital, 4) Distribution of surplus as dividend on purchases, 5) Cash trading, 6) Selling only pure and unadulterated goods, 7) Education, and 8) Political and religious neutrality.

Co-ops were formed primarily for the benefits of farmers, (Circlepinescenter 2005).The purpose of the Co-op was to help farmers keep their costs low through joint purchases of suppliers, such as tools, equipment or food. In addition, Co-ops also helped farmers

in marketing and distribution. For example, by combining their crops together, farmers were able to sell in large quantities or ask for the best prices for their goods. They were also able to share marketing costs to promote their products. In decision making, co-ops are similar to alliances in that each member or partner firm has its own right to vote for /its own interests. The difference between a Co-op and an alliance is that Co-op is a legal status whereas an alliance is formed by contract agreements.

To sum up, as small, family owned manufacturers, the TWMMI may have difficulties in establishing a creative function to generate novel ideas for product innovation. The Taiwanese woodworking manufacturers may have problems in adopting advanced technology to produce new products and introduce them into the global market. However, merging, cooperative strategy, corporation and co-ops can be good methods for the TWMMI to share resources with their partners to create, develop, manufacture and distribute new products worldwide.

2.6 Conclusions

Through the SWOT analysis, two options have been identified as potential competitive strategies for the TWMMI to adopt. The first strategy is to produce products at a low cost and market them at a low price, and the second is to produce high-tech products and market them at a premium price.

The literature review has demonstrated that innovation is necessary for the TWMMI to create, develop and manufacture innovative products. If the TWMMI want to increase or maintain market position in the international market, they need to adopt a creativity

function to create novel and useful ideas to develop, design and manufacture a new product. Creativity allows the TWMMI to create novel ideas to compete with the market leaders. Creative ideas of the TWMMI come from employees' creativity contribution. To be creative, the TWMMI, therefore have to establish a systematic creative function to provide resources to encourage, cultivate and stimulate employees' creative ideas.

Through the literature review, it has been identified that to produce low cost products, it is necessary to review the manufacturing processes and then select the best option for the TWMMI to implement. Mass production systems allow firms to produce a huge amount of products at a lower cost but they could increase the holding cost of stock developed by the large scale manufacturing systems. Lean manufacturing systems enable companies to design and produce products in a shorter time with fewer people and lower investment because of the adoption of "Just-in-Time" management, which integrates suppliers into their production processes. However, this production system may not fit into uncertain demand environment because this production system only enables manufacturers to make a few models with large quantities at low cost. This system can be solved by installing FMS within factories. A FMS allows manufacturers the ability to produce a variety of products at lower total costs (production costs and transaction costs) to meet customers' requirements.

A FMS is aimed at producing new products whereas lean manufacturing system focuses on product modification. In a Flexible Manufacturing System, the product development process integrates all key players (e.g. customers, suppliers, R&D, manufacturing and

marketing) in design, manufacturing and the use of the products. In lean manufacturing system, the product development process is simultaneous (parallel) whereas within mass manufacturing system it is sequential.

The literature review also considered the use of ICT design–manufacturing technology combined with FMS, and it was identified that FMS combined with Information Communication Technology may help the TWMMI develop, design and manufacture a variety of customised products, thus improving its business performance.

ICT software technology such as Database Systems allow the TWMMI to retrieve the information about the most popular model purchases by regular customers and then develop these models to target these customers. CSM enables the TWMMI to manage stock, analyse and compare the prices of component parts from each supplier. The ERP system enables the TWMMI not only to control their stock more effectively, and efficiently, but also help resource planning. ICT hardware technology such as E-mail communication systems may compensate for the inability of TWMMI's salespeople to close orders, because it enables Taiwanese salespeople to confirm crucial information in detail with their clients immediately in writing. A well-designed website can help the TWMMI to deliver their key information, e.g. company history, product range, product specification and provision of targeted services for their customer base. Web transition systems can help the TWMMI to increase sales while the Internet trade network technology can help the TWMMI extend their existing market to new geographical areas. As a result, the use of ICT in these areas can assist the TWMMI in manufacture and promotion processes. As Taiwan is the third largest PC supplier in the world, the

resources needed to implement ICT are readily available. Already Taiwan is the fifth largest user of ICT based e-commerce in APEC (Asian Pacific Economic Cooperation), hence the development and the use of ICT by TWMMI should be a relatively quick and simple process. These main uses of ICT have been identified in the literature review, ICT software technology and ICT e-commerce.

There is a major weakness with the TWMMI which may prevent them from implementing innovation. The TWMMI consists of small, family owned businesses which lack the necessary capital for creativity and manufacturing innovation. The literature review has identified that cooperation with suppliers, customers and competitors may help the TWMMI to solve resource problems to implement innovation activities.

The next chapter will identify the level of innovation necessary within the TWMMI in order to improve their business performance. Chapter 6 will also discuss factors influencing the TWMMI innovation strategy. In addition, a case study based on the Toyota car manufacturer's innovation activities is provided. The Toyota case study is relevant as it may show the TWMMI how to challenge the market leaders, German and Italian. Toyota has challenged Ford successfully in 2003 and since then has become the market leader in the car industry. One of the main reasons that Toyota is able to compete over Ford is because Toyota not only concentrate on developing new products but also on re-design e.g. the redesigned Camry and Corolla, Sedans and Tundra (light truck), which have made Toyota's overall profitability positive, Zaun and White (2002).

Thus, in order to increase market share, the TWMMI can not only produce

breakthrough products but also redesign existing products and re-launch them as new ones into the international market. Breakthrough products enable the TWMMI to ask for premium prices for their products because they are introduced into the marketplace for the first time. It also enables the TWMMI to increase their market position in the international market because successful new product development allows manufacturers to grasp a rapid growth in market share. Modifying products allow the TWMMI to reduce the risk of producing breakthrough products and hence maintain their profitability.

Toyota's market performance was better than their rivals, e.g. Ford because it emphasised on integration between different departments in its design and manufacturing processes, (Soberk, Liker and Ward 2000). An effective cross-functional project team allows the company to manufacture their product at low cost and launch their products quickly into the market place, (Burt and Ibison 2001). A creative environment is also provided by Toyota to cultivate expertise creativity and creative thinking. To cultivate expertise creativity, for example, Toyota employs a "mentor-apprentice" approach in its working process. To inspire creative thinking, supervisors avoid telling their apprentices what to do and instead they ask questions to which their students are to find answers. The creation of a creative environment is crucial to the TWMMI as it enables them to create useful ideas for developing, designing and manufacturing breakthrough products to compete with the market leaders.

In order to target different customers' requirements, Toyota utilises advanced manufacturing technology incorporated with ICT design-manufacturing technology to produce a variety of products. This software system was developed by Nara

Information System Ltd. To save repetitive work and changes to the blueprints, Toyota uses ICT e.g. CAD. Toyota also utilises modern technology, e.g. websites to promote its products globally. Manufacturing technology and ICT are crucial to the TWMMI because this advanced technology allows them to produce a wide range product at a low total cost to compete with the market leaders.

Chapter 3 Research framework and research design

3.1 Introduction

This study aims to investigate the potential future of the TWMMI and make recommendations for actions to be taken to improve business performance. The initial SWOT analysis (Chapter 1) has identified the major problem in relation to the TWMMI:

- it can no longer compete effectively in the low-tech Woodworking Machinery market, because of the small size of the companies within the TWMMI, the high labour costs relative to the South-East Asian and Chinese producers.

The subsequent literature review (Chapter 2) has discovered possible solutions to help the TWMMI to solve the problem:

- establish creative function to develop novel ideas.
- utilise FMS combined with ICT to produce a small number of customized products to introduce into the international market.

This chapter will discuss how the research framework is formed for this study and then identify the research hypotheses to be investigated. Finally, the research structure will focus on the various methodologies, which will be reviewed. There will be an explanation as to why face to face interviewing was the method selected as the major vehicle for data collection, and this is followed by a definition of the population as well as questionnaire design.

3.2 Main variables

A major motivation for this study was for the findings to be useful for the owner managers of the TWMMI, not only in creating and developing new ideas but considering designing as well as manufacturing new products to compete with the market leaders. The Chapter 2 literature review (2.3.1 pp: 41-44) revealed that 'employees creativity skills' can be developed and strengthened by the TWMMI to create novel ideas. The review of literature in Chapter 2 (2.3.2.1 pp: 52-54) disclosed that a Flexible Manufacturing systems combined with ICT can assist the TWMMI to develop, design and manufacture a small batch of customised products. Hence, variables in this study would emphasise creative function, which is a process undertaken by the TWMMI to create and develop new ideas, and a FMS combined with ICT, which is a process undertaken by the TWMMI to design and manufacture valuable products into the global market.

Creative function is the TWMMI's actual implementation process to create and develop new ideas. An understanding of creative function could help the owner managers of the TWMMI to determine the appropriate level of complexity for creative function. For instance, should the TWMMI establish a training program to create new ideas from a group of employees or should the TWMMI look for information to stimulate new ideas? FMS combined with ICT is seen as an important independent variable that attempts to identify manufacturing technology that the TWMMI should implement within their production lines. Small companies might be advised to implement FMS combined with ICT to produce small batches of customised products or increase productivity. However, this advice is conventional wisdom, derived from the fact that large companies would

implement it more successfully than small companies. As advanced manufacturing technology and ICT design-manufacturing technology require companies to invest in very different hardware and software technology, large companies are more likely to implement it successfully due to the capital available. Such conventional wisdom needs to be tested in small companies such as the TWMMI, for example, should the TWMMI take advantage of FMS and ICT design-manufacturing technology to produce small batches of customised products to improve their business performance.

Both increased creative success and improved business performance are dependent variables. The overall improved business performance might therefore depend on the success of implementing creative function to create and develop new ideas and the success of implementing FMS combined with ICT to design and manufacture new products and then take them into the global market.

Previous researchers have used a number of ways to measure new product success. Some researchers emphasised the technological aspects of strategy, e.g. Clark and Wheelwright (1993) (see table 3.1 over page). Some researchers stressed the market aspects of strategy, e.g. Syamil, Doll and Apigian (2004), Griffin and Page (1996), Hultink and Robben (1995) and Trueman and Jobber (1995),(see table 3.1). For the market aspect of strategy, some researchers concentrated on end-result measures of overall project performance; that is business strategy, (Syamil, Doll and Apigian 2004 and Trueman and Jobber (1995). Some researchers focused on project level; that is project strategy and business strategy, (Griffin and Page 1996 Hultink and Robben 1995).

Table 3.1 measures for new product success

<table>
<tr><td>Authors</td><td colspan="4">Project strategy measurement</td><td>Field of study</td></tr>
<tr><td></td><td>Short term</td><td>Long term</td><td>Overall</td><td></td><td></td></tr>
<tr><td>Yoon and Lilien (1985)</td><td>•First year sale
•Market share
•Profit</td><td>•R.O.I.
•Growth</td><td></td><td></td><td>A questionnaire interview of 52 firms</td></tr>
<tr><td>Clark and Wheel-wright (1993)</td><td></td><td></td><td>•Time-to-market
• Quality
• Productivity</td><td></td><td>An overview in car industry</td></tr>
<tr><td>Trueman and Jobber (1995)</td><td></td><td></td><td>• New product development time
•Number of products developed and launched
•Sales growth
•Return on Capital</td><td></td><td>A questionnaire survey of 108 UK foul weather clothing manufacturers and multimedia companies</td></tr>
<tr><td>Hultink and Robben (1995)</td><td>• Speed-to-market
• Product launched time</td><td>• Customer satisfaction
• Profitability
• Margins</td><td></td><td></td><td>A questionnaire survey of 107 Dutch switchboard companies</td></tr>
<tr><td>Griff and Page (1996)</td><td colspan="4">Project strategy measurement
<table><tr><td>New to the world</td><td>New to the company</td><td>Product improvements</td><td>Line extension</td></tr><tr><td>• Customer satisfaction</td><td>• Profit
• Competitive advantage (manufacturing lead time or shelf life time)</td><td>• Profit
• Competitive advantage (manufacturing lead time or shelf life time)</td><td>• new product development ability
• ROI</td></tr></table>
Business strategy measurement
<table><tr><td>Prosper/ Honda</td><td>Analyser/ Toyota</td><td>Defender/ General Motors</td><td>Reactor/ Subaru</td></tr><tr><td>• % of sales
• profits from new products</td><td>• New product development efficiency
• ROI</td><td>• new product development ability
• ROI</td><td>• ROI
•Success/ failure rate</td></tr></table></td><td>A review by the six scenarios by academics knowledgeable in the Booz, Allen and Hamilton (BAH) typology</td></tr>
</table>

As can be seen in table 3.1 approaches to measure new product success performance sometimes overlapped as follows:

- Product design cost
- Manufacturing costs
- % of sales
- ROI
- Success/failure rate
- Profitability
- Productivity
- Quality
- **New product development efficiency**
- **New product development ability**
- **Customer satisfaction**
- **Time-to-market**

This study attempts to measure the TWMMI's improved business performance (new product success performance) based on four approaches, which are highlighted in bold and mentioned above. These approaches are a reliable measure of the TWMMI's new product success performance; if the TWMMI want to compete with the market leaders successfully, they should undertake a process which involves a creative function and FMS combined with ICT to create, develop, design and manufacture new products and then distribute them into the global market. However, these approaches ignore how

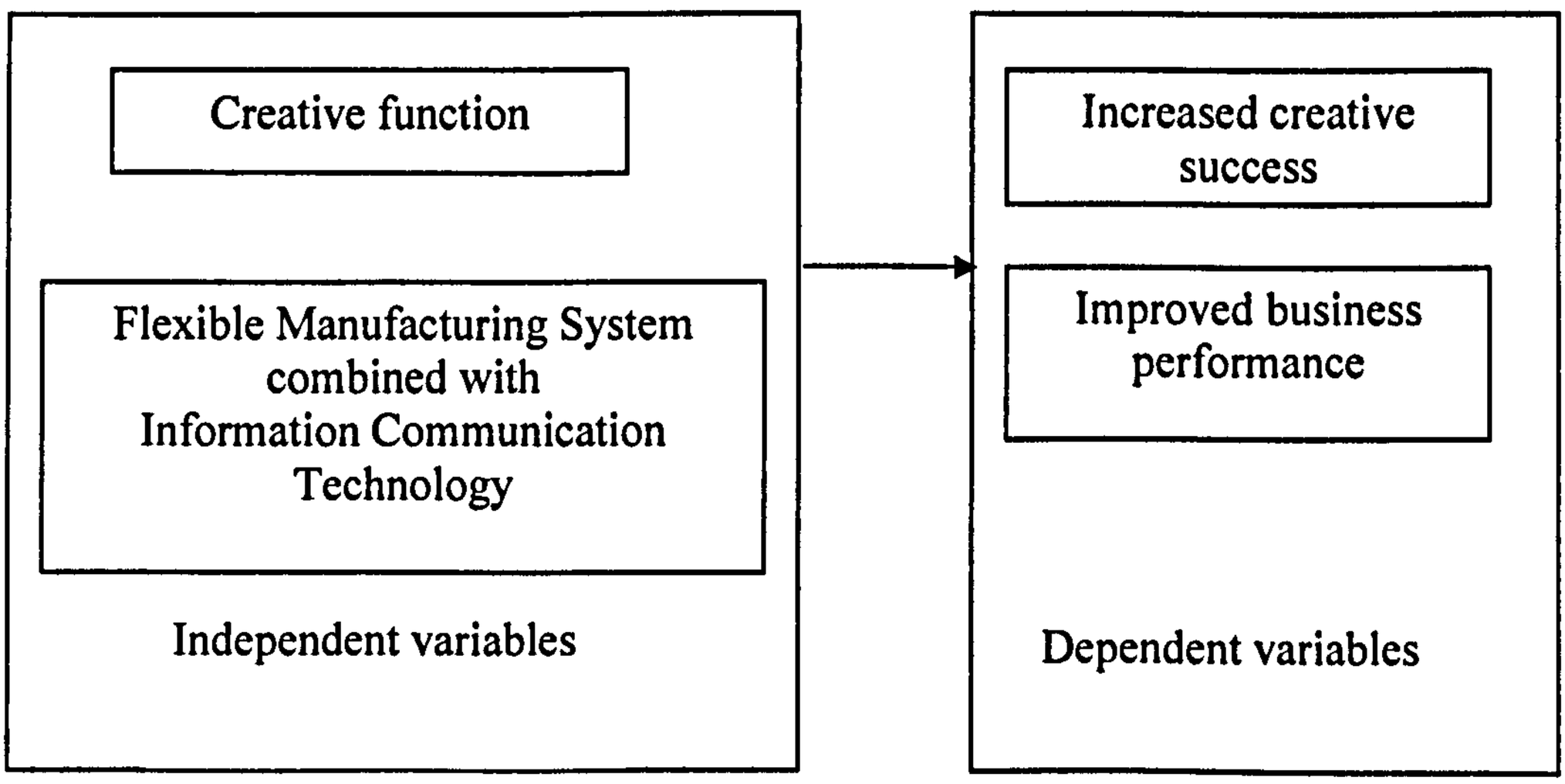
effectively the creative function is working because they emphases the overall outcome performance.

Therefore these approaches would be more reliable in measuring FMS combined with ICT effects because they focus on transforming new ideas into concept design and then finally into manufacturing physical products. In addition, this empirical study intends to add three approaches: delivery time, customers' response and geographical coverage to measure FMS combined with ICT improved business performance. This is because factor of FMS combined with ICT (design-manufacturing integration) would affect delivery time and ICT e-commerce could affect lead time in responding to customer response as well as geographical coverage. In practice, it is very difficult to measure the effects of FMS and ICT based on product design cost, manufacturing costs, % of sales, ROI, Success/failure rate, profitability, productivity and quality. This is because most Taiwanese woodworking manufacturers are relatively small, family owned business, as identified in Chapter 1 SWOT (1.5.2 pp: 16-17). Therefore this study has decided to use developing new product ability, developing new product speed, manufacturing lead time, delivery time, customers' response, geographical coverage and customer satisfaction to measure FMS combined with ICT effect.

Increased creative success is included as a dependent variable because without creative ideas, there will be no innovation in an organisation; the organisation needs ideas before it can develop and implement them, (Amabile 1988). This author states that it is very difficult to rely on a person or process measure in identifying creativity. Therefore, she suggests that product measure is considerably more straightforward. Prequest's (2005) document review argues that measuring the number of patents registered by an

organization is a more quantitative measure of its innovative capability, e.g. creativity, than that product-based measurement. This study agrees with Prequest's view and will use patents as an indicator of the TWMMI's creative function capability. Prequest (2005) also recommends that excellent awards, e.g. technology awards received by an organization is another indicator of the organisation innovative capability. This study agrees with Prequest's recommendation and will use government awards as an indicator of the TWMMI's creative functional capability. Furthermore, this study also believes that diversification to the other sectors, e.g. semi-conductor industry is another indictor of the TWMMI's creative function capability. Hence, this study has determined to use patents, government awards and diversification as indicators of the TWMMI's creative function. The two independent variables used in this study are creative function and FMS combined with ICT. The two dependent variables will be increased creative success and improved business performance. These two independent variables and two dependent variables are the basis of the research framework of this study, which are depicted in Figure 3.1.

Figure 3.1: The Research Framework of this empirical study



The aim of the primary research stage is to investigate the correlation between the independent variables and dependent variables. To this end three hypotheses can be considered:

Hypothesis 1: the higher the level of creative function, the greater the level of increased creative success in TWMMI.

Hypothesis 2: the higher the level of FMS combined with ICT, the greater the level of improved business performance in TWMMI.

Hypothesis 3: the higher the level of creative function and FMS combined with ICT, the greater the level of the improved business performance in TWMMI.

3.3 Research hypotheses

3.3.1 A creative function

A creative function includes funds, internal and external idea generation as well as creativity integration to create new ideas for the TWMMI to develop, design and manufacture new products to compete with the market leaders. Cummings and Oldham (1997) advise that firms must focus on internal idea creation for long term survival. They suggest first to employ people with the potential for creativity, and then structure their employees' environment in order to bring out this creative potential. The managers can use publications or patent registers to assess the past performance of a potential employee, as suggested by Twiss (1992). Once the selected employee enters

the workforce, management must establish a training program to encourage the output of creative ideas from that employee.

Freedman (2000) further stresses that 'ideas are the currency of the future' and those ideas can be generated by brainstorming. Brainstorming can be used by employees to find new ways to improve productivity, quality and safety, (Global 1992). Introducing brainstorming methods into an organisation would facilitate creativity, Osborn (1953 cited by Vernon (1970). Brainstorming is suitable for application to the TWMMI because it allows them to gather a group of employees together to contribute creative ideas. Basadur, Wakabayashi and Green (1990) used the optimiser (thinking-evaluation) style, generator (experiencing –ideation), conceptualise (thinking-ideation) and implementation (experiencing-evaluation) as independent variables, before and after training as dependant variables to test their research hypotheses. The results reported that the optimise style of creative problem solving improved creativity more than the other three types.

Barron (1969) based on Galton Hereditary Genius's theory studied the relationship between personality and originality in Irish top management. The results showed that managers who had a strong sense of destiny, independence of judgement, cognitive flexibility and inquiringness, were more creative people. Barron concluded that a certain level of intelligence was required for creativity but beyond that level, intelligence would minimise creativity productivity. As a result, the less original managers needed to be cultivated in creativity by establishing a training programme that is tailored to the individuals and their mind.

To examine the effects of individual and/or organisational creativity on innovation performance, Bharadway and Menon (2000) used innovation performance as a dependent variable, and individual creativity learning efforts and organisational creativity learning efforts as independent variables. They found that higher levels of individual and organisational creativity yielded the highest level of innovation performance. However, in their study, Griffith and Grover (2006) discovered that organisational variables, not individual-level variables produced positive creative ideas for innovation.

Internal idea generation is potentially important to TWMMI because it will help TWMMI to generate novel ideas from employees. So this empirical study sets out to identify the ways in which Taiwanese companies generate ideas internally, the extent to which they do it and the extent to which these activities affect business performance.

Cooper (1993) states that an innovation process begins with a new product idea. An idea occurs when technological possibilities are matched with market needs, (market pull) ideas can be generated by customers' requests or a competitive product. However, (technology push) ideas need to be generated by R&D, which plays an important role in producing breakthrough products. Twiss (1992) states that many Japanese Companies, e.g. Honda, pursue a policy (technology push) of generating new ideas to innovate their new products. On the other hand, most western firms establish a linkage with markets as a prerequisite for an investment in technology. As far as western firms are concerned both (technology push) and (market pull) play a crucial role in successful innovation.

As a result, this author advises that creativity; that is creative ideas, not only come from

a firm's R&D but also resides in outside sources such as universities. Cooper (1993) also adds that customers, competitors, suppliers, trade shows and publications can be used as sources of idea creation for firms.

These sources of creative ideas were studied by (Cooper and Kleinschmidt 1987). This author ranked these sources in order of their effectiveness and created the sources of table, which can be seen as follows:

Sources	Percent of Projects
Customer requests	20.0
Sales force	17.4
Management	13.3
R&D group/department	12.3
Competitor's product	7.7
Engineering/design group or department	7.2
All others: distributor, service department, creativity session (brainstorming), trade show, result of customer survey, etc.	22.1
Total	100.0

External ideas are potentially important to TWMMI because external sources will assist TWMMI to create new ideas for product innovation. So this empirical study embarks on investigating the methods by which Taiwanese companies generate ideas from external sources, the extent to which they do it and the extent to which these activities affects business performance.

Once new ideas have been generated, it is the responsibility of R&D design department to conceive product ideas, select the most appropriate and develop them through to the prototype stage (Jones 1997). Hise at al (1990) suggest that management should focus on the design stage of idea creation for new product development. However, to have a

better chance for new product success, R&D/ design department should be integrated with the marketing section because marketing personnel will be able to describe in detail customers' requirements to designers when they conduct specification design. Hise at al's (1990) study demonstrated that when R&D and marketing are integrated, their joint effort in determining the final design of a new product has a greater chance of success.

Twiss (1992) states that there is a need to integrate the design and production process because, with the anticipated sales volume; a design which is suitable for small-scale batch production may be inappropriate for mass production. This consideration should be taken into account at an early stage in the design process. Iansiti (1993) further explains the importance of R&D/ design and production coordination. He believes that any change in the production system, for instance, the use of a more reliable material in the production process, will change the entire design and manufacturing. Iansiti (1993) conducted a comparison study between R&D and production integration on product improvements. These results showed that the company with R&D and production integration achieved the best product improvements in the shortest time and at the lowest cost.

There is a need to integrate R&D/ design and customers' input for the success of product innovation. Wikstrom (1996 cited by Piller and Moeslein 2002) suggest that customer integration can be defined as a form of industrial value creation where the customers take part in activities and processes which used to be seen as the domain of the company alone. A firm's R&D/design integration with the customer may take place

during the configuration and therefore the design of the customer's specific product and enables the company to meet the customer's requirements exactly (Piller and Moeslein 2002). By bringing the customer into the prototype stage to review facets of the product, firms can obtain instance feedback regarding market acceptance and need design, (Cooper 1993).

R&D integration with suppliers can speed up product innovation by adding information, ideas, and technical expertise. Engineers from suppliers can aid in the identification of design capability problems or potential manufacturing problems at an early stage and hence avoid later costly design changes, (Kessler and Chakrabarti 1999) cited in Sherman (2000). Suppliers who are part of the concept development process can offer valuable suggestions early, thereby avoiding wasted effort, (Rosenthal 1992). They can start their own process development activity earlier thereby providing needed materials, components or tooling sooner in the prototype testing. Baldwin and Clark (1997) argue that R&D Integration with suppliers can also boost the rate of innovation, because each supplier takes responsibility for separate modules and ensures that a reliable product will arise from their collective efforts.

In their study, Sauder, Sherman, and Davis-Cooper (1998) used R&D/marketing integration and R&D/ customer integration as independent variables and cycle time, prototype development proficiency and product launch proficiency as dependent variables to test their hypotheses. They discovered that there were positive effects of both R&D/ marketing and R&D/customer integration on new product development effectiveness. Sherman, Saunder and Jessen (2000) used integration of knowledge from

past projects, R&D/marketing integration, R&D/manufacturing integration, R&D/customer integration and R&D/strategic partner integrations as independent variables and cycle time as a dependent variable to examine a set of hypotheses was conducted. These results showed that R&D knowledge from past projects yielded the greatest performance on new product development. Creativity integration is potentially important to TWMMI because it could enable TWMMI's R&D department to utilise feedback from customers, suppliers, competitors, marketing & sales and production for creating and developing valuable products to the international customers.

At this stage is not clear to what extent TWMMI companies currently implement a creative function. This empirical study attempts to explore the degree to which TWMMI employ a creative function to improve their business performance. Thus this empirical study aims to test the first hypothesis:

Hypothesis 1: the higher the level of creative function, the greater the level of increased creative success in TWMMI.

3.3.2 A Flexible Manufacturing Systems and Information Communication Technology

Grouping of manufacturing equipment, Flexible Manufacturing Systems (FMS) and ICT design-manufacturing technology, e.g. CAD and CAM allow manufactures to produce small batches of (one of a kind) sophisticated industrial product within their factories for international markets, (Hayes and Wheelwright(1984). Grouping of

technology such as FMS and ICT software technology etc. is a powerful tool for allowing small numbers of component parts to be manufactured economically, (Katayama and Bennet 1996). These authors conducted 4 case studies in Japanese manufacturing industry to examine the effects of production technology and improve business performance. They reported that advanced manufacturing technology helped Japanese manufacturers to improve their ability to produce a variety of products efficiently while still remaining competitiveness.

Jayaram, Vickery and Droge's (2000) empirical study used information system infrastructure as independent variables and supply chain time based performance as dependent variables to test a series of hypotheses. They discovered that firms used computer aided design (CAD) and computer aided manufacturing (CAM) incorporated with NC/CNC technology to shorten manufacturing lead time and new product development time, and computerised production planning systems, e.g. ERP and automatic data capture systems, e.g. CSM to shorten customers' response and delivery time.

A database management system enables organisations to specify the set of actions that need to be performed, e.g. checking stock situations and updating inventory, (Rowley 2002). Databases have an important role in websites, both in providing the data that is displayed in the creation and malignance of website, and in collecting data that is entered through the website. Firms who keep valuable customers are more profitable than those with little repeat business. Customers, therefore, need to be classified and analysed as individuals, and database systems provide this functionality then draw those

products out to modify them. Those modified products can then be sold to price sensitive customers. Naylor and Willam's (1994) study reported that database, spreadsheet and accounting capability enable the sales manger to examine updated sales figures and to forecast future sales trends.

FMS incorporated with ICT design-manufacturing technology is potentially important to TWMMI because it can use CAD functionality to draw blueprints instead of by hand and then save them into PDM systems for efficient information retrieval. The TWMMI can utilise CAD, CAM incorporated with NC/CNC machinery centres to produce component parts effectively. CSM, ERP, database and accounting systems enable the TWMMI to select optimal parts, materials based on both business and technical criteria, to reuse designs and preferred parts, to manage the procurement and delivery of raw materials, parts to the right place at the right time, to check their levels of stock but also analyse customers' preference.

So this empirical study embarks on investigating the methods by which Taiwanese companies apply advanced technology combined with ICT software technology, it assesses their effectiveness and the extent to which advanced manufacturing technology affects business performance.

Leenders and Wierengas' (2002) study used ICT hardware as independent variables such as the Internet, e-mail, video conferencing, and new product performance as dependent variables such as the speed at which new products are developed, the cost efficiency of the development of new products and the ability to react to new

opportunities to test their hypotheses. The results showed that ICT was the most effective tool for enhancing new product performance. Moodley's (2002 and 2003) study of South African furniture companies discovered that websites and the internet trade network could help developing countries to expand their geographical territory. The results of Poon and Swatman's (1999) multi-case study reported that internet commerce did not reap direct benefits to companies but rather speeded up future opportunities. These results were also shown by Levy and Powell's (2003) case study.

ICT e-commerce is potentially important to TWMMI because, e-mail not only enables the employees of the TWMMI to broadcast their message to customers but also accumulates knowledge from customers' feedback, thereby assisting creativity. It also allows companies to promote their products by attachment to their targeted customers in order to increase sales. Web systems can be used by TWMMI as a promotion or distribution channel to sell their products globally. TWMMI's websites with links to business partners' websites, allow companies to collect information about competitors' movements to help idea creation. Internet trading exchanges link buyers and sellers to facilitate the sale and distribution of products. These linkage websites enable TWMMI to obtain information about customers' needs and then turn these needs into more concrete ideas for product innovation.

It is not clear to what extent TWMMI companies currently implement FMS combined with ICT software technology, e.g. CAD/CAM and ICT hardware, e.g. e-commerce to improve business performance. Therefore this empirical study intends to investigate the

degree to which TWMMI applies FMS and ICT technology resulting in improved business performance. This empirical study proposes to test the following hypothesis:

Hypothesis 2: the higher the level of FMS combined with ICT, the greater the level of the improved business performance in TWMMI.

3.3.3 Creative function and FMS combined with ICT

Amabile (1988) stresses that individual creativity efforts are strengthened by the organisational systems, procedures, and processes that enable creativity. An experimental study found that more creative personalities produced more creative output than less creative personalities only when they were surrounded by an organisational context that facilitated creativity, (Barron 1969, Cumming et al 1997). Creativity is concerned with creating novel ideas, (Amabile 1988), while advanced manufacturing technology is concerned with translating these ideas into valuable products, (Hayes and Wheelwright 1979) and ICT e-commerce brings these products into global markets, (Moodley 2003, Fruling and Digman (2000). An exploratory study found that organisational creativity mechanism could lead to innovation companies, (Bharadway and Menon 2000), FMS and ICT could lead to shortened product development time and delivery time, Jayaram and Droge 2000). Thus, the final hypothesis in this empirical study assumes that a combination of creative function, FMS combined with ICT would lead to improved business performance.

Hypothesis 3: the higher the level creative function and FMS combined ICT, the greater the level of the improved business performance.

3.4 Research design

3.4.1 Research strategies

During this empirical study a range of research methodologies and approaches have been explored. The benefits of qualitative research is that it examines a small number of cases, whereas quantitative research investigates a relatively small number of features (that is variables) across many cases, (Ragin 1994).

Firestone (1987) suggests that researchers can adopt both quantitative and qualitative methods for their study, citing in Miles ad Huberman (1994). Quantitative studies would be de-emphasising individual judgement and stressing the use of established procedures, leading to more precise and generalised results. Qualitative studies offer rich depiction and strategic comparison across cases; therefore they overcome the "abstraction inherent in quantitative studies. Qualitative methods are good at finding specific, concrete and historically-grounded patterns to small sets of cases while quantitative data is good for finding probablistic relationships among variables in large population, as suggested by Miles and Huberman (1994).

Kaplan (1964) stresses that quantitative is qualitative, cited by Miles and Huberman 1994). Seber (1993) believes that quantitative data can help with the qualitative side of a study during design by finding a representative sample and locating deviant cases,(cited by Ragin 1994). It can also help during data collecting by supplying background data and getting overlook information. During analysis quantitative data can help by

showing the generality of specific observation, and verifying or casting new light on qualitative findings. This author believes that qualitative research can help the quantitative side of a study during the design stage, by assessing conceptual development and instrumentation. It can also help during data collection by making access and collecting data easier. During analysis qualitative research approaches can help develop quantitative analysis by validating, interpreting, clarifying and illustrating quantitative finding, as well as through strengthening and revising theory. Salmon (1991) argues that the issue is not quantitative-qualitative at all, but whether researchers are taking an "analytic" approach to understanding a few controlled variables, or a "systematic" approach to understanding the interaction of variables in a complex environment. This approach, therefore, identified and staged the author's methodological positive.

Identifying general patterns and relationships are crucial for quantitative researchers because they offer important clues about causation. The strength of the correlation between independent and dependent variables provide evidence in favour of, or against the idea that two variables are casually connected. On the other hand, images that are constructed by qualitative methods are in-depth knowledge about cases and attempts to piece together meaningful images for evidence, with the help of concepts. Therefore qualitative methods are used to enhance evidence rather than condense, as identified by Ragin, (1994).

In order to explore what factors are critical for the TWMMI to improve business performance, this empirical study attempts to conduct quantitative research because this

research seems to have the ability to collect data from a large number of companies. However, one of the major disadvantages of the quantitative approach is that the important variables have to be known in advance. Thus it can be only used in relatively well understood situations. The SWOT analysis has enabled this empirical study to identify the general pattern within the TWMMI, and the subsequent literature review clarified the range of variables to be explored, it may have helped to develop more reliable variables to be investigated.

The quantitative approach seems to be powerful with respect to quantifying relationships between variables, but weak at providing in-depth understanding of a phenomenon about cases. Seber (1993) suggests that this problem can be solved by data collection which supplies background data and overlook information.

3.4.2 Data collection techniques

Quantitative research can be conducted in three different ways: by telephone, by mail, and by face-to-face interviews, (Dillman 1978). As mentioned in 3.4.1 the pitfall of quantitative research is that it is unable to obtain in-depth knowledge about respondent companies. Interviewing can compensate for this problem because it allows the interviewer to obtain valid, reliable information from the interviewee, (Marshall and Rossman 1995). Face-to-face interviews were the primary source of data in this empirical study. They were deemed most appropriate for exploring the perceptions of the participants. Telephone interviews were regarded as complementary data gathering and provided to be especially useful during later analysis stages of the research.

3.4.2.1 The on-site interview and telephone interview

A structured interview instrument and semi structured interview instrument are used during the face-to-face interviews in data collection. Interview instruments typically consist of a range of questions that give both more structured responses and more flexible open-ended responses that enable further probing and development (Marshall and Rossman 1995). The instrument used in this empirical study consisted of questions requiring a structured response, and questions encouraging an open-ended response.

Interviews used for research purpose can be categorised as unstructured, structured open ended, and structured closed ended interviews (Lawler, Nadler et al. 1980). In an unstructured interview, little guidance is provided to the respondent regarding questions or possible answers. The structured open-ended interview is characterised by a list of predetermined questions covering certain topics. The respondent is not constrained in answering the questions. The structured fixed-response (closed end) interview utilises predetermined questions as well as a set of predetermined responses from which an appropriate answer must be selected by the respondent.

The interview used by this empirical study contained open-ended questions and closed-ended questions. Both types of questions were necessary to establish a response to the research questions. The interviews were formal and the duration of the interview ranged from one to one and a half hours. The researcher requested and received permission to follow up the interviews for any clarification of details that might be needed later.

The on-site interviews also provide opportunities for the researcher to tour the company for a glimpse of the manufacturing process, as well as the application of modern technology. Relevant documentation was provided by participating firms or obtained from participants' websites.

The telephone interview served as complementary data gathering in this empirical study because it has two functions. First, it afforded an opportunity to determine if the target companies were willing and able to participate in this empirical study. Secondly, the telephone interview was used to confirm that the target companies met the criteria that would qualify them for inclusion in this empirical study.

3.4.3 Small size company's defined

The size of a company can be classified as micro, small, medium or large size, according to the European definitions (Sbs 2006). A micro company has less than 10 employees. A small size company has an average number of employees less than 50. A medium size company has an average number of employees of between 50 and 249. A large company has an average number of employees greater than 250. This empirical study adopted the European definitions.

3.4.4 The sample frame

The sample used in this empirical study is a 'convenient' sample rather than a random sample. Tai-Chong was chosen as the sample county due to its large members representative of this industry. 87 per cent of Taiwanese Woodworking Manufacturers

are centred in Tai-Chong, (TWMA 2005). The Buyer's Guide & Directory 2005 was used to search for potential respondents because it contained most of the companies' contact details, including the name of the owner-manager, the firm's name, address, e-mail and telephone number.

3.4.5 Questionnaire design

Questionnaires used in industrial research can be classified into three categories, structured, unstructured, and semi-structured (Rhys 1978; Hague 1992). In a structured questionnaire the questions are written out fully in detail so every respondent can be asked the same questions in the same order and the responses are, therefore, recorded in the same way. Structured questionnaires are used wherever a large number of interviews need to be carried out.

Structured questionnaires would have only been useful in this empirical study to gain a clear outline of the workings of the TWMMI. However, the rigidity of this method would not have allowed the deeper probing and understanding needed for this research, thus elements of an unstructured questionnaire have been adopted for this purpose. An unstructured questionnaire allows the researcher to modify the interview to suit the circumstances. Semi-structured questionnaires lie between structured and unstructured questionnaires. According to Hague (1992), in a semi-structured questionnaire the questions have a suggested wording and are in a fixed order. Semi-structured questionnaires also include open-ended questions to allow respondents to explain their answers more freely, which contrasts with the rigidity of structured questionnaires. The interviewer can also adjust the questions in a semi-structured questionnaire to suit

different situations in similar ways to unstructured questionnaires. Semi-structured questionnaires therefore have many advantages and are often used in a business-to-business interview program where it is necessary to maintain some flexibility to allow for the large differences that exist between respondent firms (Hague, 1992). As mentioned, each type of questionnaire has its own advantages and disadvantages, so knowing which questionnaire to apply to a particular scenario forms the basis for a successful industrial research.

In designing the questionnaire, the main concern was the content or questions, which were heavily dependent on the hypotheses that had been formulated. In view of the research hypotheses, both open-ended and close-ended questions were necessary to satisfy the research. Therefore a semi-structured questionnaire with open-ended and close-ended questions was used to obtain information from respondent companies, (Appendix 1 pp: 215) whilst a highly structured questionnaire with close-ended questions was used to obtain information from respondent customers, (Appendix 2 pp: 218). Open questions were used to enable the respondents to explain their answers more fully. Closed questions consisted of 6-point rating type scales where the extreme scales were anchored by a definition in words. Other closed questions used were the binary yes/no response.

3.4.5.1 Questionnaire content

The research framework mentioned in (3.2 pp: 82) identified four major variables; 1. Creative function involving funds, internal idea generation, external idea generation and creativity integration 2.Flexible Manufacturing System combined with Information

Communication Technology involving FMS combined ICT design-manufacturing technology and ICT administrative technology and ICT-e-commerce 3 increased creative success, 4 improved business performance related to successful implementation of a creative function and a FMS combined with ICT. This section shows that the questions on each of these variables were developed and incorporated into the questionnaire.

A creative function

The SWOT assessment in chapter 1 (1.5.3 pp: 18) identified that a major threat was that the TWMMI were only able to produce low-tech woodworking machines. In addition, a major threat within the TWMMI was a shortage of wood. The literature review discovered that creative function could enable the TWMMI to develop breakthrough products for the international market. Question 10 to 16 of section 3A and question 17 to 18 of section 3B and question 20 to 24 of section 3C attempted to obtain information about the respondent companies' creativity activities.

FMS combined with ICT manufacturing technology

The SWOT assessment identified that the market followers (South-East Asian and Chinese producers) use labour cost to compete with the international rivals. The review of literature indicated that FMS incorporated with ICT design-manufacturing technology could help to produce a variety of customised products at low total cost. Questions 29 a-b and g to l are intended to extract information about the respondent companies' manufacturing processes.

From the assessment it was found that the price of raw materials, e.g. steel, has increased gradually. Question 19 of section 3B was intended to extract information about how the respondent companies had to react to these issues.

ICT e-commerce technology

The SWOT assessment identified that the TWMMI brought existing products into a narrowed market. The literature review showed that ICT e-commerce allowed manufacturers to expand their geographical territories. Questions c to f in section 4 were aimed at extracting information about the respondent companies' e-commerce activities.

Improved business performance

Questions 30 a to g of section 5 attempted to obtain information about the respondent companies' perceived benefits of adopting innovation process. Questions 30 a to g of section 5 also translated to obtain customers' opinion about TWMMI' innovation performance.

Owner characteristics

Questions 1 to 3 were used to test the role of the owner managers in the firm.

Organisational product

The SWOT assessment identified that the TWMMI were unable to produce high-tech machines like the market leaders. Question 4 was aimed to obtain information about the respondent companies' product against the market leaders.

Questions 5, 6 and 8 were used to determine the eligibility of respondents in terms of being independent, with less than 50 employees and revenue.

Globalisation forced manufacturers to move their production lines to countries with cheaper labour costs. Question 7 was used to obtain information about the respondent companies' production bases.

The SWOT assessment identified that there will be a shortage of wood in the future. Question 9 attempted to obtain information about the respondent companies' new product development strategies.

Chapter 4 Analysis of results

4.1 Introduction

The three hypotheses identified in Chapter 3 (3:2pp:82-83) linked the four variables to be investigated. Chapter 3 stated that interviewing was used in this empirical study to answer three main research questions about the TWMMI's innovation activities. All 158 firms' interviews were conducted by telephone or via personal visits and invited to participate in this empirical study. Of the 158 companies, 30 of them responded favourably to participate in interviews. A semi-structured questionnaire with open-ended and close-ended questions (see Appendix 1 pp: 215) was used to obtain information about innovation activities from the participated companies. 18 international customers were also invited to participate in this empirical study. A highly structured questionnaire with close-ended questions was used to obtain information from respondent customers, (see Appendix 2 pp: 218). This chapter reports the results of the respondent companies' innovation activities and improved business performance as well as customers' perception about the TWMMI's improved business performance.

4.2 A creative function

4.2.1 Funding

To ascertain the extent to which respondent companies employed specific creativity enhancing activities within their organisation, question 15 section 3A asked respondents if they allocated budget spending for creativity activities. Table 4.1 shows which respondent companies allocated funds to generate novel ideas. In table 4.1, a "1" indicates that the company did allocate funds and "0" indicates the opposite.

Table 4.1 Companies that allocated funds to enhance creativity

Companies	Funds
Co.1	0
Co, 2	0
Co. 3	0
Co.4	0
Co.5	0
Co.6	0
Co.7	1
Co.8	0
Co.9	1
Co.10	0
Co.11	0
Co.12	0
Co.13	0
Co.14	1
Co.15	0
Co.16	0
Co.17	0
Co.18	0
Co.19	0
Co.20	1
Co.21	0
Co.22	0
Co.23	0
Co.24	1
Co.25	0
Co.26	0
Co.27	1
Co.28	1
Co.29	1
Co.30	0
Total	8

From table 4.1 it can be seen that eight respondent companies indicated that they invested a certain amount of money into creative activities. The main method in which companies obtain investment for creativity is through a proportion of their annual turnover. Some companies have a set percentage set aside for creativity purpose, for example, Gau Jing (Co.7) 5%, Carpenter (Co 9) 5%, Blue Steel (Co 20) 5%, and Technic (Co.27) 5%. Other companies, such as Anderson (Co.28) and UV Light (Co.24) choose to set a budget according to past projects. Other companies do not have a set amount of money for creative purposes and they merely invest when the occasion arises.

Anderson and UV Light seem to focus on R&D to generate new ideas for new product development. For example, Anderson employed a PhD graduate as the leader of the R&D department. The R&D department would propose a new product development project, which needs to be approved by the top management. The firm would appraise the new product development project and then set up a budget for the R&D department to reach their goals. When resources flow into the R&D department, the leader would allocate these resources according to the projects priority. If the new project needed a new instrument, the priority would focus on purchasing new equipment and the rest of the capital then would allocate to enhance employees' creativity thinking, such as training.

Gau Jing, Carpenter, Chang Iron, and Ru Long take 5 per cent from either their annual sales or gross profit to invest in creativity. However, they did not explain clearly about how they allocated resources to enhance creativity. Nevertheless, they indicated that

trade shows were the most effective ways to stimulate employees' creative thinking. Therefore, they treated trade shows as creativity investments.

The case of Carpenter highlighted how firms allocate their resources to enhance creativity. The annual sales of Carpenter was NT$ 2 billion. If the firm took 5% from sales for creativity, the creativity capital would be NT$ 10 million. If the firm sent 3 employees to attend 3 international trade shows per year, it is estimated that each trade show costs NT$ 1 million per person and this expenditure includes visiting local agents and end-users. Only 1 per cent of the capital is left to invest in creativity training.

4.2.2 Using training, brainstorming, and workshop to enhance creativity thinking and skilled development

To ascertain the extent to which respondent companies employ specific creativity enhancing activities within their organisation, questions 11 and 12 section 3A asked respondents if they used training/brainstorming sessions to generate new ideas and used mentor-apprenticeship and product family life practice to learn knowledge, skilled development and expertise. Table 4.2 (over page) shows how the four approaches are used by respondent companies to create novel ideas for product innovation. In table 4.2 a "1" indicates that the company did use a particular approach and "0" indicates the opposite. If the total for the various methods of internal idea generation of a company is greater than 3, then the company is judged to be an investor in creativity, indicated by a "1" in the last column. If it is less than or equal to 3, then the company is judged to not be an investor in creativity, indicated by a "0" in the last column.

Table 4.2 The results of approaches used by respondent companies for internal idea generation

Companies	Training	Brainstorm-ing	Mentor-apprentice	Product family life practice	Total	Total>3=1 Idea generation creativity
Co.1	0	0	1	1	2	0
Co, 2	0	0	1	1	2	0
Co. 3	0	0	0	1	1	0
Co.4	0	0	0	1	1	0
Co.5	0	0	1	1	2	0
Co.6	1	0	0	1	2	0
Co.7	1	0	1	1	3	0
Co.8	0	0	0	1	1	0
Co.9	0	1	1	1	3	0
Co.10	1	0	1	1	3	0
Co.11	0	0	1	1	2	0
Co.12	0	0	1	1	2	0
Co.13	0	0	0	1	1	0
Co.14	0	0	1	1	2	0
Co.15	0	0	1	1	2	0
Co.16	0	0	0	1	1	0
Co.17	0	0	0	1	1	0
Co.18	0	0	0	1	1	0
Co.19	0	0	0	1	1	0
Co.20	0	0	1	1	2	0
Co.21	0	0	0	1	1	0
Co.22	0	0	0	1	1	0
Co.23	0	0	0	1	1	0
Co.24	1	1	1	1	4	1
Co.25	0	0	0	1	1	0
Co.26	0	0	0	1	1	0
Co.27	0	0	1	1	2	0
Co.28	1	1	1	1	4	1
Co.29	0	0	1	1	2	0
Co.30	1	0	1	1	3	0
Total	6	3	16	30		2

Training for creativity thinking

From the total of column 2 in table 4.2 it can be seen that six companies stated that they have used external training programs to enhance the creativity thinking of their employees. External training involves sending employees to a specialised government training centre, called China Productivity Centre (CPC). Some training courses ask for tuition fees. Most respondents indicated that they would send their employees regularly

to CPC, if they were not required to pay tuition fees. If the training centre asked for tuition fees for courses, they would be more selective in choosing which of their employees to attend the courses based on their previous experience and expertise.

Brainstorming for creativity thinking

From the total of column 3 in table 4.2, it can be seen that one tenth of respondents indicated that informal brainstorming sessions were held on an irregular basis within their companies to generate ideas from employees. The respondent companies, for instance, invited their own agents to come to their factory and educate its employees about the current state of the market, products pattern, functionality and market trends. This helps employees to realise that different countries demand different products. By understanding the various needs of their customers, design engineers are able to design a wide range of products to appeal to their customers.

Mentor-apprenticeship for knowledge learning and skilled development

From the total of column 4 in figure 4.2 it can be seen that sixteen out of thirty respondent companies indicated that they adopt mentor-apprenticeship to enhance employees' creative skills by developing apprentices' expertise, this is one of the three components in the creativity model mentioned earlier in Chapter 2 (pp:42). The older generation employees use more practical techniques to educate their apprentices step by step about the configuration of the product. More detailed information or knowledge will also be given to their students when necessary.

Product family life practice for knowledge learning and skilled development

From the total of column 5 in figure 4.2 it can be seen that All respondents stated that looking at past product development was the best method for employees to learn relevant knowledge and skill. In order to increase new product in its product range, the respondent companies utilised the existing product's blueprint for employees to learn and develop their own skills and expertise in the workshop.

To sum up, the most popular two internal idea generation methods adopted by the TWMMI are mentor-apprenticeships and product family life practice. As far as these are concerned, mentor-apprenticeships are popular because the older generation employees can use practical techniques to educate their apprentices about the configuration of the product, enhancing the apprentices' expertise supporting their creative processes.

Furthermore, the managers give the employees a lot of leeway in how they use the time and resources available to them, thus allowing experimentation and an increase in creativity in general. By practicing on the product line, it allowed designers to design more flexible components for the final product assembly as they have a better understanding of how products are manufactured.

The fact that only two out of the thirty companies used all four methods of idea generations may signify that the TWMMI are not making the most of the idea generation methods and resources available to them. Were they to do so, this may impact positively on their creativity.

4.2.3 Using external sources to stimulate ideas

To ascertain the extent to which respondent companies implement external sources to stimulate new ideas, questions 13 and 14 section 3A asked respondents if they used any of a number of external sources to stimulate ideas for product innovation. Table 4.3 (over page) shows how the six approaches are used by respondent companies for idea stimulation. In table 4.3 a "1" indicates that the company did use a particular approach and "0" indicates the opposite. If the total for the various methods of internal idea generation of a company is greater than 5, then the company is judged to be a user of external ideas, indicated by a "1" in the last column. If it is less than or equal to 5, then

the company is judged to not be a user of external ideas, indicated by a "0" in the last column.

Table 4.3 The results of approaches used by respondent companies for idea stimulation

Companies	Customer	Competi-tors' products	Supplier	Research institution	Trade shows	Publi-cations	Tot-al	Total >5=1 external idea source creativity
Co.1	1	1	1	0	1	1	5	0
Co, 2	1	1	1	0	1	1	5	0
Co. 3	1	1	1	0	0	1	4	0
Co.4	1	1	1	0	0	1	4	0
Co.5	1	1	1	0	1	1	5	0
Co.6	1	1	0	1	1	1	5	0
Co.7	1	1	1	0	1	1	5	0
Co.8	1	1	1	0	1	1	5	0
Co.9	1	1	1	0	1	1	5	0
Co.10	1	1	1	0	1	1	5	0
Co.11	1	1	1	0	1	1	5	0
Co.12	1	1	1	0	1	1	5	0
Co.13	1	1	1	0	0	1	4	0
Co.14	1	1	1	0	1	1	5	0
Co.15	1	1	1	0	1	1	5	0
Co.16	1	1	1	0	1	1	5	0
Co.17	1	1	1	0	1	1	5	0
Co.18	1	1	1	0	0	1	4	0
Co.19	1	1	1	0	0	1	4	0
Co.20	1	1	1	1	1	1	6	1
Co.21	1	1	1	0	0	1	4	0
Co.22	1	1	1	0	1	1	5	0
Co.23	1	1	1	0	0	1	4	0
Co.24	1	1	1	1	1	1	6	1
Co.25	1	1	1	0	1	1	5	0
Co.26	1	1	1	0	0	1	4	0
Co.27	1	1	1	1	1	1	6	1
Co.28	1	1	1	1	1	1	6	1
Co.29	1	1	1	1	1	1	6	1
Co.30	1	1	1	0	1	1	5	0
Total	30	30	29	6	22	30		5

Customers

From the total of column 2 in figure 4.3 it can be seen that all respondents stated that customers were a valuable source of information and helped them to generate novel ideas for product innovation. As agents, they had information and ideas about local end-users' needs and were willing to share their ideas with the TWMMI for product innovation.

Competitive products

From the total of column 3 in figure 4.3 it can be seen that most Taiwanese manufacturers indicated that they have learned technical knowledge from the market leaders' products by breaking them down into pieces in order to learn the product architecture. This expertise can then be used to support creative product development.

Suppliers

From the total of column 4 in figure 4.3 it can be seen that twenty nine respondents claimed that suppliers brought valuable information into their organisation and hence stimulated their employees' creative ideas. Suppliers not only supply component parts to the TWMMI but also to other industries. Therefore, they owned a wide range of information about the market trends, which helps the TWMMI generate ideas for product innovation.

Research institutions

From the total of column 5 in figure 4.3 it can be seen that only six out of thirty respondents claimed that they had cooperated with the Industrial Technology Research Institute in developing new products. The lack of cooperation with the institution is due to a low awareness of how the institution can help in developing new products. There is also a lack of financial resources to support any cooperation.

Trade shows

From the total of column 6 in figure 4.3 it can be seen that twenty two out of thirty respondent companies believed that trade shows were the best methods for employees' idea generation. The market leaders will exhibit their new machines in exhibition centres around the world, which allows the TWMMI's employees to not only ask questions but also test these machines' reliability and precision.

Publications

From the total of column 7 in figure 4.3 it can be seen that all respondents believed that publications are good stimuli for them to generate new ideas for product innovation. For instance, the market leaders' catalogues contained the introduction of the new models with specifications and functionality, which stimulate their employees' creative ideas.

To summarise, most Taiwanese woodworking manufacturers do not have the experience of cooperating with research institutions such as colleges or universities for idea generation due to a lack of awareness of how the institutes can help. Manufacturers also

lack the financial resources to offer research institutions as identified in my primary research.

The favourite external stimuli for the TWMMI to generate ideas are trade shows and the market leaders' catalogues. Most companies send their sales people and designers to attend famous international trade shows at least three times a year. The three prominent trade shows, in Hanover, Milan, and Atlanta are important for woodworking manufacturers to predict their future business direction. Attending trade shows is a crucial method for this industry to learn new knowledge from their competitors because almost every machine in the trade show allows attendants to trial the machine's functionality and quality. The international trade show is also a place where market leaders introduce their new products to their potential customers. Therefore a wide range of attendees' new product models with specifications are available for attendants to collect, analyse key information and hence stimulate employee's creativity thinking.

The fact that one sixth of companies scored 1, i.e. only five companies adopted all six methods for idea stimulation may be a reflection of how the TWMMI are not making the most of all resources of external idea generation available to them. Were they to do so, this may improve their idea generation and creativity in general.

4.2.4 Using creativity integration to develop new products

To ascertain the extent to which respondent companies employ creativity integration within their organisation, questions 20-24 of section 3C asked the respondents to score their companies against a 6-point scale (1="disagree", 6="strong agree"). This 6-point scale was converted into a simple scale of 0 and 1. If the respondent companies scored 3 or less out of 6 (i.e. towards the lower used end of the integrated approach to implement the innovation process), a score of 0 was given. If the respondent companies scored more than 3 (i.e. towards the higher used end of the integrated approach to implement the innovation process), a score of 1 was given. In table 4.4 a "1" indicates that the company did use a particular approach and "0" indicates the opposite. If the total for the various methods of creativity integration is greater than 3, the company is judged to be a user of creativity integration, indicated by a "1" in the last column. If it is less than or equal to 3, then the company is judged to not be a user of creativity integration by a "0" in the last column.

Table 4.4 Converted results of approaches used by respondent companies for creativity integration

Co.	R&D/ Customers	R&D/ Suppliers	R&D/ Competitors	R&D/ Marketing	R&D/ Production	Tot-al	Total> 3=1 Creativity integration
Co.1	1	1	0	1	1	4	1
Co, 2	1	1	0	1	1	4	1
Co. 3	1	1	0	0	0	2	0
Co.4	0	1	0	0	0	1	0
Co.5	0	1	0	1	1	3	0
Co.6	1	1	0	1	0	3	0
Co.7	1	1	0	1	1	4	1
Co.8	0	1	0	1	1	3	0
Co.9	1	1	0	1	1	4	1
Co.10	1	1	0	1	1	4	1
Co.11	1	1	0	1	1	4	1
Co.12	0	1	0	1	1	3	0
Co.13	1	1	0	0	0	2	0
Co.14	1	1	0	1	1	4	1
Co.15	1	1	0	1	1	4	1
Co.16	1	0	0	0	0	1	0
Co.17	1	1	0	1	1	4	1
Co.18	0	1	0	0	1	2	0
Co.19	1	1	0	0	0	2	0
Co.20	1	1	0	1	1	4	1
Co.21	1	1	0	0	1	3	0
Co.22	1	1	0	1	1	4	1
Co.23	1	1	0	0	0	2	0
Co.24	1	1	0	1	1	4	1
Co.25	0	1	0	1	1	3	0
Co.26	1	1	0	1	1	4	1
Co.27	1	1	0	1	1	4	1
Co.28	1	1	1	1	1	5	1
Co.29	1	1	0	1	1	4	1
Co.30	1	1	0	1	1	4	1
Total	24	29	1	22	23		17

R&D/Customers

From the total of column 2 in table 4.4, it can be seen that twenty four respondent companies stated that they have a close relationship with their customers. This may be due to the fact that manufacturers sell their products to end users through distributors or agents. Distributors or agents have more information about their local customers' demand. In order to meet customers' requirements, distributors or agents have their own

R & D departments to research and design quality products for their eventual customers. These distributors or agents cooperate with their manufacturers to design, manufacture and distribute valuable products to their profitable customers.

R&D/Suppliers

From the total of column 3 in table 4.4, it can be seen that twenty nine out of thirty respondents indicated that they have a close relationship with their suppliers. This may be due to the application of outsourced manufacturing systems within this industry. Outsourced manufacturing systems allow producers to break a product into subsystems which not only enables suppliers to share a proportion of producers' investments in the new product development but also allows the suppliers' designers to participate in product design.

R&D/ competitors

From the total of column 4 in table 4.4, it can be seen that only one company, Anderson had a partnership with its competitors to innovate its products. This may due to the fact that well-established international competitors prefer to cooperate with the local market leader to crate and develop new products to global market.

R&D/production/marketing

From the total of column 5 and 6 in table 4.4, it can be seen that both R&D/production and R&D/ marketing have high integration for the majority of Taiwanese manufacturers. This is due to the flat organisational structure of the companies as most of them are small and family owned. The small companies facilitate frequent information flow producing high integration within the company.

To sum up, customers play a crucial role in the TWMMI's creativity in design because they know exactly what the local users' require. Therefore, customers (agents) participate in the manufacturers' product design to reach their goals.

Domestic suppliers also play an important role in the manufacturers' component parts design. In order to reduce production costs, Taiwanese woodworking machinery manufacturers share the core product design skills and production costs with their local suppliers due to an outsourced manufacturing system.

Taiwanese woodworking machinery manufacturers do not have the opportunity to learn knowledge and technical skills from the market leaders (except Anderson). This is because they do not have well-established reputations and resources to attract potential partners.

From the above table, it can be seen that above half (17/30) of the companies scored a total of one, thus showing that they adopted this particular approach of creativity integration. This may be a reflection of the lack of capital the companies have chosen

or could spare to invest in creativity. Creativity integration allows companies, suppliers and customers to share ideas, and it is less costly than some of the other external and internal idea generation methods mentioned above.

4.2.5 A creative function related performance measured by patents registered

Almost half of respondent companies have never applied for patents. Three companies (Co.10, Co.29 and Co.30) had patented many products consistently, but had not applied for new patents since 2001. Three companies (Co.5, Co. 20 and Co.27) had new products patented but only two companies (Co.5 and Co.27) had patented as new products internationally. On the other hand, twelve companies had their products patented as structured modification to the existing products.

Table 4.5 Registered patents by respondent companies (Tipo 2005).

Firms	The subject of patent	International patent code	Start-end date	Total patent
1 POM	多片圓鉅之薄片承接板改良結構 多片薄片機圓鉅片冷卻及除銷裝置	B27B 5/29 B23D 59/92 B23B45/10	2001-2012 2002-2012	2
2 Starmaster	鉋木機之吸塵結構裝置 砂光機 之 微調 鉋木機之換刀裝置 砂光機 之鎖緊結構	B27G 21/00 B24B 21/00 B27C 1/00 B27C 1/02 B24B 21/12	2000-2011 2000-2011 2000-2011 2001-2011	4
3 GoingE	NONE			0
4 Shine Yun	NONE			0
5 Joyway	仿型磨邊機 鉋邊機之改良 鉋鋸木工 機	B24B 17/50 B27C 1/06, B27C 7/06 B27C 1/04	1994-2004 1995-2005 2003-2013	3
6 Fullpower	NONE			0
7 Gau Jing	氣冷式切割濁總 成四面鉋 短料送料輪快速插銷定位補助臂結構	B27B 5/29 B25F 5/02	1998-2009 2001-2012	2
8 Sun Gaun	NONE			0
9 Carpenter	鉋木機之鉋刀定位 結構 鉋木機之鉋刀卡止裝置	B27C 1/14 B27C 1/02, 1/14	2000-2011 2001-2011	2
10 Chang Iron	木工機之傳動結構改良 四面鉋木機之刀具結構改良 鉋床工作升降結構改良 四面鉋木工壓 料板結構改良	B27C 1/00 B27C 1/00 B27C 1/04 B23Q 1/14	1993-2003 1994-2005 1995-2006 1995-2005	4
11Mung Sung	NONE			0
12Powermax	進行研磨表面砂光機構 砂光機之鉋銷 轉換結構 砂光機之結構改良	B24B 21/16 B27C 1/02 B27C 1/02 B24B21/12	1993-2003 1999-2010 1999-2009	3
13 Longel	NONE			0
14 Champ Ford	木工機械之可掀式定規平台 木工機械之可縮式定規 木工機之板體斜向壓制裝置 木工機之調整可承載台 木工機械之基準靠板 木工機械之板面定位器	B27B 27/10, B27G 23/00 B27B 27/10, B27G 23/00 B27B 27/10, B27G 23/00 B27C 3/00 B27C 3/00 B27G 23/00 B27B 27/10, B27G 23/00	2005-2015 2005-2015 2005-2015 2005-2015 2005-2015 2005-2015	6
15 Boarke	砂光機 之結構改良 棕刷機 換裝結構改良 砂光機研磨機構之改良	B24B 7/08 B24B 29/00 B24B 21/04	1991-2001 1996-2007 1996-2007	3
16 Lih Woel	自動仿型機之送料輸送裝置改良 具防塵門之自動鉋邊機	B23Q 35/00	1990-2000 1992-1997	2
17 Chen Sheng	NONE			0
18 Ta Sane	NONE			0

19 Yung Ming	NONE			0
20 Bluesteel	帶鋸片之安全門裝置 帶鋸機之帶鋸片鬆緊控制裝置 橫式帶鋸機結構改良 帶鋸機之驅動結構 帶鋸機定位料件結構改良 帶鋸機升 降結構 帶鋸機 (2) 帶鋸機(3) 帶鋸機(4)	F16P 3/00 B26D 7/22 B27B 13/08 B27B 13/02 B27B 13/06 B27B 13/00 B27B 13/02 B27B 13/16	2002-2014 2003-2013 2003-2014 2003-2014 2003-2014 2003-2013 2003-2014 2003-2013 2003-2013	9
21Hun Fong	NONE			0
22Yoken Dan	NONE			0
23K.Kae Lian	NONE			0
24U:Light	NONE			0
25 Long Ger	NONE			0
26 Jainn Jong	NONE			0
27Technic	具有可置換機心板之木工 機 臥式旋轉中心加工機 刀塔結構 模組化組裝木工 機械之方法 臥式中心加工機	B25H 1/02 B27C 7/00 B23P 23/00, B27C 9/00 B23B 29/24 B23B 29/24 B23P 23/00 B23P 23/00, B27C 9/00	1997-2009 2000-2018 2000-2010 2000-2010 2000-2017 2000-2018	6
28Anderson	改良式浮動加工裝置	B23Q 15013	2004-2013	1
29Leadermac	木工機架升降之改良 木工機械之輸送輪之結構改良 木工機械輸送輪之調整角度結構 四面鉋木工機切绡輪之傳動皮帶鬆緊調結構 四面鉋木工機之材料輸送結構 四面鉋木工機之無段調整之送料輪護蓋結構 木工機切绡酌支撐結構改良 木工機切绡酌支撐裝置	B27C 5/02 B27B 31/00 B27C 1/12 B27C 1/12 B27C 1/12 , B27C 1/12 B27C 1/08 B27C 7/06 B27C 1/14	1998-2008 1998-2008 1999-2010 2001-2011 2001-2011 2001 2001-2012 2001-2012	8
30 Ru Long	木工立濁機之安全防護裝置 立濁機之可調安全防護裝置 CNC 工作臺之單傳動機構 手動鉋花機之改良	B27G 21/00 B27G 21/00 B23Q 5/22 B27C 1/00	1992-2002 1993-2003 1994-2006 2001-2011	4

4.3 FMS combined with ICT to produce a variety of quality products into global market

4.3.1 FMS combined with ICT software technology to produce a variety of products

To ascertain the extent to which respondent companies implement Flexible

Manufacturing System combined with ICT software technology to produce valuable products within their factories, question g, h and i in section 4 asked respondent companies the degree of the use of FMS and ICT in companies. The respondents were asked to score his/her company. With respect to scores of FMS, this empirical study used a 6-point scale (1= don't have it, 6= have it and use it). Out of the 3 categories, if the respondent companies have over 6 categories which scored 3 or more on the 6-point scale (i.e. towards the "have it and used it" end), they were awarded a score of 1. Companies which do not satisfy these criteria were given a score of 0.

In table 4.6 a "1" indicates that the company is a FMS and ICT user and "0" indicated the opposite. In order to qualify as a FMS user, it is necessary for the company to have two machining centers, a convey system and a robotic. Thus if the total for machining centre is greater than or equal to 2, and convey system is greater than or equal to 1, and robotic is greater than or equal to 1, the company is judged to be a FMS user, indicated by "1" in column 5. If the total for machining centre is less than 2 and convey system is less than 1, and robotic is less than 1, the company is judged to be not a FMS user, indicated by "0" in column 5. To qualify as an ICT manufacturing technology user, it is necessary for the company to adopt both CAD and CAM, thus if the total for the various

methods is equal to 2, the company is judged to be a ICT manufacturing technology user, indicated by "1" in column 9. If the total for the various methods is less than 2, the company is judged to not be a ICT manufacturing technology user, indicated by "0" in column 9. To qualify as a user of both FMS and ICT manufacturing technology user, the company must have a "1" in column 5 and "1" in column 8, and then the company is judged to be a FMS and ICT user, indicated "1" in the last column. If the company did not have "1 in both column 5 and 9 and then the company is judged to not be a FMS and ICT user, indicates "0" in the last column.

Table 4.6 the results from the respondent companies who implement FMS approaches to produce a variety of customized products.

	FMS			FMS Total	ICT manufacturing technology		ICT Total	Total FMS and ICT
Companies	Machining Centre	Conveys	Robotics		CAD	CAM		
Co.1	0	0	0	0	1	0	0	0
Co, 2	1	0	0	0	1	0	0	0
Co. 3	0	0	0	0	1	0	0	0
Co.4	0	0	0	0	0	0	0	0
Co.5	1	0	1	0	1	0	0	0
Co.6	0	0	0	0	0	0	0	0
Co.7	0	0	0	0	1	0	0	0
Co.8	0	0	0	0	0	0	0	0
Co.9	1	0	0	0	1	0	0	0
Co.10	1	0	1	0	1	0	0	0
Co.11	1	0	1	0	0	0	0	0
Co.12	0	0	0	0	1	0	0	0
Co.13	0	0	0	0	1	0	0	0
Co.14	2	0	0	0	1	0	0	0
Co.15	0	0	0	0	0	0	0	0
Co.16	0	0	0	0	0	0	0	0
Co.17	0	0	0	0	0	0	0	0
Co.18	0	0	0	0	0	0	0	0
Co.19	0	0	0	0	0	0	0	0
Co.20	1	0	0	0	1	0	0	0
Co.21	0	0	0	0	0	0	0	0
Co.22	0	0	0	0	0	0	0	0
Co.23	0	0	0	0	0	0	0	0
Co.24	2	0	1	0	1	0	0	0
Co.25	0	0	0	0	0	0	0	0
Co.26	0	0	0	0	0	0	0	0
Co.27	2	0	0	0	1	0	0	0
Co.28	2	0	2	0	1	0	0	0
Co.29	2	0	0	0	1	0	0	0
Co.30	2	0	0	0	1	0	0	0
Total	18	0	5	0	16	0	0	0

Machining Centre/Robotics/Convey System

From the total of column 2 in table 4.6, it can be seen that three fifth respondents claim that they have applied Flexible Manufacturing Systems (FMS) in their manufacturing processes, none of them have really utilised it. This is because respondents confused the terminology of FMS with Machine Centre (MC). Flexible Manufacturing Systems are

used to link together numerically-controlled machining centres and automated material handling systems whereas a numerically-controlled machining centre is a system which is capable of controlling a variety of machine processes and automatic tool changes. It is also capable of moving the workpiece to positions programmed in advance with little additional human input. Automatic material handling system is the use of conveyers to efficiently move materials. Having FMS systems in a factory would require two conditions to be met; one is having more than two machining centres and the other is automated material handling systems. The research shows that limited robotics are used and a sixth of respondents used it. Even in this group the use of robotics is limited as robotics is often only doing one job e.g. welding.

Computer-added Design (CAD) and Computer-added Management (CAM)

From the total of column 6 in table 4.6, it can be seen that almost half of respondents use CAD and CAM. However, there was confusion between CAD and CAM; closer examination showed that respondents used only CAD but not CAM. CAD is used for image production while CAM is the program language. The purpose of CAM is to use 3D models to develop specific programs for numerically-controlled machines to cut various forms, shapes and contours into various component parts such as steel. This system is hard to understand, Taiwanese employees may not have the ability to use the package, and hence CAM is not used at all in this industry.

In short, the TWMMI does not use FMS within their organisation to produce new products. None of the manufacturers use FMS combined with ICT to produce a variety of customised products. Some companies use Machining Centres to produce small

amounts of component parts for final assembly. Most component parts are outsourced to close-by suppliers. They do not use robotics to assemble their final products and all assembly work is done manually.

Most Taiwanese manufacturers still use hand drawings to produce their blueprints because owner managers did not trust their designers' capability. The owner managers believe that designers who have the ability to draw component parts to construct a machine virtually need to be trained for more than 10 years. Most of their designers do not have 10 years work experience and therefore the owner managers prefer their designers to learn the design knowledge from the blueprints, which are drawn by hand.

The fact that no respondent companies used FMS combined with ICT may indicate that the TWMMI are not applying advanced manufacturing technology within their manufacturing processes. Were they to do so, this may impact positively on their productivity.

4.3.2 Using ICT administrative technology to manage business activities for developing and manufacturing variety of products

To ascertain the extent to which respondent companies apply ICT administrative technology to manage day-to-day business activities, question 29 a, b, j, k and l in section 4 asked respondent companies the degree of application of ICT technology to help innovation activates. The respondents were asked to score his or her company with respect to six scores of ICT technology by using a 6-point scale (1= "don't' have it", 6=

"have it and use it"). Out of the 4 categories, if the respondent companies have over 6 categories which scored 3 or more on the 6-point scale (i.e. towards the "have it and used it" end), they were awarded a score of 1. Companies which do not satisfy these criteria were given a score of 0. Table 4.7 (over page) shows how the five approaches are used by respondent companies who implement the approaches to assist, manage and manufacture their products. In table 4.7 a "1" indicates that the company did use a particular approach and "0" indicates the opposite. If the total of for the various methods of ICT administrative technology of a company is greater than or equal to 4, the company is judged to be a user of ICT administrative technology, indicated by "1" in the last column. If it is less than 4, then the company is judged to not be a user of ICT administrative technology, indicated by "0" in the last column.

Table 4.7 Converted results for use of ICT to help administrative activities

Companies	PDM	CSM	ERP	Accounting	Database	Total	Total>4=1 FMS+ICT
Co.1	0	0	0	1	1	2	0
Co, 2	1	0	0	0	1	2	0
Co. 3	0	0	0	1	1	2	0
Co.4	0	0	0	1	1	2	0
Co.5	1	0	0	1	1	3	0
Co.6	0	0	0	1	1	2	0
Co.7	1	1	0	1	1	4	0
Co.8	0	0	0	1	1	2	0
Co.9	1	1	1	1	1	5	1
Co.10	1	1	1	1	1	5	1
Co.11	0	0	0	0	1	1	0
Co.12	0	0	0	1	1	2	0
Co.13	0	0	0	1	1	2	0
Co.14	1	1	1	1	1	5	1
Co.15	0	0	0	1	1	2	0
Co.16	0	0	0	1	0	1	0
Co.17	0	0	0	1	1	2	0
Co.18	0	0	0	0	0	0	0
Co.19	0	0	0	0	0	0	0
Co.20	0	0	0	0	0	0	0
Co.21	0	0	0	0	0	0	0
Co.22	0	0	0	1	1	2	0
Co.23	0	0	0	0	0	0	0
Co.24	1	1	1	1	1	5	1
Co.25	0	0	0	0	0	0	0
Co.26	0	0	0	1	1	2	0
Co.27	1	1	0	1	1	4	0
Co.28	1	1	1	1	1	5	1
Co.29	1	0	0	1	1	3	0
Co.30	0	1	1	1	1	4	0
Total	10	7	6	22	23		5

Product Design Management (PDM)

From the total of column 2 in table 4.7, it can be seen that twenty out of thirty respondents do not use PDM. The respondents who use PDM, often use it for designing component parts, once the skill is mastered, the system is heavily used, as an average machine requires several thousand images to form a product (machine). The PDM software allows them to be easily managed and store all component parts.

Component Supply Management (CSM)

From the total of column 3 in table 4.7, it can be seen that fifteen out of thirty respondents do not use CSM but of those who do use this system seven respondents claimed to use it heavily. The reason for this may simply be a lack of knowledge as to how to use this software and those who use it find it useful, seven out of 30, are heavy users. The limited usage of CSM is also due to the fact that another system is available, inventory packages.

Enterprise Resource Planning (ERP)

From the total of column 4 in table 4.7, it can be seen that ERP is heavily used only by a fifth of respondents. The reason for this is the difficulty in learning how to use this system. Managers have either bought the software from a company, who is responsible for modifying the system to the company's demands. Alternatively large companies can employ, at high costs, specialised foreign software company to design individual ERP systems.

Accounting

From the total of column 5 in table 4.7, it can be seen that accounting is an essential part of the companies as only one out of thirty respondents do not use it in their operations. Eight companies claim to be light users while twenty two respondents used it heavily. This is due to the necessity of accounting to produce cash flows, balance sheets and profit-loss accounts.

Database

From the total of column 6 in table 4.7, it can be seen that the use of databases is also an important feature for companies as seven in thirty are considered light users while two-thirds of the respondents used databases heavily. This is due to the theory that firms who keep valuable customers are more profitable than those with little repeat business. Customers therefore, need to be classified and analysed as individuals, and database systems provide this functionality.

To sum up, the Taiwanese woodworking machinery manufacturers were unable to link PDM, CSM and ERP together. The major problem faced by manufacturers is the lack of integration of data among different functions such as finance, materials, sales and production. It is believed that this is due to the fact that Micro software packages developed and sold in Taiwan are not being adequately supported to be properly implemented. Micro software packages are not expensive and can be installed very quickly but if manufacturers bought the software package from people who have a lack of expertise and knowledge in this industry, it becomes difficult to use the systems to achieve manufacturer's business objectives.

The fact that five companies adopted ICT administrative technology may be an indication of how the TWMMI are not applying advanced software technology to assist developing and manufacturing their products. Were they to do so, this may impact positively on their creativity and productivity.

4.3.3 Using ICT e-commerce technology to expand geographical territories

To ascertain the extent to which respondent companies apply ICT e-commerce to expand geographical territories, question 29 c to f in section 4 asked respondents the degree of the use of ICT in companies. The respondents were asked to score his or her company against a 6-point scale (1= " don't' have it", 6= " have it and use it"). Out of the 4 categories, if the respondent companies have over 2 categories which scored 3 or more on the 6-point scale (i.e. towards the "have it and used it" end), they were awarded a score of 1. Companies which do not satisfy these criteria were given a score of 0.

Table 4.8 (over page) shows the results from the respondent companies who implement the approaches to promote and distribute their products. In table 4.8 a "1" indicates that the company did use a particular approach and "0" indicates the opposite. If the total for the various methods is greater than 2, then the company is judged to be an ICT e-commerce user, indicated "1' in the last column. If it is less than or equal to 2, then the company is judged to not be an ICT e-commerce user, indicated by "0" in the last column.

Table 4.8 Converted results for use of ICT to help geographical expansion

Companies/ICT	E-mail	Website	Web-trading	Internet Exch.	Total	Total >2 FMS+ICT
Co.1	1	0	0	0	1	0
Co, 2	1	1	0	0	2	0
Co. 3	1	1	0	0	2	0
Co.4	1	1	0	0	2	0
Co.5	1	1	0	0	2	0
Co.6	1	1	0	0	2	0
Co.7	1	1	0	0	2	0
Co.8	1	1	0	0	2	0
Co.9	1	1	0	0	2	0
Co.10	1	1	0	0	2	0
Co.11	1	1	0	0	2	0
Co.12	1	1	0	0	2	0
Co.13	1	1	0	0	2	0
Co.14	1	1	0	0	2	0
Co.15	1	1	0	0	2	0
Co.16	1	1	0	0	2	0
Co.17	1	1	0	0	2	0
Co.18	0	1	0	0	1	0
Co.19	0	0	0	0	0	0
Co.20	0	0	0	0	0	0
Co.21	1	1	0	0	2	0
Co.22	1	0	0	0	1	0
Co.23	1	1	0	0	2	0
Co.24	1	1	0	1	3	1
Co.25	1	1	0	0	2	0
Co.26	1	1	0	0	2	0
Co.27	1	1	0	0	2	0
Co.28	1	1	0	1	3	1
Co.29	1	1	0	0	2	0
Co.30	1	1	0	0	2	0
Total	27	26	0	2		2

E-mail

From the total of column 2 in table 4.8, it can be seen that e-mails are relied on heavily as none of the respondents do not use it and ninety percent of the respondents class themselves as heavy users. The heavy usage of e-mail is due to its convenience. E-mail can be sent quickly and is often very cheap. In addition, e-mail can be used both within the company and to contact suppliers or customers.

Website

From the total of column 3 in table 4.8, it can be seen that the website is another essential system used by the companies. All of the respondents use the web and eighty percent of the respondents claim to be heavy users. The extensive use of websites is due to the opportunities of promoting their products. This is reinforced by the fact that limited companies have the option of buying products online.

Website ordering systems

From the total of column 4 in table 4.8, it can be seen that website ordering systems are used by just over half the respondents, showing that most websites are used for an advertising purpose only. An additional reason for this is the cost of establishing a website ordering system as well as customer's demands to see the products and the manufacturing plants for themselves.

The Internet exchange network

From the total of column 5 in table 4.8, it can be seen that twenty six respondents do not use the trade network systems due to the fact that they have never heard of them. Four out of thirty of the respondents claimed to use the trade networks and only two respondents claimed that they used it heavily.

In short, none of the manufacturers have used the internet function for automatic electronic trading. Customers and manufacturers prefer to use the traditional way. This is because Letter of Credit (L/C) techniques is a common method used by this industry

to close deals. An additional reason for this is the cost of establishing a website transaction system as well as customer's demands to see the product and the manufacturing plants for themselves. Furthermore, when placing orders, customers prefer signing contracts with companies as after-sales services are often involved.

The fact that only two companies adopted ICT e-commerce may show how the TWMMI are not applying modern technology to help promote and distribute their products globally. Were they to do so, this may impact positively on their market share and profitability?

4.3.4 Manufacturing technology and ICT related performance measured by respondent companies

To ascertain the extent to which respondent companies perceived business performance, question 30 a to f in section 5 asked respondent companies the degree of business performance they perceived (previously identified in Chapter 3). If the respondent companies scored 3 or less on the 6-point scale, their self evaluation of their improved business performance would be low in relation to that of their competitors. However, if the score was more than 3 on the scale, their self evaluation of their improved business performance would be high compared with their competitors. In table 4.9 a "High" indicates that the company perceived its improved business performance is greater than its competitors and "Low" indicates the opposite.

Table 4.9 Manufacturing technology and ICT related performance measurement by the other respondent companies

Co.	Developing new product ability	Developing new product speed	Manufacturing lead time	Deliver y time	Customer's response	Geogra-phical coverag e
Co.1	L	L	H	H	H	L
Co, 2	H	H	H	H	H	H
Co. 3	H	H	H	H	H	H
Co.4	L	L	L	H	H	H
Co.5	H	H	H	H	H	H
Co.6	H	H	H	H	H	H
Co.7	L	L	H	L	H	H
Co.8	H	H	H	H	H	L
Co.9	H	H	H	H	H	H
Co.10	H	L	L	L	H	L
Co.11	H	H	H	H	H	H
Co.12	H	H	H	H	H	H
Co.13	H	H	H	H	H	L
Co.14	H	H	H	H	H	L
Co.15	H	H	H	H	H	H
Co.16	L	H	H	H	H	H
Co.17	H	H	H	H	H	L
Co.18	L	L	L	L	L	L
Co.19	H	H	H	H	H	H
Co.20	H	H	H	H	H	H
Co.21	H	H	H	H	H	H
Co.22	H	H	H	H	H	H
Co.23	L	L	L	L	H	H
Co.24	H	H	H	H	H	L
Co.25	L	L	H	H	H	L
Co.26	L	L	H	H	H	L
Co.27	L	L	L	H	H	H
Co.28	H	H	H	H	H	L
Co.29	H	H	H	H	H	L
Co.30	H	L	H	H	L	L
Total	21	20	25	26	28	17

From the total of column 2 in table 4.9, it can be seen that twenty one out of thirty respondents believed that they had better capability to develop and manufacture new products than their competitors.

From the total of column 3 in table 4.9, it can be seen that almost two thirds of respondents claimed that developing new product speed was shorter than their competitors.

From the total of column 4 in table 4.9, it can be seen that twenty five out of thirty respondents stated that their manufacturing lead time was shorter than their competitors.

From the total of column 5 in table 4.9, it can be seen that twenty six out of thirty respondents indicated that their product delivery time was shorter than their competitors.

From the total of column 6 in table 4.9, it can be seen that most respondent companies claimed that their customers' response time was quicker than their competitors.

From the total of column 7 in table 4.9, it can be seen that more than half of the respondents stated that they had a wide scope of geographical coverage.

4.3.5 Manufacturing technology and ICT related performance measured by international customers

In this questionnaire (Appendix 2 pp: 218), question 30 a to f asked the extent to which customers' opinion about the TWMMI improved business performance (previously identified in Chapter 3). If the customers scored 3 or less on the 6-point scale, they would have received low satisfaction from the respondent suppliers compared with other international suppliers. However, if they scored over 3, it meant they have high satisfaction from the respondent suppliers. Table 4.10 (over page) shows how customers' perceive the respondent companies' improved business performance. In table 4.10 a "High" indicates that the international customers' perception of the TWMMI's improved business performance is greater than their competitors, and "Low" indicated the opposite. Thus, if the international customer perceived that a particular Taiwanese woodworking machinery supplier's improved business performance is greater than its competitors, the company is judged to be a "High" improved business performance in each specified category. If the international customer perceived that a particular Taiwanese woodworking machinery supplier's improved business performance is lower than its competitors, the company is judged to be a "Low" improved business performance in each specified category.

Table 4.10 A Customers' perception of respondent companies' manufacturing technology and ICT related performance

Number of customer	C1	C3	C8	C15	C11	C17	C6	C13	C14
Number of company	Co. 9		Co.1		Co. 3		Co5		
Developing new product ability	H	L	L	L	L	L	H	H	L
Developing new product speed	L	H	L	L	H	H	L	L	H
Manufacturing lead time	L	H	H	H	L	L	L	H	L
Delivery time	L	L	H	H	L	L	L	L	L
Customer's response	H	L	H	H	H	L	L	H	H
Geographical coverage	L	L	L	L	L	L	L	H	H

Table 4.10 B Customers' perception of respondent companies' manufacturing technology and ICT related performance

Number of customer	C4	C7	C12		C18	C16	C5	C9	C2	C10
Number of company	Co.29				Co.26	Co.2	Co.17	Co.7	Co.10	Co.28
Developing new product ability	H		H	H	L	L	H	H	L	H
Developing new product speed	H		H	H	H	H	H	H	L	H
Manufacturing lead time	H		H	H	H	H	H	H	L	H
Delivery time	L		H	H	H	L	H	H	L	H
Customer's response	H		H	H	H	L	H	H	H	H
Geographical coverage	H		L	H	L	L	H	H	L	L

From the column 2 and 3 in table 4.10 A, it can be seen that Carpenter (Co. 9) were awarded from two customers (C1 and C3). These customers had different opinions about Carpenter's developing new product capability, product development time, manufacturing time and customers' response time. However, they agreed that Carpenter's delivery time was not shorter than its competitors and it has a more narrowed geographical coverage than its competitors.

From the column 4 and 5 in table 4.10 A, it can be seen that Pom (Co.1) was awarded by two customers (C8 and C15). These customers had the same perception about Pom's developing new product ability, developing new product speed, manufacturing lead

time, delivery time, customer's response, and geographical coverage. They stated that its manufacturing lead time, delivery time and customer's response were shorter than its competitors but not its developing new product speed.

From the column 6 and 7 in table 4.10 A, it can be seen that Going E. (Co. 3) was awarded from two customers (C11 and C17). These customers indicated that is product delivery time was shorter than its competitors but not manufacturing lead time and delivery time.

From the column 8 and 9 in table 4.10 A, it can be seen that Joyway (Co.5) was awarded from three customers (C6, C13 and C14). These customers gave different perception about its improved business performance.

From the column 2, 3 and 4in table 4.10 B, it can be seen that Leadermac (C0. 29) was also awarded from three customers (C4, C7 and C12). They all agreed that its improved business performance was better than its competitors, except geographical coverage.

From the columns 5, 6, 7, 8, 9 and 10 in table 4.10 B it can be seen that the other customers gave awarded to a particular company's improved business performance. They claimed that the TWMMI did not have a wider geographical coverage than its competitors.

4.4 Data reliability

The data given in this empirical study is not completely reliable. This is mainly due to four critical factors:

1. wrong questions were asked to the respondent companies,
2. flawed increased creative success measurement,
3. false information and
4. low respondent rate.

An example of asking the respondent companies wrong questions can be seen from questionnaire 29 g (CAD and CAM) and 29 i (FMS). Question 29 g should have been separated into two questions: Firstly.the application of CAD and secondly. the application of CAM. 29 i should have been separated into 3 questions: 1. the application of machining centres, 2. conveyer systems and 3. robotics. Question 29 should have included 3 D modelling system for rapid prototyping. These wrong questions were pointed out by the respondent companies and then accurate data was found to answer these questions. However, there could still be some wrong questions designed in this empirical study which was not pointed out by respondent companies. Despite this inconsistency, the flaws in the research approach have not reduced the value of the data obtained during the research process.

The measurement of patents as an indicator of increased creative success is not wholly reliable, as patents can be for minor modifications to an earlier patent rather than a

novel idea or development. Therefore, making diversification compensates for this lack of reliability and can be used to identify increased creative success.

This empirical study concerns the accuracy of the answers provided by the respondents' participating in the interview. The researcher must rely on respondents to provide factual information. Impression management is always a risk in a study of this nature, and occasionally respondents may provide the researcher with false information (Van Maanen 1979) intentionally or unintentionally. In interview situations, researchers have to rely on the validity, accuracy and reliability of their questions and their interpersonal skills to relate to the respondents in a professional non-threatening manner.

The respondent rate was relatively low because the interview was designed by and had to be responded to, by owner managers. It was believed that as the TWMMI is mainly composed of small, family owned firms, the decision making process for day-to-day activities is managed by the owner managers of the firms.

Most owner managers were busy travelling around the world for their businesses' activities and therefore it was difficult to find a suitable time for interviews. Another reason for the low response rate was that potential respondent firms perceived their innovation activities as confidential, so they did not want to disclose this information to the researcher. The timetable of interviews with respondent firms was shown in Table 4.11 (pp: 143).

The International Woodworking Machinery Trade Show is held in the Taipei World Trade Centre every three years. It was held from 1st July 2005 to 4th July 2005. This gave the researcher a good opportunity to interview the international customers regarding their opinion of Taiwanese Woodworking Manufacturers' improved business performance. However, only 18 respondents were willing to participate in the interview. The main reason why the interview had so few international respondents was because the required criteria for the interviewees state that they must have had traded with the 30 respondent firms listed in the questionnaire. However, the international customers who came to the trade show were potential buyers from all over the world, and many of them had not bought products from any of the 30 respondent firms in the questionnaire before. As trade show was only held for four days, and there was a very limited time to collect a large quantity of data.

It could be argued that this restriction and the lack of respondents answering the questionnaire, have limited the reliability of the research results. However, these 18 respondents have provided a good overview of the TWMMI's dealing with international customers, and, as long term customers, they have in-depth knowledge of the strengths and weaknesses of the TWMMI's products and customer dealings.

Table 4.11 the list of questionnaire interview with top managers and time table

Number	Company	The position of interviewee	The date of interview
1	Pow	president	1-March-2005
2	Starmaster	Marketing manager	2-March-2005
3	Goine.E	Owner-manager	2-March-2005
4	Shine Yun	Owner-manager	2-March-2005
5	Joyway	Owner-manager	2 and 19-March-2005
6	Fullpower	Managing director	3-March-2005
7	Gau Jing	Managing director	3-March-2005
8	Sun Gaun	R&D and production manager	3-March-2005
9	Carpenter	Marketing and purchasing manager	3 March and 1April2005
10	Chang-Iron	Owner-manager	4-March-2005
11	Mung Suang	Managing director	4-March-2005
12	Powermax	Owner-manager	7-March-2005
13	Longel	Owner-manager	7-March-2005
14	Champ	Owner-manager	29-March-2005
15	Boarke	Owner-manager	8-March-2005
16	Lih Woei	Owner-manager	9-March-2005
17	Chen Sheng	Owner-manager	13-March-2005
18	Ta Sane	Managing director	10-March-2005
19	Yung Ming	Owner-manager	11-March-2005
20	Blue Steel	Owner-manager	11-March-2005
21	Hun Fong	Owner-manager	14-March-2005
22	Yoken Dan	Managing director	14-March-2005
23	K .Kae Lian	Owner-manager	15-March-2005
24	UV Light	Owner manager and IT manager	15-March-2005
25	Long Ger	Managing director	1-April-2005
26	Jainn Jong	Owner-manager	16-March-2005
27	Technic	R&D manager and production manager	16-March-2005
28	Anderson	R&D manager	4 and 25-March-2005
29	Leadermac	Managing director	30-March-2005
30	Ru Long	Owner-manager	29-March-2005

4.5. Conclusions

Through this empirical study, it can be seen that most Taiwanese manufacturers did not invest in creativity. Those companies, which had invested in creativity perceived that trade shows as better investment in creative thinking. The TWMMI used product life cycle practice to enhance employees' knowledge in creative thinking and supervisor to cultivate employees' technical skills for creativity. They did not cooperate with research institution and competitors to learn new knowledge and technical skills in their field for creativity. They did not establish a formal or informal training program to generate new ideas from a group of employees. They failed to utilise FMS combined with ICT to manufacturing variety products. As a result, they were only able to modify their existing products and take them into Asian and U.S. DIY market. As mentioned above in the data reliability section, these results may not be wholly accurate as there were wrong questions asked of respondent companies, flawed increased creative success measurements, false information and low respondent rate, the information presented here may be affected by these errors. However, the 18 respondent companies were long term customers of the TWMMI thus should give an accurate overview into the workings of this industry.

Chapter 5 Discussion

5.1 Introduction

Chapter 4 represents the results of how respondent companies use a creative function to create novel and useful ideas, and utilise Flexible Manufacturing System combined with Information communication Technology to develop, design and manufacture customised products and then distribute products into global markets. This chapter presents the descriptive analysis responding to the three main research questions.

The three main research questions are:

(1) Does implementing a higher level of a creative function mean that the Taiwanese woodworking machinery manufacturers have a greater level of increased creative success?

(2) Does implementing a higher level of Flexible Manufacturing Systems combined with Information Communication Technology mean that the Taiwanese woodworking machinery manufacturers have a greater level of improved business performance?

(3) Does implementing a higher level of a creative function and FMS combined with Information Communication Technology mean that Taiwanese woodworking machinery manufacturers have a greater level of improved business performance?

The term "creative function" defined in Chapter 3 is the process undertaken by the TWMMI including funds, internal idea generation, and external sources to stimulate ideas as well as creativity integration to create and develop novel ideas.

The term "Flexible Manufacturing systems combined with ICT" defined in Chapter 3 is the process undertaken by the TWMMI to develop, design, manufacture and distribute valuable products into the global market.

The term "increased creative success" defined in Chapter 3 is measured by patents registered, diversification and government awards.

The term "improved business performance" defined in Chapter 3 is measured by new product development ability, speed of new product development, shortened manufacturing lead time, delivery time, customer response, increased geographical coverage and customer satisfaction.

5.2 (H1) Does implementing a higher level of a creative function mean that the Taiwanese woodworking machinery manufacturers have a greater level of increased creative success?

As mentioned in Chapter 3 (3.2 pp: 82), this empirical study decided to use patents registered, government awards and diversification to measure increased creative success in terms of the TWMMI's implementation of a creative function successfully within their organisations. Therefore, this section attempts to examine the correlation between a higher level of a creative function and a greater level of increased creative success.

In order to classify respondent companies into high or low creative function groups, this empirical study has developed a summary table of creative function , which is derived from Chapter 4 (the last column of table 4.1 pp:105, the last column of table 4.2 pp: 108, the last column of table 4.3 pp111 and the last column of table 4.4 pp: 116).

Table 5.1 The summaries of results of creative function

Companies	Total Funds invested in creativity	Total Idea generation creativity	Total External idea source creativity	Total Creativity integration	Overall total (sum columns 4.1-4.4)
Co.1	0	0	0	1	1
Co, 2	0	0	0	1	1
Co. 3	0	0	0	0	0
Co.4	0	0	0	0	0
Co.5	0	0	0	0	0
Co.6	0	0	0	0	0
Co.7	1	0	0	1	2
Co.8	0	0	0	0	0
Co.9	1	0	0	1	2
Co.10	0	0	0	1	1
Co.11	0	0	0	1	1
Co.12	0	0	0	0	0
Co.13	0	0	0	0	0
Co.14	1	0	0	1	2
Co.15	0	0	0	1	1
Co.16	0	0	0	0	0
Co.17	0	0	0	1	1
Co.18	0	0	0	0	0
Co.19	0	0	0	0	0
Co.20	1	0	1	1	3
Co.21	0	0	0	0	0
Co.22	0	0	0	1	1
Co.23	0	0	0	0	0
Co.24	1	1	1	1	4
Co.25	0	0	0	0	0
Co.26	0	0	0	1	1
Co.27	1	0	1	1	3
Co.28	1	1	1	1	4
Co.29	1	0	1	1	3
Co.30	0	0	0	1	1
Total	8	2	5	17	

Figure 5.1 uses the overall scores shown in column 6 of table 5.1 to plot the relative position of respondent companies (identified by their company number) on a creative function scale, where 4= high creative function, 0 = low creative function and 2= the break point. This point was chosen because it is half way on the 4 point scale used in this empirical study. As a result, companies who employ more than two approaches to generate and develop new ideas for product innovation are classified as high creative function for the purposes of.

Figure 5.1 the position of respondent companies with respect to their level of creative function

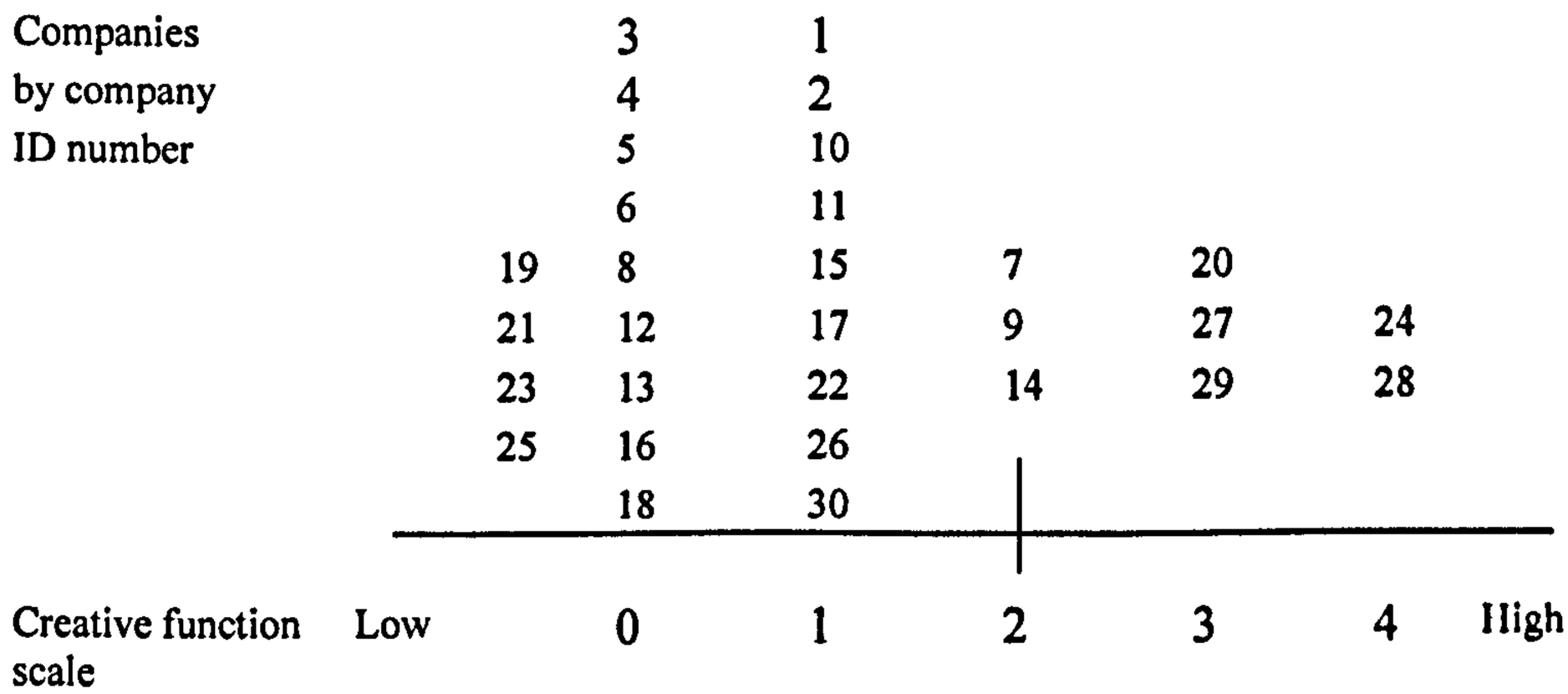


Figure 5.1 shows that 5 companies (Bluesteel 20, UV Light 24, Technic 27, Anderson 28 and Leadermac 29) are classified as high whereas 25 companies are classified as having a low creative function.

In order to identify respondent companies into high or low number of patent registered, this empirical study has developed a summaries' table (table 5.2 over page), which is derived from Chapter 4 (the last column of table 4.5 pp: 120-121).

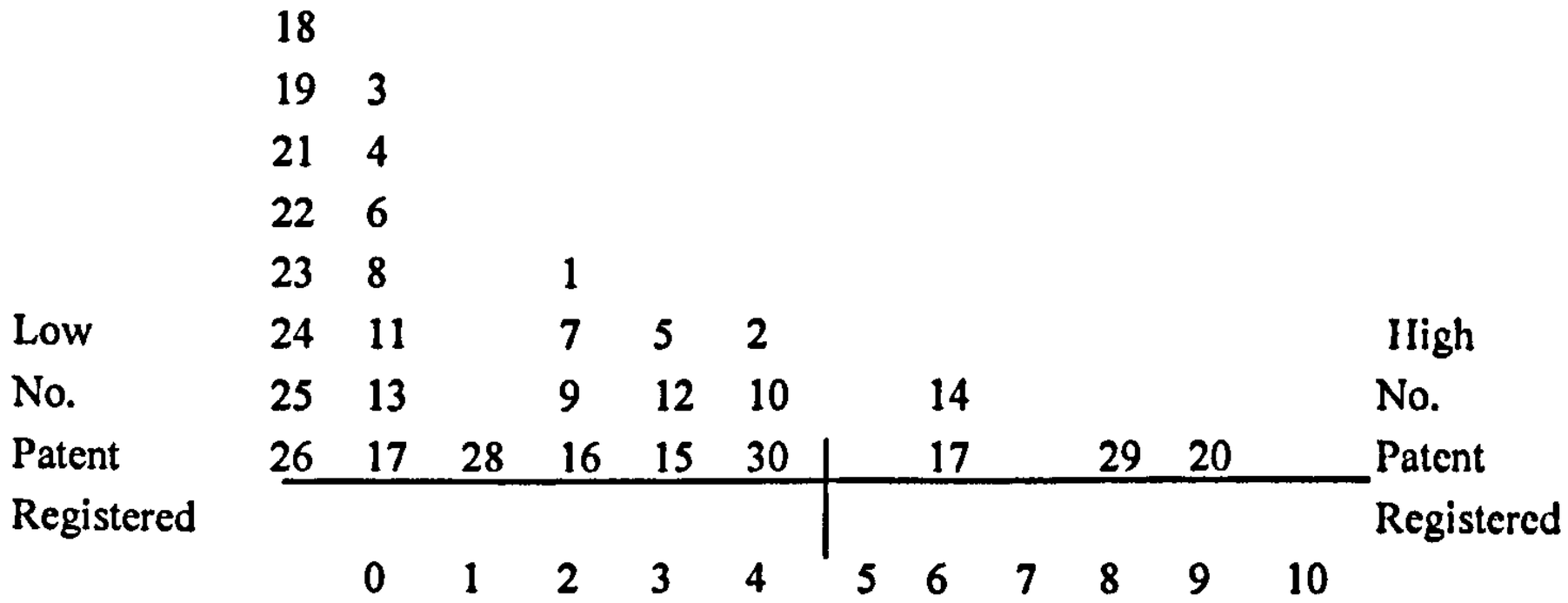
Table 5.2 the summary of results of patent registered by respondent companies

Companies	Number of patent registered
Co.1	2
Co, 2	4
Co. 3	0
Co.4	0
Co.5	3
Co.6	0
Co.7	2
Co.8	0
Co.9	2
Co.10	4
Co.11	0
Co.12	3
Co.13	0
Co.14	6
Co.15	3
Co.16	2
Co.17	0
Co.18	0
Co.19	0
Co.20	9
Co.21	0
Co.22	0
Co.23	0
Co.24	0
Co.25	0
Co.26	0
Co.27	6
Co.28	1
Co.29	8
Co.30	4

The summary of results of respondent companies' patent registered in table 5.2 are represented in graphically in figure 5.2 plotting in the relative position of respondent companies from 0 to 9 based on the patent that they have registered. To classify respondent companies into high or low number of patent registered, this empirical study

chose 4.5 as the critical point. This point was chosen because it is half way on the 9 point scale used in this empirical study. Thus, companies who registered more than 4.5 patents are classified as high level of patent registered.

Figure 5.2 the position of respondent companies in patent registered



The purpose of developing figure 5.1 and 5.2 is to examine the correlation between high/low creative function and high/low increased creative success by patent registered.

In table 5.3 below, the companies classified as high patent registers are shown in column 1. Column two shows the remainder. The columns have been divided horizontally to separate the high creativity group (row 1) from the low creativity group (row 2).

Table 5.3 The level of creative function and number of patent registered

	High No.Patent	Low No.Patent
High creativity	20 27 29	24 28
Low creativity	14	1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 17 18 19 21 22 23 25 26 30

Three companies: Bluesteel (Co. 20), Technic (Co. 27) and Leadermac (Co. 29) are in the position of high level of creativity with high number of patents registered. Only one company, Chang Fong (Co. 14) is in the position of low level of creativity with high number of patents registered, whereas two companies: UV Light (Co. 24) and Anderson (Co.28) are in the position of high level of creativity but low level of patents registered. The remainder companies are in the position of low level of creativity with low level of patents registered. With this research alone, it may be hard to understand the results found. Chang Fong, (Co.14), UV Light (Co.24) and Anderson (Co.28) with a low level of creativity adopted should be equal to a low number of patents registered and vice versa. However, these anomalies may be evidence of how patents may not be the best measure of increased creative success for the TWMMI because patents can be registered as either minor to change structure of core products or significant to change structure of core products. Furthermore, many innovators do not patent their products at all, (Kraft 1989). For this reason, this empirical study used diversification as an indicator of increased creative success measurement to compensate for this discrepancy. Diversification enables this empirical study to identify companies who have breakthrough products to diversify into new markets.

Originally, UV Light specialised in UV drying machines for logs. In 1996, the company discovered that, in the future, there would be a shortage of wood; therefore, they decided to launch research into IR dryer machines for paper and semi-conductor sectors. Successfully, UV Light has diversified its business into new areas, (UV Light 2005). A similar case occurred for leading company, Anderson, who also diversified its business into the Printed Circuit Board, (PCB) sector, (Anderson 2005). Chang Iron conducted a

backward diversification to produce parts for the woodworking machinery industry, (Chang Iron 2005) whereas Carpenter carried out a forward diversification and entered into the furniture sector to produce wooden floors, (Carptenter 2005). Ru Long used its manufacturing woodworking machines' experience, knowledge and skills to produce a number of high-tech machining centres for this industry to produce their component parts, (Ru Long 2005). Although, Carpenter and Chang Iron as well as Ru Long conducted forward and backward diversification, they still conduct business in the woodworking machinery industry. It is high risk that they did not diversify into other sectors because there could be a shortage of wood in the future.

This empirical study also attempts to use government award as increased creative success. In the high creativity group, Anderson has its CNC router, CNC machine centre and CNC profile grinding machines awarded, a certificate excellence by the Ministry of Economic Affairs in Taiwan in 1992, (Anderson 2005). In the low creativity group, Carpenter's rip saw series were awarded excellent by the Ministry of Economic Affairs in Taiwan, (Carpenter 2005). This measurement seems insufficient for identification of the actual companies' increased creative success because one can not clearly identify that respondent companies had produced breakthrough products.

A higher level creative function helped the TWMMI to increased creative success. For instance, a high level creative function had helped Anderson to transform from a woodworking machinery tools import company into designing and manufacturing woodworking machines, and PCB processing machines corporation. Anderson and UV Light successfully developed high-tech products and brought them into new markets

such as the semi-conductor industry. Leadermac did not produce new products and bring them into new markets but had several patents registered. Bluesteel and Technic had several patents registered in producing entirely new machines. On the other hand, a lower level creative function did not help the TWMMI to increased creative success. The respondent companies in this group made only minor modifications to existing products and sold them into existing markets.

Therefore, it can be concluded that hypothesis 1 should be accepted as it can be seen that companies with a higher level of creative function achieved greater level of increased creative success.

5.3 (H2) Does implementing a higher level of Flexible Manufacturing Systems combined with Information Communication Technology mean that the Taiwanese woodworking machinery manufacturers have a greater level of improved business performance?

As mentioned in Chapter 3 (3.2 pp: 81), this empirical study determined to use developing new product ability, developing new product speed, manufacturing lead time, delivery time, customer's response, and geographical coverage as well as customer satisfaction to measure improved business performance in terms of the TWMMI's successful implementation FMS combined with ICT within their manufacturing process. Therefore, this section examines the correlation between a higher level of FMS combined with ICT and a greater level of improved business performance. In order to identify respondent companies into high or low FMS combined with ICT, this empirical study has developed a summaries' table of FMS and ICT (table 5.4 over page), which is derived from Chapter 4 (the last column of table 4.6 pp 124, the last column of table 4.7 pp:128 and the last column of table 4.8 pp:132).

Table 5.4 The summaries of results of FMS and ICT

Companies	FMS + ICT design-manufacturing technology	FMS+ICT Administrative technology	FMS+ICT e-commerce	Overall total Sum columns 4.6-4.8
Co.1	0	0	0	0
Co, 2	0	0	0	0
Co. 3	0	0	0	0
Co.4	0	0	0	0
Co.5	0	0	0	0
Co.6	0	0	0	0
Co.7	0	1	0	1
Co.8	0	0	0	0
Co.9	0	1	0	1
Co.10	0	1	0	1
Co.11	0	0	0	0
Co.12	0	0	0	0
Co.13	0	0	0	0
Co.14	0	1	0	1
Co.15	0	0	0	0
Co.16	0	0	0	0
Co.17	0	0	0	0
Co.18	0	0	0	0
Co.19	0	0	0	0
Co.20	0	0	0	0
Co.21	0	0	0	0
Co.22	0	0	0	0
Co.23	0	0	0	0
Co.24	0	1	1	2
Co.25	0	0	0	0
Co.26	0	0	0	0
Co.27	0	0	0	0
Co.28	0	1	1	2
Co.29	0	0	0	0
Co.30	0	1	0	1

Figure 5.3 uses the overall scores shown in column 5 of table 5.4 to plot the relative position of respondent companies (identified by their company number on a FMS combined with ICT scale, where 3= high FMS combined with ICT, 0= low FMS combined with ICT, and 1.5= the break point. This point was chosen because it is half way on the 3 point scale used in this empirical study. Thus, companies who employ more than 1.5 approaches to produce a variety product are classified as high FMS and ICT adopter companies.

Figure 5.3 The position of respondent companies with respect to their level of FMS Combined with ICT

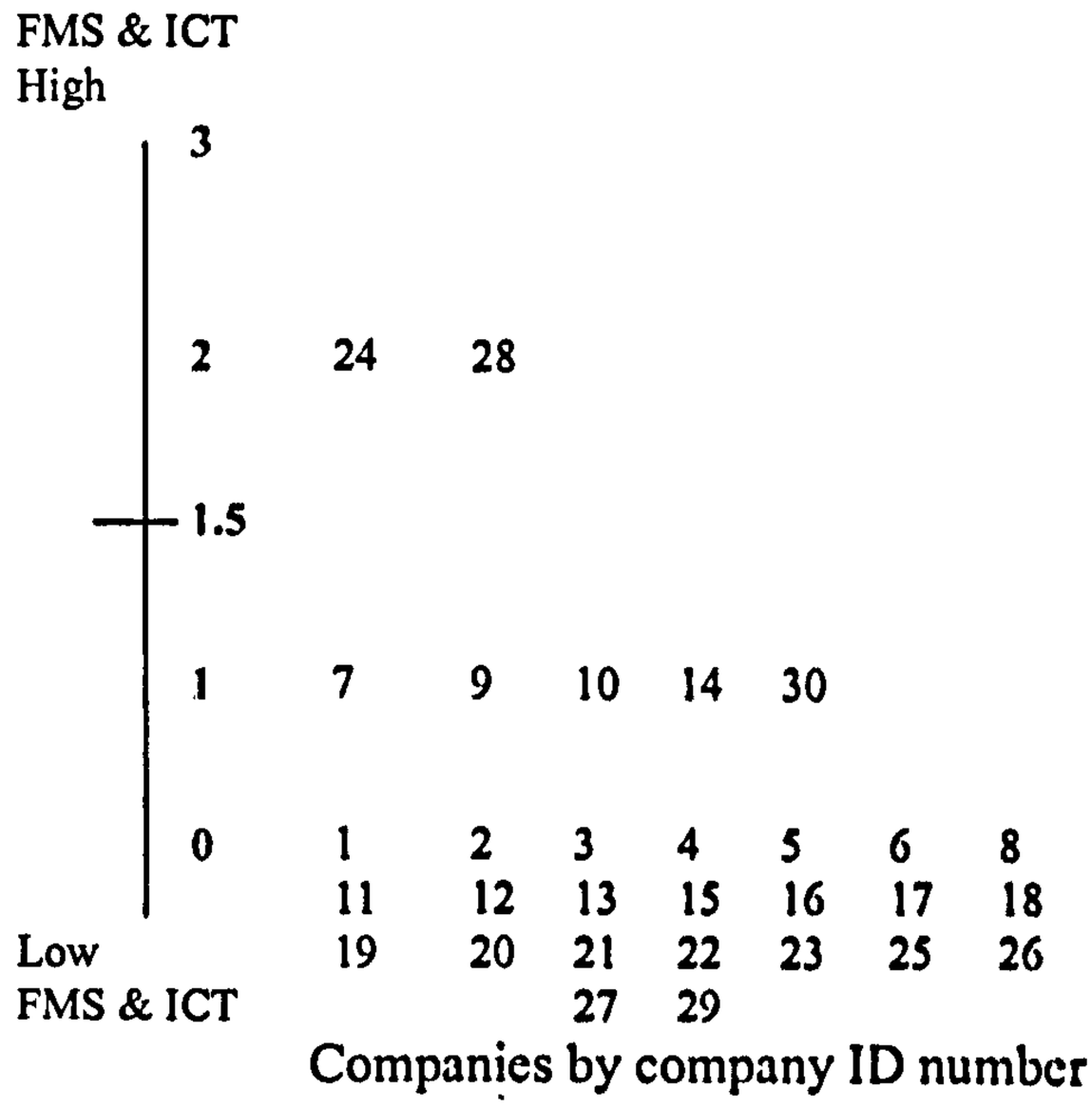


Figure 5.3 shows that two companies: UV Light (Co.24) and Anderson (Co.28) are classified into the high FMS and ICT adopters. The remainder companies are classified into the low FMS and ICT adopters.

To examine the correlation between FMS combined with ICT and improved business performance by respondent companies' perception, figure 5.4 uses the results shown in column 2, 3, 4, 5, 6, and 7 of table 4.9 (pp:135) to plot the relative position of respondent companies' perception (identified by their company number) on an improved business performance scale; where 1=developing new product ability, 2=developing new product speed, 3=manufacturing lead time, 4=delivery time, 5=customer's response, and 6=geographical coverage, plotted on the x axis. The

columns have been divided horizontally to separate the high perception of improved business performance (row 1 positive y value), and the low perception of improved business performance, (row 2 negative y value).

Figure 5.4 The position of respondent companies with respect to their level of improved business performance.

Y

Company Perception improve business Performance	2	14	15	2	16	1	1	16	1	15	2	11						
	3	15	16	3	17	2	2	17	2	16	3	12						
	5	17	17	5	19	3	3	19	3	17	4	15						
	6	19	19	6	20	5	4	20	4	19	5	16						
	8	20	20	8	21	6	5	21	5	20	6	19						
	9	21	21	9	22	7	6	22	6	21	7	20						
High	10	22	22	11	24	8	8	24	7	22	9	21						
	11	24	24	12	25	9	9	25	8	23		22						
	12	28	26	13	26	11	11	26	9	24		23						
	13	29	28	14	28	12	12	27	10	25		27						
		30	29		29	13	13	28	11	26								
					30	14	14	29	12	27								
						15	15		13	28								
									14	29								

X

	1	2	3	4	5	6	Improved Business Performance
Company Perceive improved business Performance	1	1	4	7	18	1	17
	4	4	10	10	30	8	18
	7	7	18	18		10	25
	16	10	23	30		13	26
	18	18	27			14	29
	23	23				24	30
Low	25	25				28	
	26	27					
	27	30					

It can be seen from figure 5.4 (in red colour), UV Light (Co.24) and Anderson (Co.28) claimed that they have better capability to develop and manufacture new products than their competitors. This is because they have shared their resources with research

institutions, customers, and suppliers to develop new products. They also outsourced some component parts to nearby suppliers, which enables them to shorten their manufacturing lead time and delivery time. They believe that ICT enables them to effectively manage their product design and business administrative activities and consequently they are able to respond to customers' requirement faster than their competitors. UV Light and Anderson admitted that they did not have a wider scope of geographical coverage than the market leaders because they concentrate on U. S. and Asian markets.

The majority of respondent companies that adopted low FMS combined with ICT believed that their product development capability was better than their competitors (in black colour). This is because they perceived minor modification of existing products or imitating market leader's products as new product development. A minor modified product is easier to develop and manufacture because it does not involve significant changes to core product structure, product design and manufacturing process. Therefore, most Taiwanese woodworking machinery manufacturers stated that their new product development time and manufacturing lead time were shorter than their competitors. As small, family owned business, they believed that they were able to respond more quickly to customers' requirements than their competitors. The TWMMI perceived that U.S. and South-East Asian countries were their main markets, therefore they admitted that they did not have a wide scope of geographical territories.

This empirical study also used customer satisfaction to measure improved business performance. It can be seen in table 4. 10 (pp: 138) customers gave high scores in the

five categories; develop new product, product development time, manufacturing lead time, delivery time and customer response time, in higher level of FMS combined with ICT adopters, e.g. Anderson. However, they claim that Anderson did not have a wider geographical coverage than the market leaders, such as German producers because it is very difficult to recognise the brand name of Anderson.

Customers gave respondent companies in low FMS combined with ICT the highest score for new product development capability, but they claimed that most Taiwanese companies were not able to produce breakthrough products like German and Italian producers did. They only conducted minor modification in their existing products or imitated products from the market leaders so that they were able to shorten their product development time, manufacturing lead and delivery time. Almost all international customers indicated that it is difficult to recognise the brand name of the Taiwanese manufacturers therefore they gave low scores for geographical coverage.

Customer satisfaction is insufficient for identification of the actual companies' improved business performance. This is because as export oriented industry, the TWMMI have many different customers, who come from different countries to purchase their machines. Each customer has different perceptions of the TWMMI' improved business performance and it is difficult to calculate the low or high improved business performance. For example, the TWMMI's delivery time and response time were awarded from Asian customers were better than their competitors. However, European customers gave lower awarded to the TWMMI' delivery time and response time, compared to European competitors, e.g. German and Italian.

Therefore, it can be concluded that it may be unnecessary that implementing a higher level of FMS combined with ICT to gain a greater level of improved business performance. The data analysis demonstrated that competitive advantage gained through outsourcing the manufacturing of component parts to nearby suppliers, which means companies can focus on assembling component parts as opposed to the company manufacturing all component parts itself .

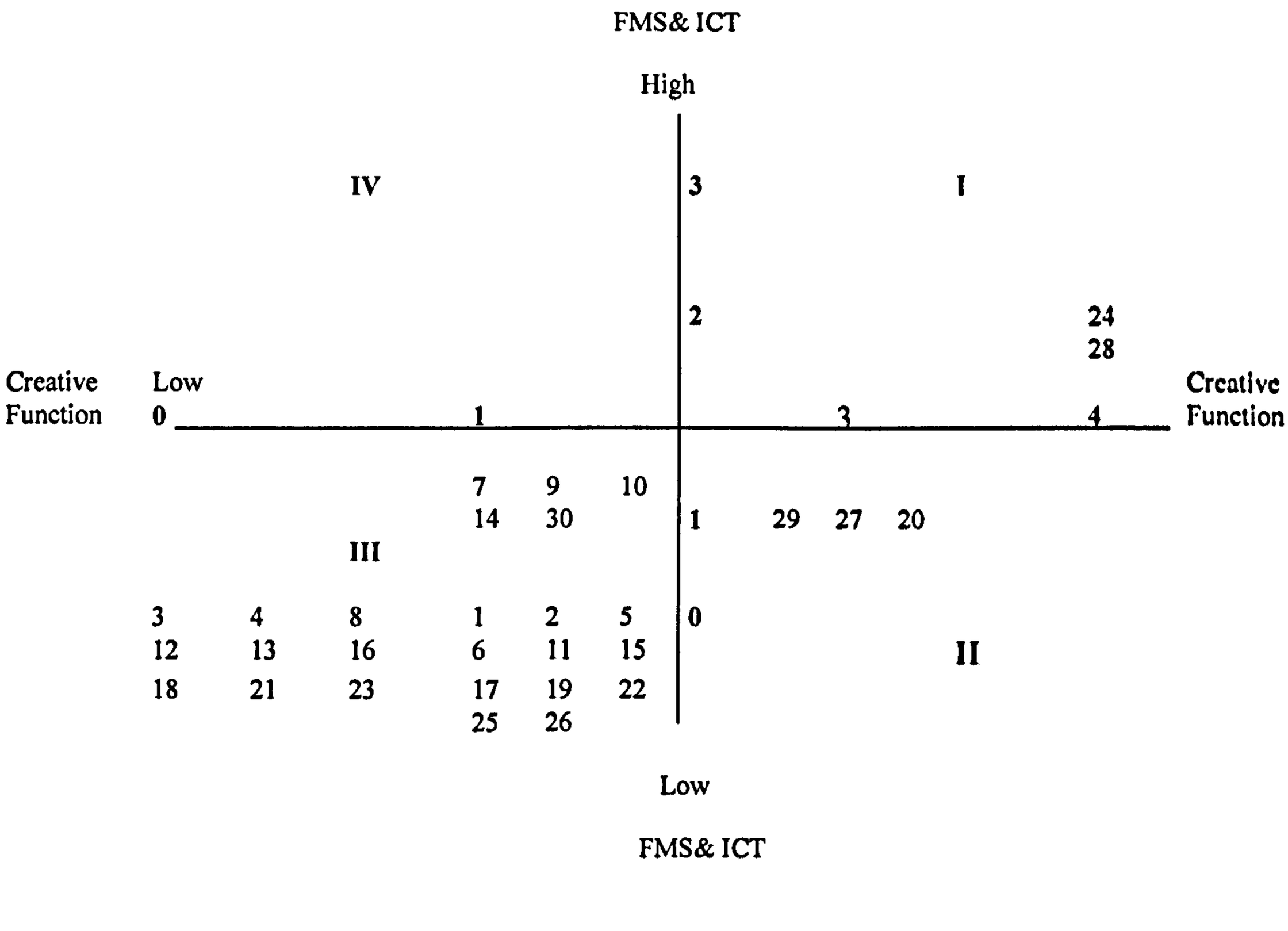
5.4 (H3) Does implementing a higher level of a creative function and FMS combined with Information Communication Technology mean that Taiwanese woodworking machinery manufacturers have a greater level of improved business performance?

Section 5.2 (pp: 146-153) demonstrated that a higher level of creative function had helped a number of companies to improved a greater level of increased creative success. Section 5.3 (153-159) illustrated that a minimal level of FMS combined with ICT had helped several companies to improve their business performance. This section is to highlight these points by combining figure 5.1 (pp: 148) and figure 5.3 (pp: 155), which formed figure 5.5 (over page). To illustrate a number of case studies that show how companies conducted their innovation activities across the specified quadrants. Figure 5.5 is the combination of figure 5.1 and figure 5.3. The position of respondent companies with respect to their level of creative function in figure 5.1 is represented in figure 5.5 x axis, where 4= high creative function, 0= low creative function, and 2= the break point. The position of respondent companies with respect to their level of FMS combined with ICT in figure 5.3 is presented in figure 5.5 Y axis, where 3= high FMS combine with ICT, 0= low FMS combined with ICT, and 1.5= the break point.

Combining the two axes created 4 quadrants. The first quadrant represents high degrees of creative function with high degrees of FMS and ICT. The second quadrant represents

high degrees of creative function with low degrees of FMS combined with ICT. The third quadrant represents low degrees of creative function with low degrees FMS combined with ICT. The fourth quadrant represents low degrees of creative function and high degrees of FMS and ICT. As can be seen in figure 5.5, two companies – Anderson (C0.28) and UV Light (C0.24) fell into the first quadrant. Bluesteel (Co.20), Technic (Co.27) and Leadermac (Co.29) fell into the second quadrant. The other respondent companies fell into the third quadrant. None of respondent companies fell into the fourth quadrant. This may be because, if the respondent companies had the capability to adopt creative function, they would prefer to apply FMS combined with ICT within their factories to produce variety products.

Figure 5.5: the position of respondent companies in creative function and FMS combined with ICT.



In order to examine the correlation between a higher level of creative function and a higher level of FMS combined with ICT, and a greater level of improved business performance, Anderson has been chosen as a case study for this research. As its position is in the first quadrant and it means that Anderson has adopted a higher level of creative function and a minimal level of FMS combined with ICT to improve its business performance. Technic has been chosen as a case study for this research because its position is in the second quadrant. It means that Technic has adopted a higher level of creative function and a low level of FMS combined with ICT to improve its business performance. The majority of the TWMMI are in the position of third quadrant. This means that a lower level creative function and a lower level of FMS combined with ICT to improve business performance. Therefore two companies: Joyway and Jainn Jong have been selected as case studies for this research.

5.4.1 The Anderson Group (Co.28); its improved business performance (first quadrant)

The Anderson Group is Taiwan's largest woodworking machinery manufacturer generating annual sales revenue in excess of one billion New Taiwanese Dollars (NT$) and employing more than 100 workers.

The company was established in 1972 and engaged in importing woodworking tools from Japan and selling them in Taiwan, (Anderson 2005). In 1980 it acquired a dealership from the current world number one woodworking machinery producer, Homag, and sold its products in Taiwan. The following year, Anderson set up its own

factory in Taiwan, and in 1985 it was able to design and produce its own brand CNC routers and then sold them into the international market. Anderson's CNC router, CNC machining centre, and CNC profile grinding machine received "National Excellent Product Awards" from the Ministry of Economic Affairs in Taiwan in 1992. In the same year, the company began a partnership with Homag and agreed to produce Homag's products under the name of the Homag Group and sold them in the Asian market. The purpose of partnership with Homag was that Anderson wanted to position itself as a high quality Taiwanese producer in the international market. It was very difficult for Taiwanese manufacturers to be recognised as reliable and quality producers worldwide because they were known as imitators and were only able to produce low-tech products to target low-end customers. In order to promote Anderson's image with reliability and quality, the company took the partnership opportunity not only to raise its global reputation in this industry but also to learn new knowledge and technical skills from its partner. The strategic agreement between the two parties was that Anderson could use the Homag Group's identity on Anderson products, which was designed in Homag (Germany) and manufactured in Anderson. The Homag Group identity could be seen as "I-C Anderson".

For the Homag group, in order to create synergy the market leader held annual meetings in September in its German headquarters. During the meetings, the leading company also provided training courses to its customers and members about the group's new products. The R&D designers and engineers within Homag would demonstrate how new products were developed and how they worked when customers used them. The aim of Homag's partnership with Anderson was to increase its market share in the

Asian market. Homag was aware that in the future, it would be unable to compete with its international rivals due to high labour costs to produce products in Germany. Homag believed that Anderson had both the ability to produce large quantities of products at a reasonable price to be sold in the Asian market. This was because Anderson had factories in Taiwan and China, and it also shared similar political, economic, cultural and language with its neighbouring countries, particularly China.

In 1996, Anderson entered into the semi-conductor sector, and successfully diversified its business into processing equipments, which were machines used by semi-conductor manufacturers to produce its products. The successful diversification was due to two factors; by cooperating with a research institution in Taiwan as well as with one of the leading companies in PCB sector, Elmar Wessel, in Germany, and setting up a creative environment to encourage employees' creativity thinking.

Anderson was under pressure of fierce competition from the market leaders who took the advantage of its well-established reputation, and from the Chinese rivals who competed with lower prices. For long term prospects, the company needed to find opportunities for its business growth. As a result, Anderson conducted a series of market research in order to find the market opportunity for its new products. The marketing department discovered that there was a potential market where Anderson could used its past knowledge and experience to develop new products, such as processing machinery.

Taiwan was the leading manufacturer in the semi-conductor industry in the world and it required advanced processing equipments for this sector to produce their products. However, high-tech equipment suppliers in Taiwan were only able to supply approximately 5 % to 10% of the processing machines needed to the local semi-conductor manufacturers. The rest of the processing equipment relied on imports from overseas, such as Japan and Korea. If Anderson was able to develop and manufacture these processing machines and then sell them in the local market, it would offer the company an opportunity to stabilise domestically and then expand internationally. The new product idea was brought by marketing personnel to several board meetings, through R&D, production, human resources and finance appraisal. After this, the company's final decision was to take the risk to develop the PCB processing machines. The R&D department realised that depending on its past experience in designing, producing and implementing to the new product was impossible. Thereby, it decided to cooperate with a local research institution and one of the leading PCB companies, Elmar Wessel to develop the new products. Anderson did not produce all component parts in its factories; some of them were outsourced to local suppliers, and hence suppliers also contributed their ideas and technical skills to help Anderson's new product development.

Anderson perceived its employees as an asset to the company because innovative ideas came from employees' creativity. The company believed that to attract or retain creative employees in its workforce, it needed to provide a friendly working environment. The traditional working environment in the TWMMI was physically shabby and not only affected employees work productivity but also their creativity. As a result, Anderson

opened a new factory which was environmentally friendly in Miao-Li, Taiwan. The company asked its employees to dress in white uniforms while working in the factory and gave them a short break between 10:00-10:15 in the morning and 15:00-15:15 in the afternoon. Anderson believed that break times and the canteen area were the best places to encourage employees' creativity because they would feel more relaxed and able to discuss the problems in their day-to-day activities and seek solutions with their colleagues. Some employees were unable to write their ideas down formally but they used oral communication to speak to their supervisors. Supervisors were encouraged by Anderson to cultivate their workers' creativity thinking, e.g. a "mentor-apprentice approach". This approach came from the Japanese car industry's new product development management, e.g. Toyota. To inspire creativity thinking in the workforce, supervisors avoided telling their apprentices what to do when problems occurred and instead asked them questions to help find answers by themselves.

To encourage creativity within the company, Anderson invited its own agents, and business partners to come to its factory and educate its employees about the current situation of the market, products pattern, and functionality and market trends. This helped employees to realise that different countries had different demands for different products. By understanding the various customer needs, design engineers were able to design a wide range of products to appeal to their customers. The consultant technique was adopted by Anderson to cultivate employees' creativity thinking. The consultant group comes quarterly to train all employees into thinking that creativity within Anderson is everybody's responsibility and to visualise the relationship between problems and solutions.

Information Communication Technology (ICT) was also used by Anderson to help new product development. The company indicated that it used 3D modelling packages frequently to produce component parts and physical prototype on screen to evaluate the developed design in terms of ease of manufacturing and its fulfilment. However, it did not have 3D simulation software packages to test the prototype on the screen. The company needed to produce a real physical prototype to test the new product's reliability and its precision. The company was also unable to link CAD and CAM to the machining centre to produce a variety of component parts. They claimed that making a woodworking machine required more than one thousand component part blueprints, which were very difficult to convert into a CAM program and then link this to the machining centre for production. Anderson did not use robotics to assemble its final products as they were assembled by manually. The level of stock played an important role in Anderson as the lower the level of stock, the more efficient of the working capital. Therefore the company used CSM systems to control their stock and ERP systems to set more accurate budget for developing their new products.

In order to enhance the quality and flexibility of communication channels and information processing capability, Anderson employed foreign technical experts to develop its information system. For instance, in order to fully utilise the functionality of Customer Relationship Management (CRM) software system to capture customer information from telephone, mail, fax, sales force, publications, e-mail and website for ideas to innovate new products, the company employed German experts to develop the system. However, by the end of 2005, this system did not work as expected. Only the e-mail system was heavily used by the company both internally and externally.

Nevertheless, Anderson only used basic functionality of the website to promote its company and its products. It did not use its website to increase sales.

To sum up, a higher creative function and manufacturing technology facilitated by ICT helped Anderson to transform from a tool importer into woodworking machinery manufacturer and PCB processing producer. This successful transformation could be derived from adopting internal and external idea generation scheme as well as design integration. For instance, a systematic information system was adopted by Anderson to identify the critical types of competitive information and the best source of this information for novel ideas. Cooperation with research institution also allowed the company to use scholars' knowledge to develop new ideas. Employees' creative thinking was cultivated by establishing external and internal training programs within the organisation. To encourage employees' technical skills for design creation, the company not only managed employees to learn from external competitors but also learn from internal supervisors. ICT design technology helped employees' to design their component parts and ICT administrative technology assisted employees to manage day to day business activities. ICT e- commerce helped the company to promote products and expand its market into different countries.

Therefore, it can be seen that a higher level of creative function and some level of FMS combined with ICT had helped Anderson to change from being an importer of component parts, to diversify into producing woodworking machinery and PCB processing machines.

5.4.2 The Technic Group (Co. 27); its improved business performance (second quadrant)

Technic Associates, INC was established in 1981. The firm employed about 50 workers with an annual turnover of NT$ one billion and above. The organisational structure involves R&D, Marketing & Sales, Purchasing and Finance. The firm started as an exporter as well as an importer. The firm exported Taiwanese woodworking machines to the U.S.A. and Canada in 1981 and imported German and Italian machines to Taiwan in 1982, (Technic 2005).

With more than 10 years of international trading experience, the founder, Mr Chiu decided to extend his business by opening a new factory to manufacturer panel saw and banding machines etc in 1992. The owner believed that the crucial factor in succeeding in this industry was continuous product innovation. This was because when the firm imported machines from German and Italy, it discovered that the market leaders not only consistently introduced new products but also modified their existing products by replacing old key components with new ones into the market. For instance, the modified products had been in-cooperated with advanced technology, e.g. with digital positioning or digital measuring scales in their products to add more value to customers.

Having experiences in the importing and exporting business, Technic realised the importance of information. It believed that innovative ideas came from valuable information and hence it conducted a systematic information searching. The first step of this action involved planning what information they were looking for and why and how this information would be useful and therefore implemented, innovating their new

products. The following step involved collecting information from secondary data and then transmitting and sorting this information into either archives or electronically. The owner manager then used his past experience to analyse the information, look for patterns and come up with ideas and then shared these ideas with his production manager. For instance, from this analysis the owner manager discovered that the steel price had gradually gone up since 1998 and the price of the steel would continue to rise. As a result, it would affect the company's long term cost of materials. The owner manager discussed this issue with his production manager in meetings and searched for solutions. The solution was found by the production manager and one of his workers, using steel-recycling. Normally, the processing of a piece of steel to a machine component required the cutting of this material into the desired shape and the excess metal was wasted. However, due to increases in steel prices, wastage was reduced by melting the steel, pouring it into a particular mould to be made into the desire shape for the required component parts. The modularisation idea had a patent registered in 2000-2017 in Taiwan, (see table 4.5 pp: 121).

The firm also believed that a system for education and training was very important to innovate its products. The firm planned to have a formal education and training course for all its employees. At present, the firm only encourages its employees to acquire knowledge and experience in their spare time often using the firm's existing resources.

Technic did not use FMS combined with ICT to produce a variety of component parts. The company only used CAD to produce component part blueprints and PDM to store

these blueprints for future product design as references. The company did not use robotics to assemble its final products as they were assembled by manually.

In short, there is some evidence in this case study that a higher level of creative function had led to increase creative success for Technic because of the number of patents issued to the company, which are significant changes to the structure core products. However, another measure of creative success is diversification and there is little evidence of Technic diversifying into other sectors, which may be due to a high risk involvement or may be because it did not cooperate with research institutions to generate new ideas and cooperate with competitors to develop, design new products.

Technic did not use a higher level of FMS combined with ICT to produce its products. It outsourced most component parts to nearby suppliers to improve its business performance, e.g. to shorten product development speed. This may be because as a small, family owned business, the company cannot afford the higher level of investment required to implement FMS and ICT. Unlike Anderson, as the market leader in Taiwanese woodworking machinery industry, which can afford some level of investment required to implement FMS and ICT. Some level of FMS and ICT allowed Anderson not only to produce specific component parts within its factory but also outsourced standard and consistent component parts to nearby suppliers to improve its business performance. As a result, it can seen that a higher level of creative function and outsourcing manufacturing component parts to nearby suppliers had helped Technic to change from being an importer and exporter of woodworking machines to become a manufacturer woodworking machines.

5.4.3 The Joyway (Co.5); its improved business performance (third quadrant)

Joyway Machinery Co., LTD was established in 1988 and specialised in RIP Saws, (Jowaylao 2005). It employed around 30 workers with an annual turnover of over one billion NT dollars. Its product distribution is mainly through channels such as agents or distributors. The organisational structure within Joyway includes R&D, marketing and finance departments. The owner manager is in charge of marketing and finance. The R&D manager is responsible for product design and production.

The first generation product of the firm was SLR-12, JR-14 and JR-18 (Straight Line Rip Saw), and mainly targeted domestic wood furniture companies, which produced large quantities of furniture to sell to end users. During the 1990s, the firm was aware that the domestic market was declining and that there was a potential market abroad. The owner manager believed that if the firm wanted to succeed in the international market, product innovation was needed. However, developing breakthrough products required a huge amount of resources to be invested and its success was not guaranteed. In order to minimise the risk of product development, the firm conducted product family strategy to innovate its products. The product family innovation strategy not only allowed Joyway to define new product characteristics in terms of similarities and differences from existing products but also enabled employees to acquire new knowledge while developing one product to another.

For example, the new product, JM-320 (Multi Rip Saw) only took two months to develop from minor modification to its launch in the international market. However, during 1995, the firm felt greater competitive pressure from Chinese producers because

they were able to manufacture similar products but asked for lower prices due to government support and low labour costs. In order to compete with the new entrants, a serious innovation strategy was needed by the firm. Therefore basic market research collecting information from secondary data was conducted by its marketing department. They discovered a gap in the market for self-employed interior designers or design companies who may need a convenient machine when decorating houses or offices. In addition, this machine could be used by furniture companies to produce samples.

This idea was brought to design and production teams while meetings were held. The marketing department stressed that the new product should be lighter than the existing products, making it easier for customers to carry and setting a higher price for the customised product. One of the supervisors came up with the idea that a rip saw can be made of two materials, cast-steel or alloy. Since the price of steel has gradually increased due to the growth of the Chinese market. If the new product is made of alloy instead of steel, it would be lighter and also cheaper to produce than the original product.

For instance, if the machine was made by cast steel, it required 500kg of materials. The price of this material is NT$18/kg, 500kg of steel works out to be 500x18=NT$9000. However, since the year 2000, the price of cast-steel has gone up by 80%. The cost of material is now in 2005 is NT$32/kg, making the cost of the machine NT$16,000.

When the machine was made by alloy, it required 300kg of material. The price of material was NT$30/kg, which meant that each machine cost NT$9000. The price of

material of alloy has increased 40% to NT$42, meaning each machine now costs NT$12,600.

The owner-manager worked on the idea and roughly drew the concept of each component part on paper and then handed it to his designers to develop a virtual model on the screen. Designers were able to learn the product architecture and the interface from the drawing and if they had any questions they could ask for help from the lead supervisor.

Joyway outsourced most component parts to nearby suppliers, and only produced a small amount of component parts in its own factory. When designing a new product, designers need to consider each component part's interface in order to effectively and efficiently assemble the final product. Once the blueprints were completed, they would be sent to suppliers. When suppliers had problems with the product design, they would come to the Joyway factory in person to discuss these problems and then work together to find solutions. The production team produced a physical prototype according to the blueprint for testing the precision and reliability of the new product. During the testing process, the production team detected that there was a problem with the conveyance system in the new Panel Rip Saw, and called the relevant supplier, in this instance, its motor suppliers to help. Through minor corrections, the new product was launched in 2003. The successful introduction of the P-2800 and P-3200 (Panel Rip Saw) into the international market encouraged Joyway to concentrate on product development. In the same year, the company also successfully developed a new product, an Auto Double

Spindle Planer, which had a patent registered for it from 2003-2013, (see table 3). An Auto Double Spindle Planer with Muti Rip Raw was also developed the following year.

The company installed the market available software packages, e.g. CAD, PDM, CSM and ERP but it did not fully utilise the functionality of these software systems. For instance, Joyway did not have a 3D simulation software system to prototype products but also test them on screen. It was unable to link CAD, CAM and Number Control Machining Centre to produce component parts. The company only used e-mail to contact its customers for order taking but did not use the functionality of website ordering system and the internet trade exchange to increase sales.

Above all, the owner manager perceived that there was a potential market in medical care equipment because of the huge ageing population. Joyway intends to use its existing experience and technical skills to diversify into machinery related to health care equipment. Hence in 2003, the firm employed Mr Lou as a R&D leader, who came from the leading company of the TWMMI, Anderson.

To sum up, a lower level of creative function had helped Joyway to modify its existing products and have them patent registered as minor changes to the structure of core products. Joyway perceived imitation or modification as new product development and than outsourced most component parts to nearby suppliers, like Technic. Therefore, the company believed that this strategy enabled it to improve its business performance.

5.4.4 Jainn Jong, (Co.26); its improved business performance (third quadrant)

The owner, a former POM supervisor, established Jainn Jong in 1985 with a capital approx NT$500,000, (Jong 2005). It employs 7 workers and has an average turnover of about NT$30,000,000 and it specialises in 4-sides moulders. The organisational structure of the firm includes design, production and finance. The owner manager is responsible for order-taking and design. His younger brother is in charge of production and his wife deals with administration. A typical day-to-day working process within Jainn Jong is shown in table 5.5.

Table 5.5 a typical working process within Jainn Jong

As we can see in table 5.5, when a new order is placed, the first working process is to produce a blueprint to make a physical prototype. Any problems occurring during the prototype process were solved by the two brothers working together. Once the prototype is completed, it was sent to a local wood furniture manufacturer for testing the new product's precision and reliability. Precision and reliability play an important role in a 4-sides moulder because it may have to run for 24 hours per day in customers' factories. When the testing is finished, the customer would come to do the final trial and then the new product was ready to be delivered. Jainn Jong did not worry about orders because the company only focused on one single product and aimed at domestic markets and therefore it has a good reputation in this industry. However, since 1994 domestic demand for woodworking machines seemed to have declined dramatically because most

Taiwanese wood furniture manufacturers have moved their factories to low labour-cost countries, such as South-East Asia and China.

The company did not seriously take into account the changing competitive environment, although it had received the market signal that demand had shifted from the domestic market to the international market. This was because the owner-manager realised that entering the international market required a huge amount of money to invest in creativity and advanced manufacturing technology. The company had insufficient funds to invest in higher level of innovation. The lack of resources inhibited Jainn Jong's ability to employ capable marketing personnel to deal with international market research, look for new distribution channels, recruiting capable salespeople who are able to speak other foreign languages and employ technically qualified engineer designers to design its products.

However, in order to survive in this industry, the owner manager realised that the-out-of-date products needed to be replaced. In order to generate ideas to modify the existing products, the owner manager attended many trade shows in Asia. Asian trade shows can be seen as good places for smaller Taiwanese businesses to generate ideas because most Asian countries share similar political, economic, culture and language with Taiwan. Therefore, it is easier to communicate with people from those countries, who run business locally in these countries instead of in Europe and America. Another reason for this is that smaller manufacturers have constraints on allocating their resources for a wider range of idea generation, and hence choosing nearby destinations can be seen as a cost-saving idea source. In addition, Jainn Jong collected a number of relevant

competitors' catalogues to analyse their product ranges, specifications and reliabilities and to evaluate the possibility of imitating or modify competitors' products.

Jainn Jong utilised outside capability such as suppliers and customers to develop new products. Jainn Jong relied on external information and expertise to develop its new products. For example, In June 2004, one of Zaire's agents came to Taiwan and looked for manufacturers who were able to produce sawing machines, which could run on petrol and not a power supply. Zaire is a central African country and has plenty of wood and petrol as its natural resources. In order to process wood from forests, they needed sawing machines. However, most sawing machines needed a power supply to function and Zaire lacked this. Jainn Jong wanted to take this opportunity and called on its suppliers to develop a new product to meet Zaire's needs. Jainn Jong was able to do this without carrying out R&D development as its suppliers did this. For instance, one of the suppliers not only supplied universal joints to the woodworking machinery industry but also to the car sector. The supplier used car engine principle applying it into Jainn Jong product and as a result a physical prototype of the new product was produced in August 2004. This new machine was shipped to Zaire for testing its reliability in October 2004. Together, the manufacturer, supplier and customer came up with the idea to use a petrol engines to replace the electrical motor.

The company did not install software systems, e.g. CAD, CAM, PDM, CSM and ERP to help to develop and produce variety products. It only used a simple account and database software package to manage its day-to-day business activities. The finance staff, the wife of the owner manager, has never produced a balance sheet and profit-loss account for the company. Therefore the company asked a small account agent firm to

produce accounts for taxation. Jainn Jong installed a simple company website with e-mail access to promote its products and contact its customers. None of the staff in the company is able to speak, read and write English. When orders come from English speaking customers, it needed to employ a temporary interpreter to help to process the order.

In short, a lower level of creative function allowed Jainn Jong to imitating or modifying its existing products. However, it did not patent its products internationally and did not diversify into other sectors. This may be because Jainn Jong did not invest in a high level of creative function, like Anderson and Technic. Jainn Jong, like Joyway, perceived that minor modification of exiting products or imitating market leaders' products as new product development and then outsourced all its component parts to nearby suppliers, which leads to improvements in its business performance, e.g. to shorten manufacturing lead time.

5.5 Conclusions

This empirical study aims to identify the potential difficulties faced by the TWMMI and make recommendations to improve business performance. Analysis of the data in this chapter reveals that the majority of the Taiwanese woodworking machinery manufacturers are not able to produce breakthrough products to compete with the market leaders. Instead they imitate market leaders' products and then produce low technology machines to compete as market followers. There are a number of reasons why they are not able to develop novel ideas, manufacture high technology machines and then sell them into global markets. These are discussed below:

Hypothesis 1: the higher the level of creative function, the greater the level of increased creative success in TWMMI.

• Most woodworking manufacturers do not allocate a proportion of funds to invest in creative function. The manufacturers who have more funds to invest in creativity perceive trade shows as better investments in creative thinking rather than training courses to cultivate individual competence.

•The Taiwanese woodworking machinery manufacturers do not utilise scholars' knowledge to help them develop novel ideas for new product development.

•They are unable to acquire knowledge and design skills from the market leaders to develop and design their new products. Product family life practice and supervision support are used by owner managers to encourage their employees technical skill learning but these encourage conformity and conservative thinking rather than creativity.

The market leader Anderson and LV Light in Taiwan emphases the importance of creativity. These companies have established a higher level of creative function to create and develop novel ideas for new product development. In conclusion there is some evidence to support the hypothesis that the higher level of creative function, the greater the level of increased creative success. However, the TWMMI do not appear to invest significantly in creativity.

Hypothesis 2: the higher the level of FMS combined with ICT, the greater the level of the improved business performance in TWMMI.

•The TWMMI is not yet advanced enough in technological terms to link together CAD, and CAM and Numerical Controlled Systems for manufacturing a variety of customised component parts.

•The owner managers do not give opportunity for designers to learn and practice their design ability.

•The TWMMI have failed to use ICT administrative technology effectively and hence are unable to support their daily running business activities, such as sales support, resource planning and forecasting, they are also unable to process the data gathered from their website and integrate this with database management functionality.

•Production managers are not able to find ways of designing and managing the layout of production lines effectively.

•The TWMMI do not use the full function of the internet trade exchange technology and website to expand their geographical territories.

The market leader, Anderson and UV Light use machining centres to produce some of their component parts within their factories. These companies also utilise CAD to draw their component parts and ICT administrative technology to help manage their day-to-

day business activities. As a result, the higher level creative function and manufacturing system in cooperation with ICT technology has helped Anderson transform from a tool importer into a serious woodworking machinery innovator. Therefore this empirical study concluded that it seems if some level of manufacturing technology is incorporated with ICT, a greater level of improved business performance may be achieved.

Hypothesis 3: the higher the level of creative function and FMS combined with ICT, the greater the level of the improved business performance in TWMMI.

As a result of the failure of the TWMMI to embrace firstly, creativity, and secondly advanced manufacturing technology and ICT, many companies subsequently failed to improve business performance. Where creativity, advanced manufacturing technology and ICT could be incorporated into the company's strategy and the company would be transformed from an imitator into an innovator such as Anderson.

In conclusion creative function, FMS combined with ICT are critical to the successful performance of the TWMMI. Developing creative function, FMS and ICT approaches could enable the TWMMI to create, develop and manufacture a variety of products and then bring them into new markets. The next chapter attempts to investigate what factors influence the majority of Taiwanese woodworking machinery manufacturers' creativity and innovation activities.

Chapter 6 Present and Future prospects for the TWMMI

6.1 Introduction

In Chapter 1 the SWOT assessment identified that the major problem in relation to the TWMMI is: no longer competing effectively in the low-tech woodworking machinery market. In Chapter 2 the Literature Review discovered possible strategic solutions which could help the TWMMI to solve the problem. Chapter 3 set out to find the reasons why the TWMMI do not create, develop and manufacture breakthrough products in the international market In Chapter 4 analysis and 5 discussion showed that most of the TWMMI failed to implement higher levels of innovation within their organisation. This Chapter intends to focus on exploring factors, at macro level, influencing the implementation of innovation capability in the TWMMI. A competitiveness strategy will be presented at the end of this Chapter.

6.2 Present situation of the Taiwanese Woodworking Machinery Industry

In Chapter 4 and 5 the results of analysis discovered that the majority of Taiwanese Woodworking Machinery Manufacturers implemented lower levels of innovation and therefore they were able to make only minor changes to the existing products. They were unable to adopt higher levels of innovation to produce breakthrough products, that is, making a significant change in core products entering into a new market or an existing market. Seven main reasons inhibited Taiwanese manufacturers' creation of

novel ideas and implementation of FMS and ICT to translate these ideas into a variety of customised products into the international market.

First, they do not invest in education and training courses to cultivate individual employees' creativity, (as shown in table 4.2 pp: 108). This is because of a lack of funds, which forced smaller manufacturers to utilise external sources to stimulate ideas. Second, they do not cooperate with research institutions, e.g. universities, to produce novel ideas, (as shown in table 4. 3 pp: 111). Lack of finances to pay for research was cited as the main reason for little cooperation. Third, as suggested by anecdotal evidence is the academic field in Taiwan concentrates only on large manufacturers and neglects smaller firms. Fourth, the TWMMI do not generally cooperate with competitors to take opportunities to learn new knowledge and skills, (as shown in table 4.4 pp: 116). As smaller firms, they found that it is very difficult to attract partners for cooperation because they have few benefits to offer to their potential partners. Fifth, Taiwanese Woodworking Machinery Manufacturers do not use Flexible Manufacturing Systems combined with ICT design and manufacturing technology to produce customised products, (as shown in table 4. 6 pp: 124). They utilise a group of machining centres to produce a small amount of component parts and assemble the final products within their factories. Most component parts are outsourced to local suppliers. They do not have in-house expertise to integrate CAD/CAM modelling and analysis coupled with Numerical Controlled (NC) and Computer Numerical Controlled (CNC) machines to produce a variety of component parts. The owner managers of the TWMMI do not trust the ability of their designers and therefore the owner managers drew up the blueprint of component parts by hand first and then asked their designers to copy them

into the computer using CAD techniques, which doubles development time and increases costs. Sixth, Taiwanese manufacturers do not make full use of ICT software technology to aid developing and manufacturing new products, (as shown in table 4.7 pp: 128). Although they have bought micro software packages and installed them on their computers, they do not appear to make much use of such packages. Seventh, they do not use the web ordering system and the Internet Trade network as distributional channels to expand their geographical territory to increase sales, (as shown in table 4.8 pp:132). This may be because product characteristics are different between industry products and consumer products. For industry products, customers prefer to test products before purchasing them.

In conclusion, many factors inhibit the Taiwanese Woodworking Machinery manufacturers' ability to create, develop, manufacture and sell their machines worldwide. A lack of creativity, manufacturing capability, technology competence and financial resources are major ones. The TWMMI's lack of capacity in these areas may will derive from political, cultural, and educational policy so in the next section the political, cultural and educational context of Taiwan is considered.

6.3 The influence of politics, education and cultural values on TWMMI' innovation capability

Political instability forced the TWMMI to be unwilling to invest in creativity and advanced manufacturing technology. This is because creativity and advanced

manufacturing technology may take a long time to reap a return on investment and future uncertainty means that the investment may be lost.

From the time of the Japanese rule and until today, most small manufacturers worked very hard in order to survive. They perceive their businesses as part of their life and they do not want to take risks to invest in unpredictable businesses. Similarly they are reluctant to invest large amounts of capital in in-house hard and software technology. As a result, the TWMMI bought cheaper versions on the market and installed them into their computers as a symbol to show their customers that they have used ICT to help their administration and production activities.

Confucian traditional cultural values have deeply influenced Taiwanese parents to raise their children to respect and obey their parents, teachers, and employers. Taiwanese parents, teachers and employers do not value assertive behaviour in their children, students and employees as assertiveness means that they attempt to challenge their parents, teachers and employers. The evidence can be seen in the relationship between the owner managers of the TWMMI and designers. Designers often do not challenge their employers over the design of component parts; they display a strong tendency to seek conformation from their employers and take action to "what should be produced" policy.

Taiwanese parents value education as an important factor for the future of their children since they know that higher education would help them to obtain not only status but also wealth. For example, a person who was born in World War II and had an undergraduate

degree, would normally have had a better job throughout his/her life, compared with those who only graduated from primary schools.

Taiwanese parents prefer their children to study science or engineering in famous universities. The main reason is that the Taiwanese government concentrates its policy on science and engineering which influences not only the education system but also entrepreneurs' perception of educational products. As a result, both parents and students believe that entering a famous university to study science or engineering instead of studying Art & Design or sport will help them to find a better well-paid job in the future. This factor affects the TWMMI's innovation capability because they need educators to cultivate talented designers for them to design high quality products to differentiate their products from the market leaders.

Almost 90 percent of junior and high school students go to private revision schools (cram schools) after their lessons in a normal school day. These continue to take place during the summer holidays. Formal education schools also provide this service. This is because Taiwanese culture is academically competitive, and parents, with their children, compete in order to be better than others in their classes. Hence, each parent wants to send their children to the best school with capable teachers able to teach their children in order to gain entrance to respected universities. Even teachers are competing with each other, at the same school because they prefer to have good students in their classes. Good students produce good academic performances and their performances become a false achievement representation of their teaching skills. The teachers consciously or unconsciously adopt Confucian traditional teaching, which teach students through

memorisation. Therefore the students do their examinations mainly through memory, with fewer critique and application skills which may affect their creative imagination. The norm of academic competition would affect the TWMMI's innovation performance because they need to recruit creative personnel to participate in their workforce.

Taiwan's Education Ministry have noticed that most Taiwanese cannot speak English with foreigners, and they remain silent in classes when they study abroad. In order to raise the nation's competitiveness, English proficiency plays an important role. Thus, the Education Ministry announced that in 2001, English would become a compulsory course at Taiwan's 2500 primarily schools, and will hail an improved business future for Taiwan as whole in a competitive English speaking market, (Singapore Press Holdings 2000).

Taiwan's politics, educational policies, and traditional Chinese culture, influence the Taiwanese manufacturers' innovation capability. In order to reposition themselves in the international market, the TWMMI should develop innovation strategies. Only then is it possible for the TWMMI to transform themselves from imitator firms to innovators and hence be able to compete with international rivals.

6.4 Future prospects for the TWMMI

If the TWMMI can strengthen their creativity and design capability for product innovation, and then adopt advanced manufacturing technology for production as well

as implement modern information communication technology for business management, they should have great potential to be a market leader of this industry.

There are various ways in which the creativity of a firm can be enhanced in terms of both long and short term improvements. Cooperation with colleges and universities is a good way of promoting long term creative skills. This strategy is already present in Taiwan with various universities cooperating with large firms such as RT-Mart, Taiwan's foremost hypermarket chain. The companies ensure further training and jobs for the graduates and the university/college provides a steady supply of new personnel. During their course at the university/college students will learn the theory behind the industry as well as basic machine manufacture; most faculties of Engineering and Technology or Art and Design will have computers and CAD software programs as well as at least one CNC machine. Throughout their course, the students would be able to put the theory from text books into practice but real experience can only be obtained by working closely with industry. Doing work experience during the holidays and further training within companies would increase the graduates understanding and skills within this industry. In addition, local manufacturers may provide scholarship schemes to talented students within the universities. This in turn may encourage them to pursue a possible career with this company. This type of cooperation could significantly benefit the TWMMI as it would provide them with educated personnel. Previously, graduates would not choose to work in the traditional manufacturing sector, but this scheme may improve their understanding and interest for this industry, and thus persuade them to enter and work for the TWMMI.

Cooperation does not necessarily have to be limited to Taiwan. Globalisation encourages cooperation with other countries. It is advisable that the TWMMI cooperate with the market leaders. Western-European countries such as, Germany and Italy, would no doubt provide excellent personnel. The United Kingdom also would be a good source of creative personnel as it has been known to possess the most creative industries.

Consultants and the use of creative experts are also useful in enhancing Taiwanese companies' creativity. Companies such as Luili Gongfang and Franz have used overseas experts in their fields to great success and now have prominent positions in the international markets within their sector, (Small and Medium Enterprise Administration 2004). Consultants are able to inform the companies of the latest trends in the market and the latest technology with which to supply these demands. Furthermore, consultants are able to train personnel in R&D development, creating more ideas for product development. An example of the use of an overseas expert in Information Communication Technology is Anderson. In order to create a Customer Relationship Management database, which is able to link to ERP, CSM and PDM for product innovation, the company has employed a German expert within its organisation.

The SWOT analysis in Chapter 1 (1.5.3 pp: 30) revealed that there is likely to be a shortage of wood in the future and therefore TWMMI should diversify to other sectors offering more growth potential, for example, the semi-conductor industry because there is a huge demand in this sector. Taiwan is one of the major clients in the world for high performance semi-conductor processing equipment. However, Taiwanese manufacturing technology and equipment firms only supply 5 to 10 per cent of high

tech equipment for the domestic semi-conductor and TEF-LCD industries, (TWMA 2005). Nearly 95 per cent of high tech machinery is imported from overseas, e.g. U.S., Japan and Korea.

Anderson was aware that there was a huge market in the semi-conductor sector. Having had a successful partnership with Homag, Anderson used the same technique to partner one of the German leading companies, Elmar Wessel, in the Printed Circuit Board (PCB) sector. In recent years, Anderson continuously introduced its new machines such as PCB drilling machines, PCB routing machines and PCB measuring machines to the international market. The rest of the TWMMI may follow the pattern of Anderson and cooperate with cross-industry competitors to produce new products into the new market. Although they lack financial resources and lack of experience in R&D, if semi-conductor companies are willing to invest in TWMMI, it will benefit not only Taiwanese local manufacturers but also high-tech companies. This is because once domestic manufacturers are able to produce consistent and better quality equipment for the high-tech industry; it will reduce the production cost of that industry. Meanwhile, TWMMI can minimise their business risk by diversifying to another business sector.

In short, cooperation with research institutions, e.g. universities, competitors and customers could help the TWMMI to enhance creativity, design ability, manufacturing capacity and brand image. However, universities or foreign competitors prefer to work with large firms. To overcome this problem, a cooperative organisation could be formed by members of the TWMMI. Members gathering together as one group will have more power to negotiate.

Corporations can be formed by the members of the TWMMI to open a new factory to overcome the production problem. The new factory can adopt Flexible Manufacturing Systems to produce standard and consistent component parts, whilst specific component parts can be produced in individual firm's factory. For instance, 80 per cent of component parts can be produced in the new factory and 20 per cent of component parts can be manufactured in each member's own firm. This production method not only enables the cooperative firms to achieve economies of scale but also allows members of each firm to differentiate its products from one another and compete in the international market.

In this particular industry, individual manufacturers are specialised in the different type of woodworking machines they wish to produce. If the different type of machinery producers can form as marketing and sales cooperation to promote and sell their machines internationally, they are able to share promotion and sales cost among themselves.

For example, the main way of raising brand awareness for Taiwanese machines is to attend international trade shows regularly, finding distribution channels to increase sales and by visiting international agents or distributors. Attending international trade shows for individual firms is very expensive, as we have calculated and presented in Chapter 4 4.2.1 pp: 107). If a marketing and sales team can be formed by the cooperative firms, this team could then represent those firms in attending the selected trade shows to promote their machines. Hence the promotion costs would be reduced significantly

because they could share the costs with each other. A number of sales personnel and repair engineers can also be trained by the team and then those trained personnel can be sent to a particular geographical area to sell the cooperative firms' machines and to serve the international customers.

Mergers can be another alternative for TWMMI to implement innovation activities. If small manufacturers merge as a large company, they will have more resources to focus on creativity and have more space and capital to build up FMS for their production. In addition, they are able to save capital from fixed costs such as administration work, building or salary.

The Co-op organisation can be a strategy choice for the TWMMI to conduct their innovation projects. A Co-op system was introduced in Taitung, Taiwan by the Swiss Catholic missionary Dominik Stener in 1967. The aim was to encourage Taiwanese Aborigines to "save money for a rainy day". The Taitung Co-op formally registered with the Taiwanese government in August 1982 and became the first legal cooperative in Taiwan, (Taipeitimes 2004).

Cooperations, corporations, mergers and Co-ops' strategies with research institutions, competitors as well as customers can help the TWMMI to implement their innovation activities. Hence this empirical study strongly recommends that the TWMMI should adopt Mergers, Corporation, Co-ops and cooperation strategies to implement their higher levels of innovation activities. Table 6.1 shows the feasibility and impact of strategic choices of TWMMI in the short and long term.

Table 6.1 The feasibility and impact of strategic choices of TWMMI in the short and long term.

Short term strategic choice

Impact \ Feasibility	Low	High
Low	Mergers	Corporation
High	Co-ops	Cooperation (strategic alliance)

Long term strategic choice

Impact \ Feasibility	Low	High
Low	Mergers	Cooperation
High	Co-ops	Corporation

In the short term, the feasibility of cooperation is high because cooperation with foreign competitors for innovation has already been established within this industry for a period of time. A successful example of cooperation between German producers and a Taiwanese manufacturer is Homg/ Elmar Wessel and Anderson. However, cooperation strategies may not be suitable for the long term if one partner felt that the other part took more benefits from this cooperation. It will then be reluctant to contribute its efforts to the cooperative program.

In the long term, the feasibility of corporation is high when members of the TWMMI have learned that pooling resources as a whole will have more power to negotiate with universities, suppliers and customers as well as compete with rivals instead of individually fighting the battle. The characteristics of a corporation is that stockholders do not have the power to manage the day-to-day operational activities. Instead, management power is vested in directors, who are elected by the stockholders. One of the main advantages of this form of business is that the stockholders and directors generally are not personally liable for the obligations of the corporation. The owners risk only the investment that they make in the business to pursue their ownership interest. As a result, this type of corporation is popular in Taiwan organisations.

The feasibility of Co-ops will be low, although its impact is high on the TWMMI as it is a business owned by members of its customers and workers, which may not be suitable for the characteristics of the TWMMI. The feasibility of mergers is very low in the long term because of the Taiwanese culture. The majority of Taiwanese firms prefer to be their own bosses instead of being employed by others. In addition, for the short term, the chairman of the Taiwanese Woodworking Association (TWMA) could invite creative professionals from educational institutions and private companies to run workshops with its members to improve creativity amongst them. Furthermore, for the long term, the Taiwanese government could encourage creativity amongst future generations by employing a more 'problem-solving' approach to education, such as using seminars and workshops to encourage students to think creatively, instead of the

current 'memory-based' approach, in which students get the highest marks for memorising information.

To summarise, the strategy recommended for TWMMI is as follows:

- individual companies should co-operate with similar companies by investing capital as a group in research and development and promoting creativity
- the group (TWMMI) should promote innovation in creativity and manufacturing technology combined with ICT in order to move from the production of low-tech products to the production of innovative products (breakthrough products)

In addition to this, the success of such a strategy would be enhanced by the promotion of creative skills in education and society to facilitate creativity in the business environment as a whole.

These short term and long term strategies have been approved by five experts in this industry. The opinions of these five experts are important as they have in-depth knowledge of the TWMMI. One of the experts interviewed was the chairman of the industry allowing him a wide overview of the status and situation of the TWMMI at present. By him approving the proposals, it can be suggested that these proposals are feasible and would benefit the TWMMI as a whole in the foreseeable future. A further two experts were the owner-managers of the firms, who are able to tell how the proposals would be implemented within their firms, and how likely they would be to

succeed. Through their approval, it could be suggested that these proposals are feasible at a company level and are seen by the owner managers as a way of promoting and improving their individual companies. Finally, long term suppliers were also asked for their input and advice. The success of the TWMMI implementing innovation activities is closely likened with suppliers as they outsourced most of their component parts to local suppliers. These suppliers have in-depth knowledge not only in the TWMMI but also other industries. Therefore, they have an awareness of how the TWMMI fit in with other industries. In approving these proposals, the suppliers have shown that it is possible for the TWMMI to diversify into other industries and how they may encourage employees' creativity.

Chapter 7 Conclusions

7.1 Introduction

The field of innovation is broad. Researchers and theorists have made distinctions of studies between the "diffusion" and "adoption" of innovation as well as between studies of "innovating" and "innovativeness", (Damanpour 1991). However, most innovation studies have been conducted for consumer markets. Although the concept of innovation and most of the innovation research methods which have been suggested are applicable to industrial markets, few application of innovation have been studied in the industrial innovation.

This empirical study was aimed originally at investigating the relevance of e-commerce/e-business for the Taiwanese Woodworking Machinery Industry (TWMMI). The TWMMI manufactures a range of machines for furniture companies for producing wooden furniture. The TWMMI industry is characterised by a large number of independent, small, family owned companies. Collectively they concentrate their markets in the U.S.A. and China and this situation endangers the TWMMI's future competitiveness because recently the U.S. government, in order to help their manufacturers' competitiveness, lowered its currency significantly to make trading cheaper. Furthermore, the political tensions between China and Taiwan mean that trade can be disrupted from time to time. To minimise their business risks, TWMMI needs to gain a larger market share in Europe or South America.

The adoption of e-commerce/e-business could help TWMMI geographical expansion because it brings benefits and improvements to manufacturers without geographic boundaries.

However, secondary research reported in Chapter 1 revealed that the current situation within the TWMMI is more complex than originally envisaged. Not only does it have problems with distribution channels but also with developing new products and manufacturing a variety of products to meet customers' requirements. Major competitors, such as German and Italian producers, compete successfully in this market by producing high-tech products with a high level of innovation, while the South-East Asian and Chinese producers compete in this market by lowering costs significantly through less precision engineering and less product innovation. This "cost advantage" strategy is unsustainable in Taiwan when viewed in the context of rising domestic labour costs and new low-cost entrants to the market from developing countries. In the broader context, Taiwanese manufacturers' long term survival and competitiveness may be compromised because, in the future, there is likely to be a shortage of worldwide wood supply due to global warming, acid rain, deforestation and government regulations that have been drawn up to protect tropical rainforests. Therefore, for the TWMMI to remain competitive, higher levels of innovation are needed.

This empirical study proposed to examine if the TWMMI can become more competitive by first examining their current capabilities relating to innovation activities, and then finding appropriate methods to build special capabilities that enable the TWMMI to become an innovative industry. This empirical study expected to find a positive

correlation between the innovation activities undertaken by manufacturers and better market performance as this result is implied from the literature review.

7.2 Results of the empirical study

Based on the literature review and the interviews with woodworking machinery experts, three critical research questions relating to the innovation processes were examined in this empirical study.

(1) Does implementing a higher level of a creative function mean that the Taiwanese woodworking machinery manufacturers have a greater level of increased creative success?

(2) Does implementing a higher level of Flexible Manufacturing Systems combined with Information Communication Technology mean that the Taiwanese woodworking machinery manufacturers have a greater level of improved business performance?

(3) Does implementing a higher level of a creative function and Flexible Manufacturing Systems combined with Information Communication Technology mean that the Taiwanese woodworking machinery manufacturers have a greater level of improved business performance?

To answer the research questions above, two questionnaires were designed and interviews with woodworking machinery manufacturers and international customers were held. There were 30 companies and 18 customers involved in this empirical study. The data collected from the return questionnaires were analysed by using descriptive analysis.

Based on the data collected from the returned questionnaires, the answers to the three critical questions can be summarised as follows:

(1) Throughout the data analysis, it can be seen that hypothesis 1 (question 1) should bc accepted, thus, showing that implementing a higher level of creative function, thc greater level of increased creative success. By implementing a creative approach it can be seen from this empirical study that companies have gained a competitive advantagc by being able to patent their technology and take advantage of government awards. This has also enabled companies to extend their capabilities and diversify through thc investment in research and development, thus spreading risk and extending thc product range (as in the case of Anderson, Chapter 5 pp: 161-167 and Technic Chapter 5 pp: 168-170). This gives companies such as Anderson and Technic a competitive advantagc over Chinese manufacturers, enven though the later produce at lower cost.

(2) The data analysis demonstrated that implementing a higher level of FMS combincd with ICT can lead to a greater level of improved business performance. However, thc data also revealed that this strategy is not necessary to achieve improved business performance

In the case of Anderson, it utilised one FMS component; that is machining centres to produce specific component parts within its factory. Anderson also used ICT administrative technology to reduce the amount of stock held by the company (via CSM) and to shorten the decision making process (via ERP). They used ICT e-commerce to allow customers to remotely view product range and specification.

This shows that even some level of FMS combined with ICT does lead to improved business performance.

However, Technic in Chapter 5 pp: 168-170), Joyway in Chapter 5 pp: 171-174 and Jainn Jong in Chapter 5 pp: 175-178) also achieved improved business performance without using FMS and/or ICT. Instead they used outsourcing to shorten their manufacturing lead time and delivery time. Interestingly Anderson also outsourced its standard and consistent component parts to nearby suppliers. This manufacturing strategy allowed Anderson to produce a small amount of customised products to shorten its manufacturing lead time and delivery time. So we can conclude that while some level of FMS combined with ICT does lead to improve business performance. This strategy is not a necessary precondition for improved business performance; outsourcing can produce a similar result.

(3) Data analysis of the previous 4 case studies revealed that implementing a higher level of creative function in combination with some level of FMS and ICT could lead to improve business performance (see Anderson in Chapter 5 pp: 161-167). However, Technic in Chapter 5 pp: 168-170), Joyway in Chapter 5 pp: 171-174 and Jainn Jong in Chapter 5 pp: 175-178).showed that FMS and ICT are not be essential to improve

business performance, if outsourcing is used instead. What is common to *all* companies that exhibited improved business performance is creativity. In the case studies of Joyway and Jainn Jong, it can be seen that both companies employed minor adjustments to products to give them a short term competitive advantage. The improvements for both companies are relatively minor and can be easily imitated by other companies, e.g. those in Chinese manufacturing industry and therefore did not give either of these companies a long term competitive advantage. However, Anderson used a higher level of creative function to add value to its products, which gave it a competitive advantage over Chinese companies who had a cost advantage. As a result, the implementation of a higher level of creative function combined with some level of FMS and ICT may allow the TWMMI a greater level of improved business performance.

7.3 Contributions of the study

This empirical study makes several contributions to the literature on creativity and innovation as well as the literature on the woodworking machinery industry. The first is that this is the first empirical research performed on the Taiwanese woodworking machinery industry, which studied innovation strategies they used. There have been many publications studying the issues of creativity and innovation, and there have been other publications studying the problems facing small companies. However, no empirical study has studied creativity and innovation consistently in the context of small companies, particularly in the woodworking machinery industry in Taiwan.

The second contribution this empirical study has provided is a clear picture of the worldwide competition to this industry in Taiwan. *The TWMMI's* competitive weaknesses, threats as well as factors influencing the TWMMI's innovation capability have been identified in this empirical study.

The third contribution is to the research literature and is the empirical study of the extent to which the TWMMI implement creativity. This empirical study has identified that the TWMMI have learned new technical knowledge from the market leaders' products and their product catalogues as well as trade shows. These idea generation methods and learning processes have helped the TWMMI to modify existing products and advanced some of the market leaders' products.

This empirical study has also identified that loyal customers and suppliers of the TWMMI have significantly contributed their design concepts and skills into the TWMMI' product design. It has also discovered that the TWMMI do not apply FMS and robotics to produce and assemble their final products but outsourcing to manufacturing has helped the TWMMI to successfully creating niche market; that is targeted at low-end customers.

The TWMMI do not adopt the higher lever of ICT to help prototyping, manufacturing, and distribution of new products into global market. However, some level of ICT implementation has assisted the TWMMI to design and manage new product portfolio.

This empirical study has identified that political, cultural and education factors have influenced the TWMMI's innovation capabilities and this empirical study has produced some recommendations (chapter 6 pp: 193-196) for the owner managers of the TWWMI to implement their innovation strategies successfully. So far these recommendations have been discussed and accepted by the Chairman of the Taiwanese woodworking machinery association, and four representative companies in this industry.

7.4 Limitations of this empirical study and recommendations for future research

This empirical study has four limitations. The first limitation is the nationality of the sample questioned. The sample covered only the Taiwanese Woodworking Machinery Industry. This is in part due to the difficulty of obtaining data about creativity and innovation issues around the world. Thus, the conclusions of this empirical study may not generalise to the woodworking machinery industry globally. Future research should focus on Western countries' creativity activities and creativity performance. This is because the different contexts of political, cultural, economical and educational factors may yield different outcomes. For example, if the market leaders in Germany and Italy are studied, the outcomes of the research are very likely to be different. A well-established or large company with more capital may have fewer constraints in creating new ideas. Furthermore, their education and training systems may promote creativity rather than imitation. Future studies could focus on the differences in education and political influences etc and compare the difference between the West, e.g. Germany and East, e.g. Africa.

My sample is an example of imitation based in the woodworking machinery industry therefore cannot be representative of highly creative companies such as that in Germany. The TWMMI closely resembles the woodworking machinery industry in the East due to their imitation based culture. It cannot be representative of Western innovation based, creative companies such as these in Germany.

Second, the findings of this empirical study may only apply to the woodworking machine industry. Whether the results concerning the innovation activities in industrial markets can be extended to other industries is a matter of speculation. It may however be applicable to other machinery based manufacturing industries. However, further research will be required to determine this.

The third limitation of this empirical study and an opportunity for future research is the way this empirical study measures creativity and increased creative success. This empirical study has noticed that organisational creativity stems from individual creativity. However, this empirical study does not concentrate on individual creativity, instead it focuses on organisational creativity. As a result, this empirical study does not measure the creativity levels achieved by individuals, but by patent registered, government award and diversification of companies. Future research should include individual creativity and its impact on increased creative success.

The final limitation of this empirical study is the measurement of manufacturing technology and ICT and improved business performance based on the success of new product performance. This empirical study has noticed that it is difficult to measure

improved business performance by return on investment or rate of net profit. Therefore this empirical study measures FMS combined with ICT in terms of owner manager perception and international customer satisfaction. Future research should measure improved business performance based on new product success by return on investment and the period of new product development.

Throughout this research, all the data has been collected from personal interviews with the owner managers of the TWMMI and their international customers. The personal interviews allowed the interviewer to clarify the answers given, improving the accuracy of the data collected. Furthermore by interviewing the owner managers and international customers, the data has been collected from people who are involved in the industry and who may give the most accurate account of the TWMMI.

In order to check the validity of the proposal, I went to check with five experts, and presented the proposal and received verbal feedback. It was confirmed that the conclusions were both relevant and valid in this empirical study. In order to disseminate the information gathered this empirical study to the TWMMI in general; I would suggest placing articles regarding the thesis and its findings in the magazine Woodworking & Furniture Digest monthly. This would be a good way of distributing the information as this magazine is popular with this industry and it is often read by the owner managers who may be inspired to adopting the innovation strategies suggested. Furthermore, there is a selection of websites, e.g. www.TWMA.com.tw on which abstracts of the thesis can be placed to inform the TWMMI of this empirical study.

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Appendix 1: 2005 Creativity and Innovation survey in the Woodworking Machinery Industry

DE MONTFORT UNIVERSITY FACULTY OF ART & DESIGN

2005 Creativity and Innovation survey in the Woodworking Machinery Industry

The aim of this questionnaire is to explore issues in global technology and product- process innovation and to provide an applicable model for industrial markets. Your contribution to this survey would be very much appreciated. All replies will be treated in the strictest confidence. Please answer each question by putting a (√) in the appropriated box (❑).

Section 1: General Information - about Yourself

Q1. what is your job tile?	1❑ Chair person 2❑ president 3❑ Vice president 4❑ Plant manager 5❑Assistant manager 6❑ Others (please specify
Q2.What is your main responsibility at decision making?	1❑ Production 2❑ Marketing 3❑ R&D 4❑ Finance 5❑ IT 6❑ Others (please specify
Q3. What is your management role in your company	1❑ Owner 2❑ One of the main sharcholders 3❑ Employed as a manager

Section 2: General Information - about your company

Q4. What are the main products of your organisation?	1❑ Machines can carry out different types of machining operations with tool changing between operations 2❑ *Machines* can carry out different types of machining operations without tool changing between *operations* 3❑Sawing machines 4❑Planning, milling or moulding(by cutting) machines 5❑Grinding, sanding or polishing machines 6❑Bending, or assembling machines, presses included 7❑Boring and mortising machines 8❑Splitting, slicing or parting machines 9❑ Woodworking lathes 10❑Other machine-tools handling the main machines 11❑Presses for the manufacturers of particle or MDF board
Q5. Approximately how many employees are there in your organisation?	1❑ 1- 9 2❑ 10- 19 3❑ 20- 39 4❑ 40- 49 5❑ 50-99 6❑ 100or more
Q6. What is your organisation's approximate annual turnover?	1❑ Under NT$ 3 million 2❑ NT$ 3 – 10 million 3❑ over NT$ 10 million
Q7. Where is your main production base?	1❑ Taiwan 2❑ China 3❑ South-east Asia 4❑Other (please specify_____)
Q8. What is your company's organisation?	1❑ Self-employed 2❑ Partnership 3❑ Public limited 4❑ others
Q9. Has your firm conducted Diversification?	1❑ Vertical integration (extended production of components and raw materials into new product 2❑Horizontal integration (used experience in technology, finance and marketing in order to contribute to new market 3❑ lateral (acquisition/ merge) 4❑No diversification

Section 3: About Product-process Effort

	Section 3A: systematic creativity activities	Please tick (√) one or more in the appropriated box (❑) which apply to your firm.
Q 10	Does your firm have creative function?	1❑ No if your answer is no, please skip question 10-16 to question 17 2❑ yes if your answer is yes, please answer the following questions
Q 11	In what ways does your firm obtain creative ideas from employees?	
Q 12	How does your firm increase creativity skills to enhance creativity?	
Q 13	By what means do your firm obtain creative personnel?	
Q 14	How does your firm motivate creativities?	
Q 15	By what means would your firm obtain investment for creativity?	
Q 16	Does your firm have the manufacturing capability to put innovation into practice?	
	Section 3B: product redesign process	Please tick (√) one or more in the appropriated box (❑) which apply to your firm.
Q17	Has your firm redesigned existing products in the past years?	1❑ yes 2❑ no If your answer is no, please skip question 17-19 to question 20.
Q 18	When redesigning the product, your firm conducted which activity	1❑ changing material 2❑ changing style, e.g. sound or reduce dust 3❑ changing function, e.g. parts or components 4❑ others please specify
Q 19	How does your firm deal with the increased steel price?	1❑ find substitute of raw material 2❑ redesign existing products in order to reduce raw material cost 3❑ others (please specify:)
	Section 3C: Cross-functional integration of innovation	Please rate the extent to which you agree the following conditions

		Strongly **disagree**					Strongly **agree**
Q20	Our R&D and manufacturing departments work in close collaboration	1❑	2❑	3❑	4❑	5❑	6❑
Q21	Our firm always keep long-term relationship with our suppliers	1❑	2❑	3❑	4❑	5❑	6❑
Q22	Good information flow between our R&D and marketing department	1❑	2❑	3❑	4❑	5❑	6❑
Q23	Customers participate in our product design	1❑	2❑	3❑	4❑	5❑	6❑
Q24	Our firm coordinated with external institution (e.g. governmental research units) for product innovation	1❑	2❑	3❑	4❑	5❑	6❑
	Section 3D: Manufacturing strategies	Please rate the extent to which you agree the following manufacturing strategies adopting in your company					
		Not main strategy					Main strategy
Q25	Make to stock	1❑	2❑	3❑	4❑	5❑	6❑

Q26	Assemble to order	1❑	2❑	3❑	4❑	5❑	6❑
Q27	Make to order	1❑	2❑	3❑	4❑	5❑	6❑
Q28	Engineer to order	1❑	2❑	3❑	4❑	5❑	6❑
Section 4: About ICT Effort		Think about the following ICT techniques and describe the benefits of ICT adoption within your firm.					
Q29		Don't have it					Have it and used it
a	Accounting software packages	1❑	2❑	3❑	4❑	5❑	6❑
b	Database l software packages	1❑	2❑	3❑	4❑	5❑	6❑
c	E-mail systems	1❑	2❑	3❑	4❑	5❑	6❑
d	Website	1❑	2❑	3❑	4❑	5❑	6❑
e	Web ordering system	1❑	2❑	3❑	4❑	5❑	6❑
f	The Internet Trade Network	1❑	2❑	3❑	4❑	5❑	6❑
g	CAD and CAM	1❑	2❑	3❑	4❑	5❑	6❑
h	Robotics	1❑	2❑	3❑	4❑	5❑	6❑
i	Flexible Manufacturing System (FMS)	1❑	2❑	3❑	4❑	5❑	6❑
j	Component Supply Management (CSM)	1❑	2❑	3❑	4❑	5❑	6❑
k	Product Design Management (PDM)	1❑	2❑	3❑	4❑	5❑	6❑
l	Enterprise Resource Planning (ERP)	1❑	2❑	3❑	4❑	5❑	6❑
Section 5: About your company's business performance.		Please rate the **extent** to which you agree with the following.					
Q30		Strongly **disagree**					Strongly **agree**
a	Our firm has better capability to develop new products than our main competitors.	1❑	2❑	3❑	4❑	5❑	6❑
b	Our new product develop faster than our other suppliers.	1❑	2❑	3❑	4❑	5❑	6❑
c	Our manufacturing lead time is shorter than our competitors	1❑	2❑	3❑	4❑	5❑	6❑
d	The delivery time is shorter than our competitors	1❑	2❑	3❑	4❑	5❑	6❑
e	The response to customers' requirements is quicker than our competitors	1❑	2❑	3❑	4❑	5❑	6❑
f	We have a wider scope of geographical territories than our competitors	1❑	2❑	3❑	4❑	5❑	6❑

Appendix 2: Customers' perception about the capability of Taiwanese Woodworking machinery industry's questionnaire

The aim of this questionnaire is to explore the capability of Taiwanese Woodworking machinery industry from their customers' point of views. Please answer each question by putting a (√) in the appropriated box (❑). Thank you for your help

Please tick by the end of each row which companies you use as supplier

Number	Company	(√)	Number	Company	(√)
1	Pow		16	Lih Woei	
2	Starmaster		17	Chen Sheng	
3	Goine.E		18	Ta Sane	
4	Shine Yun		19	Yung Ming	
5	Joyway		20	Blue Steel	
6	Fullpower		21	Hun Fong	
7	Gau Jing		22	Yoken Dan	
8	Sun Gaun		23	K .Kae Lian	
9	Carpenter		24	UV Light	
10	Chang-Iron		25	Long Ger	
11	Mung Suang		26	Jainn Jong	
12	Powermax		27	Hipoint	
13	Longel		28	Anderson	
14	Champ		29	Leadermac	
15	Boarke		30	Ru Long	

For Each of the companies you have ticked above please answer the questions below by ticking the appropriate boxes. (use additional sheets if you have ticked more than one company).

Please write here the name of the company from the list above		Please rate the **extent** to which you agree with the following.					
Q1		Strongly **disagree**					Strongly **agree**
a	Our firm has better capability to develop new products than our main competitors.	1❑	2❑	3❑	4❑	5❑	6❑
b	Our new product develop faster than our other suppliers.	1❑	2❑	3❑	4❑	5❑	6❑
c	Our manufacturing lead time is shorter than our competitors	1❑	2❑	3❑	4❑	5❑	6❑
d	The delivery time is shorter than our competitors	1❑	2❑	3❑	4❑	5❑	6❑
e	The response to customers' requirements is quicker than our competitors	1❑	2❑	3❑	4❑	5❑	6❑
f	We have a wider scope of geographical territories than our competitors	1❑	2❑	3❑	4❑	5❑	6❑