Chapter 3

Internal and External Resources for Enhancing Innovation Capabilities- An Exploratory Study based on Cases from Malaysian Automotive Sector

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CHAPTER 3

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The Malaysian automotive sector is an interesting case in the region, given that it is anchored by large national vehicle manufacturing firms which have been protected by several policy measures along with foreign assemblers. More recently the market is getting liberalized with more choices for customers on one hand and more competition for the national vehicle makers and also for the automotive parts and components industry in general. This offers the backdrop to this exploratory study on innovation capabilities in the Malaysian automotive sector based on cases developed through interviews in the field. Overall findings indicate the sector itself is dominated by supplier firms that are mostly involved in not so high tech parts like plastic or metal parts and there is little by the way of product innovations and most innovations would be towards changes in processes (this is with the exception of the two national car manufacturing firms Proton and Perodua which have the full set of the value chain activities involved in automobile product design and manufacturing). The foreign players have been mostly assemblers and while are well linked in terms of intra-firm networks with access to technological resources this does not seem to have spilled over to the supplier firms – offering an option for policy to leverage this resource as done in the electronics sector. While there are indications that several of these firms are passive in terms of innovation activities / capabilities and could be in the danger of not being competitive if they lose their anchor customer – there is anecdotal evidence where firms (small and large) have become competitive and gone into export markets by developing external linkages and internal resource developments thus overcome barriers to limited resources or markets size for innovation.

1. Introduction

1.1. Introduction to Malaysian Automotive Industry and Report Outline

The Malaysian automotive industry is considered to be one of the important and strategic industries in the nation's manufacturing sector. The industry started with humble beginnings in the 1960's assembling cars for European and Japanese car making companies, prior to which cars were imported in the CBU form. Today it has grown to having four manufacturers of whom two are car manufacturers, several assemblers and a fairly large component manufacturing sector. This report presents findings from exploratory case studies regarding how firms in Malaysian automotive sector attempt to enhance their innovation capabilities.

In the first section an overview of the Malaysian automotive sector is presented followed by the aim and approach of the study. In the next section the (mini) cases developed from interviews conducted in the field are presented. Following the cases section, findings gleaned from the cases are presented and policy implications are drawn.

1.2. A Brief History of the Malaysian Automotive Sector

The Government of Malaysia through the recommendation of Colombo plan experts began to develop and encourage the automotive industry in its country. Since the implementation of the National Economic Policy (NEP) of 1971, the government had played an important role in shaping the Malaysian automobile industry. It had drawn up policies and had set up a regulatory framework according to which interested players in this industry were expected to start production of cars and automotive

components locally. In addition to this the government also imposed certain taxes and a tariff system on the import of cars, through which it hoped to discourage people from patronizing cars that were produced and assembled outside Malaysia. The assembly plants that were set up were mainly joint venture projects between European auto manufacturers and partners. But it was the establishment of Proton in 1985 and Perodua in 1993 that acted as the main catalysts to the development of an indigenous automotive sector in Malaysia, and that helped to spawn a sector of components and parts making firms across the value chain. The Proton project was a joint venture enterprise with Mitsubishi enterprises, corporation of Japan, began production of its first car 'SAGA' in 1985. It was given a preferential treatment with respect to taxes and duty rates as it was not only promoting industrial linkages but also having a national identity / brand. The second local automobile manufacturer *PERODUA*, established in 1993 which launched their first car, the Perodua Kancil in late 1994. It mainly produces superminis and therefore does not actually compete with Proton for the same market niche. Together they dominate the passenger car market in the Malaysia.

1.3. Current Status of the Automotive Sector in Malaysia

Malaysia's automotive sector's development over the last 30 years has been dependent on the protection policies by the government. Liberalization of the industry is considered to be slow. Several regulatory measures are there to promote the national car producers, Proton and Perodua. Having said that, under the ASEAN Free-Trade Area (AFTA) agreement, there has been a reduction in import tariffs, after having secured a two-year deferral from ASEAN. Import tariffs on completely built-up

(CBU) units have been were reduced from a band of 70-190% to 20% at the start of 2005. For completely knocked-down (CKD) kits, the import tariff has been cut from 25% to zero. Import duty on CBUs was cut further, to just 5%, in March 2006. All this has resulted in new dynamics in the automotive market particularly the cars market.

As of today there are four passenger and commercial vehicle manufacturers (including Proton and Perodua) and one motorcycle manufacturer, Modenas. There are also 9 motor vehicle assemblers and 9 motorcycle assemblers. To support the manufacturers and assemblers, there are 500 + motor vehicle components and parts manufacturers, of which 23 are Tier 1 status. In turn, there are 100 motorcycle components and parts manufacturers (Source - Malaysian Automotive Association).

Table 1: Summary of Passenger & Commercial Vehicles Produced and Assembled in Malaysia for the Year 1980 to December 2010

Year	Passenger Cars	Commercial Vehicles	4x4 Vehicles	Total Vehicles
1980	80,422	23,805	-	104,227
1985	69,769	37,261	-	107,030
1990	116,526	63,181	11,873	191,580
1995	231,280	45,805	11,253	288,338
2000	295,318	36,642	27,235	359,195
2005	422,225	95,662	45,623	563,510
2006	377,952	96,545	28,551	503,048
2007	403,245	38,433	-	441,678
2008	484,512	46,298	-	530,810
2009	447,002	42,267	-	489,269
2010	522,568	45,147	-	567,715

Note: (i) Passenger Vehicle industry reclassified in January 2007 and includes all passenger carrying vehicles, i.e. Passenger Cars, 4WD/SUV, Window Van and MPV models.
(ii) Commercial Vehicles also reclassified on 1 January 2007 and include Trucks, Prime Movers, Pick-up, Panel Vans, Bus and Others.

Source: Malaysian Automotive Association (MAA) (http://www.maa.org.my/info_summary.htm).

After the fall in sales due to the 2008 financial crisis, sales of motor vehicles for the first three months of 2010 increased by 22.4% to 147,415 units compared to the same period last year. Correspondingly production of vehicles is also supposed to have increased.

While the manufacturing sector in Malaysia contributes about 29% to the nation's GDP, and the automotive industry's contribution to the GDP has increased from 20% in the 1970's to about 29% currently. The sector employs almost 200,000 people. Malaysia has the highest level of passenger-car sales in the Association of South-East Asian Nations (ASEAN). Passenger car registrations in Thailand, its closest rival in the region, totalled 191,400 in 2006, compared with 367,000 for Malaysia (Sourced from

- http://www.ssig.gov.my/ssig/kcent/material/Speech_by_minister_of_MITI_Jun_9.pdf and the Economic Intelligence Unit website).

1.4. Key Players in Malaysian Automotive Sector

The automotive market is dominated by the four manufactures and in the cars market it is essentially a duopoly controlled by the two national manufacturers, Proton and Perodua. These two firms, along with two other "national" manufacturers, Hicom MTB and Industry Otomotif Komersial (Inokom), account for over 70% of car sales. Proton, the first indigenous carmaker, when it was set up in 1983, was a collaboration between the Malaysian government and Mitsubishi corporation. Today the government holds a majority stake in the company (through Khazanah Nasional). In 1996, Proton acquired a stake in Lotus engineering and increasing it in 2003 giving it engine making and other capabilities. Despite these moves Proton has lost its market

share. In 2005 Perodua overtook Proton as the largest market share holder in the in the commercial-vehicle market. Another important development was in 2002 when Perodua sold a 41% stake to Daihatsu Motor of Japan to gain access to production and management skills from Daihatsu (which is itself a subsidiary of Toyota). In 2002 a third national car manufacturer, Inokom, was established by the local Berjaya Group and Hyundai Motor of South Korea (Renault of France also has a stake). Inokom manufactures subcompact cars. The fourth national manufacturer, Malaysian Truck and Bus (MTB), is owned by Isuzu Motor of Japan and DRB-Hicom, a Malaysian conglomerate. Naza, a privately owned Malaysian company is the fifth manufacturer when in April 2006 it launched its own compact car for sale in the domestic and overseas market.

Automotive assemblers are estimated to have a total capacity of around 600,000 units a year. Assemblers include Asia Automobile Industries (assembling Mercedes, Mazda and Kia vehicles), Toyota Assembly Services, Associated Motor Industries (BMW, Ford and others) and Volvo Car Malaysia.

The domestic automotive-parts industry includes around 550 companies, manufacturing for both domestic vehicle manufacturers and assemblers of foreign cars. Around 70% of production is for the original-equipment market, with the remainder dedicated to the part-replacement market or to exports. While local content is around 80% for the national car makers Proton and Perodua; for cars assembled (but not manufactured) in Malaysia it is around 35-40%. But this still consists of relatively low-value parts, such as body panels, electrical components, drive transmissions, trim and upholstery. The manufacture of engines is confined to a few types, leaving Malaysia dependent on overseas supply for a more comprehensive range of engines.

Malaysia also has to import electronic components for vehicles. But the full abolition in 2004 of the Mandatory Deleted Item Policy, which prohibited car assemblers from importing certain components, has gone some way towards enhancing the competitiveness of some of the component makers.

Overall the Malaysian market for automobiles, particularly cars, is considered a fairly attractive enough one for several global players to be part off. There are several Japanese, European and more recently Korean players have also made inroads into the market. But the major concern for the government is Malaysian automotive exports are small compared with those from other ASEAN countries – around 95% of car production is sold domestically, with only a few successful niche markets abroad (for example for some models in the UK and Australia). There has been some growth recorded in the exports of parts and components (EIU website). Also there has not been much development of indigenous innovation capabilities in product development or even manufacturing design among the auto parts / component makers – most of them rely on designs to be supplied by the main vendor / customer and they develop abilities to deliver to these specifications (interview with Chief Procurement officer or large German Assembler)

All this sets a backdrop for this study – which is gain an initial understanding of innovation related capabilities development in Malaysian automotive sector.

2. Main and Approach to the Study

The main aim of the study is to understand what are the internal and external sources developed and linkages between firms and other actors / institutions for

enhancing innovation capabilities of firms in Malaysia's automotive sector?

The report is based on interviews of key executives from seven firms/cases supplemented with information from website sources. The details of the case firms are as below:

Table 2: Details of Firms in which Interview were Conducted

	Name	Type of Firm	Type of Products	Activity	Main Customer
1	Y& Metals	Local SME	Car Seat Brackets	Process Design, Manufacturing & Sales	Perodua
2	ABC Manufacturers	Local SME	Car Seat Parts	Manufacturing	European Luxury Car Assembler
3	Proreka	Large Local parts Supplier	Plastic Interiors and Exteriors	Design, Manufacturing & Sales	Proton, Exports and Replacement Market
4	Company A American MNC	Large Foreign Parts Supplier (Tier 1)	Car Seats	Assembly & Sales	Proton, Honda and others
5	Company B Japanese Supplier	MNC	Car Parts – Air Conditioner, Wipers etc	Manufacturing, Application Design & Sales.	Local Car Manufacturers and Japanese Assemblers
6	European Assembler	MNC	Cars	Assembly & Sales	Malaysian Market
7	Malaysian Manufacturer	Large Manufacturer	Cars	Design, Manufacturing & Sales	Malaysian and Export
8-9	Suppliers	Local SMEs	Metal Parts	Manufacturing & Sales	Local Car Manufacturer
10	Supplier	Local SME	Wipers	Manufacturing & Sales	Foreign Assemblers

The respondents for the study were varied – but care was taken in selecting the person who has been involved in decision making related to design and manufacturing / innovation capacity building and would be able to provide the information needed for the study. In the case of small and medium firms – they were the Managing Directors of the firms, in the case of the large supplier firms they were the equivalent of the heads or directors of R&D /manufacturing or corporate division. In the case of the foreign car assembler it was the chief procurement officer. The interviews lasted between one to two hours. The questions schedule is based on the Innovation audit

tool developed by Hobday (2001) were centered around the following key dimensions identified – Initial awareness and searching out triggers for change, then looking at core competencies and development of a technology strategy, followed by assessment and selection, and acquisition, implementation and absorption of the technology within the firm. This if followed the issue of operation of the technology and learning about how best to use it. Finally the questions ask about the external linkages the firm developed to enhance their innovation capabilities.

A simple content analysis is done to glean out issues emerging from the interviews. Findings are presented based on the key issues identified and some cross case analysis is attempted. A summary of interview of each firm is presented as mini cases and then findings are gleaned out and presented at the end.

3. The Cases from Malaysian Automotive Sector

3.1. Case of Y&L Metals

3.1.1. Profile of the firm

Y&L Metals started off as a supplier in the electronics sector. The Owner / Executive director had experience in a European consumer electronics firm and then decided to go out on his own as a supplier. They have been in the metal stamping and tool and die supporting industries in Malaysia for more than 20 years. They apply the Toyota Production System in their operations. The firm is categorized as an SME with about 120 workers and RM 25 million turnover and for the automotive parts the main customer is one of the local car manufacturing firms.

3.1.2. Innovation capabilities building

Awareness and Search

– Scanning and Monitoring External Technology Events and Trends

The first issue that affects all aspects of decision making, particularly technology related, is the low volume of Malaysian automotive market. This respondent of the firm feels that this aspect determines the investments and developments in technology or any investment related aspect in this sector. Quality, price and delivery are the 3 key factors for customers buying from them. In addition the service they provide. Product quality, customizations are more important factors followed by price / low costs and delivery. These issues are the same in both local and export markets. They scan regularly for developments in the industry though internet and trade publications. They plan to focus on the automotive sector and develop their competencies in the future and keep open to collaborative opportunities – with MNC customers for developing product design capabilities

Generally in terms of manufacturing technology needed to produce the metal stampings products – the respondent indicated that they are aware of the latest technologies available for manufacturing. The executives in Y&L are regular visitors to firms (with high levels of automation) particularly in Japan, that use cutting edge manufacturing technologies. They seem aware even about the different materials used in their products and use high tensile materials that are similar if not superior to their competitors. They consider themselves not at the technology frontier – but more at appropriate levels – given the low volumes of demand in the market.

Competencies Developed, Technology Strategy and Assessing & Selecting Technology

Their main capability is in Tool / Jigg design to support manufacturing of multiple products and be able to do this with low volume production at competitive prices while maintaining quality similar to competitors. In addition safety factor is the competitive advantage. For the future the focus will be developing capabilities in terms of "safety" aspects in their products.

The technology strategy is essentially in process developments – focusing on reduction of time and increase quality consistency while eliminating waste and through this achieves price competitiveness.

In terms of assessing and selecting technology (in this case manufacturing related) – the key customers are Japanese automobile firms and this has an influence in the assessment and selection of machines and related technology decisions. The assessment decisions and selection decisions are done in-house – the key executives in design, engineering and manufacturing are involved and occasionally they get assistance from an independent industry consultant. They attend international automotive shows and also visit firms in the industry in other countries to keep abreast of the technological developments.

Acquiring + Implementing & Absorbing Technology

Being a small firm – technology acquisition decisions are made internally. Key design and manufacturing executives and the executive director are involved. For the move to automotive sector – it can be said to be internal acquisition from the E&E operations and also for customization – their links with MNCs like Philips, Sony and Panasonic has helped them. Visits to other firms in the industry and some linkages to design

firms in other countries also help acquisition decisions of technology.

The TS 16949 system where a lot of documentation is involved guides implantation and abortion – the feasibility study forms as part of the TS system takes care with 4 levels of risk assessments (stage gate approach) and also offers a project management approach. The small size of the firm ensures co-operation from the different relevant departments (in addition the TS system has a KPI that needs to reflect links between different units).

Learning for Building Technological Competencies + Exploiting External Linkage and Incentives (like Tax Breaks, Grants etc)

The TS 16949 system where a lot of documentation is involved and also the process and control system of TS 16949 helps in learning and documenting of the issues related to technological competencies. They also do some informal benchmarking within the industry. There is some linkage with other firms in the industry eg. Design firms in India, Japan and Germany. They hire / interact with international technical consultants in the industry.

3.1.3. Summary

Overall this firm is interesting as it can classified as in the border of Type B and Type C firms – despite limited resources they have managed to identify their competencies and diversify from electronics sector to the automobile sector where they sensed opportunity (which the larger Japanese competitors were not able to fulfill) – low volume, high quality and low cost components to the local manufacturer of cars. The firm may be 'trapped' in a mature or slow growth sector, despite having exploited technology efficiently but they are considering the next diversification. Another constraint is also being considered – currently the key technical / engineering

personnel are all personal friends and have managed to attract a few younger staff – but they need to compete with changing behaviors in terms of aspirations of among new university leavers to add on to the technical team – as the MNCs attract most of the talent. In summary have good awareness and scanning abilities – exploit some external actors for information on technology. But limited to process related developments and are planning to develop product related design capabilities and open to collaborations.

3.2. Case of ABC Manufacturers

3.2.1. Profile of the Firm

ABC Manufacturers is a Malaysian manufacturing firm producing seat related parts (including the covers) for a European luxury car maker. The firm is sole proprietorship and can be categorized as an SME with about 80 workers and RM 35 million turnover.

3.2.2. Innovation Capabilities Building

While all other respondents in interviewed had unanimously mentioned 'low volume' as a critical constraint for technology related decisions – this firm had low-volume as a benefit or conducive to its competency development and performance.

Awareness and Search
– Scanning and Monitoring External Technology Events and Trends

Quality and reliability are of critical importance as this is for the high-end / luxury sector. While they supply mostly for the Malaysian market, the factors that affect the business or in terms of technology choice is the same for local or export markets. Role of technology as such is considered minimum and all scanning or monitoring of technology related issues is done by the main customer (large European car

manufacturer) and passed on to the firm.

Competencies Developed, Technology Strategy and Assessing & Selecting Technology

The Managing director who was the respondent says that the whole firm culture is centered on developing workers with specialized skills ad invests heavily in training. The competencies are in producing high quality products with 'precision and reliability.' The firm is said to have developed strong process controls, quality processes and special skills groups for high quality production. For the future or any technology related priorities they look to the main customer to lead.

Acquiring + Implementing & Absorbing Technology

The main customer provides the specifications and the firm acquires the required process related technologies – the process / production technologies are modular and some reverse engineering type learning takes place for learning about absorbing technology.

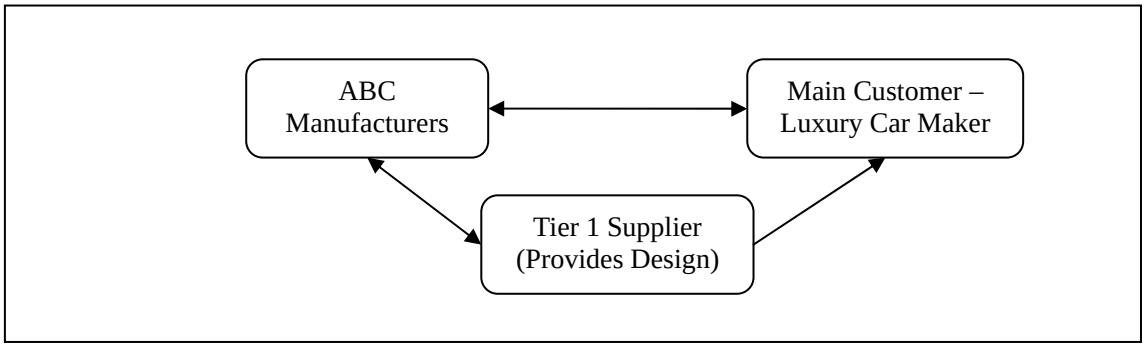
Learning – for Building Technological Competencies + Exploiting External Linkage and Incentives (like Tax Breaks, Grants etc)

There is no technology transfer and hence no specific learning in the context of process of product related technologies e.g. Jiggs and tools needed are all purchased. There is only monitoring and inspection work for faulty management and investments are made in documentation and process mapping but this is more in production and quality management related issues.

3.2.3. Summary

This is a typical type A firm where the large MNC type customer leads in all aspects and design and development and suppliers designs – directly or through the tier one supplier (in this case a firm called Lear) for the low technology inputs (in this case car seats related parts).

Figure 1: ABCs Manufactures Links for Design Resources



The SME has competencies in quality assurance and management and capabilities to produce parts for luxury / high end product producing customer with long terms contracts. The biggest fear is that the design firm (tier 1 supplier) could take over the manufacturing business.

3.3. Case of Proreka Sdn Bhd

3.3.1. Profile of the firm

Proreka is a tier 1 vendor of OEM manufacturers and components to major car manufacturers and assemblers in Malaysia. It's been in the business for nearly 10 years now and also operates in the replacement market. Proreka mainly deals with modification and styling, prototype making, engineering design and data, testing and mass production. It also does interior designing, customized modification and styling

for cars. Proreka has the necessary expertise to look at newer ways to design and process engineering. It has achieved a number of awards that stand to fact its longstanding leadership in this field. ISO/TS 16949 was also awarded to Proreka.

The firm has nearly 140 employees of whom 25 engineers are directly involved in design related work (product and process). The turnover in 2010 was between Ringgit Malaysia 60-70 million. There were three respondents for this case – the GM – Operations, Senior Manager – Manufacturing and Head of Sales.

3.3.2. Innovation Capabilities Building

One of the critical issue of building up capabilities for innovation that all the respondents mentioned is the 'low volume market' and also the slow product life cycle – i.e. Changes required in design are usually once in 2-3 years only in the local market. The lack of facilities in their lead customer (local car manufacturer) for design of car interiors and some exterior parts – has led to the development of this company.

Awareness and Search
– Scanning and Monitoring External Technology Events and Trends

The firm is highly active in scanning and monitoring external technology events and trends related to its area (plastics molding). Green technologies are the trend they see and they are not yet in the frontier of this technology. They visit and participate regularly in several trade shows and exhibitions, attend training programs sponsored by industry related development organizations to help in awareness building and scanning for new developments in related technologies.

Key factors that affect the firm are lead times, cost and then quality issues. A critical factor for the firm involved in product design is tooling capability which they

say is lacking in Malaysia and they rely on Korean or Taiwanese tool makers.

Firm Competencies, Technology Strategy + Assessing and Selecting Technology

They core competency is described as being a 'one stop shop' offering design to manufacture capabilities for car interiors and some exteriors. They have all the competencies in this value chain expect for building tools (for manufacturing) which they outsource to suppliers in Taiwan or Korea. Capabilities for building tools in Malaysia are constrained by lack of volumes (low volumes to support such skills). The key technical personnel attend training programs regularly sponsored by the firm or industry related development organizations to help in development of the competencies. A key factor they consider in the technology strategy is the 'tooling costs' as this is scarce in Malaysia and can't be done yet 'in house.'

Their business strategy is to develop into a 'modular supplier of safety related parts' and the 'technology strategy' is to support this business. Business practices like 'vendor pay upfront' peculiar to Malaysian market is considered as an impediment to make investments in product design and also in further manufacturing process design capabilities. Technological priorities include to have a lean production system including such processes as waste management, Kamban systems, etc with a 3-5 year business plan. Being part of the Proton Vendor Association they get support in terms of assessing and selecting the appropriate technology (manufacturing / process related). There is a joint venture with a firm in Indonesia and they attend trade exhibitions regularly to bring in outside knowledge. In addition subscribe to key academic and trade journal to help them judge/assess and select proper technologies.

Implementing & Absorbing Technology and Learning to Build Tech Competencies

Proreka is also a TS 16949 accredited firm – and they also mention that the TS systems requires them to follow standardized project and risk management procedures in all aspect of manufacturing or new product development. The system involves detailed documentation and process and control system of TS 16949 helps in learning and documenting of the issues related to technological competencies. The APOP – Advanced Product Quality Planning system as part of the TS process also help in cross functional coordination. They have a manufacturing feasibility study system to manage risks in new projects. They also do some informal benchmarking within the industry and the Kaizen systems help in capturing learning and understanding their level against competitors in the industry.

Learning + Exploiting External Linkage and Incentives (like Tax Breaks, Grants etc)

In addition to being part of the Proton Vendor Association, they are also linked to MyJaCo and the SME Corp of Malaysia – this gives them knowledge of and access to training programmes, trade related seminars and other such events giving knowledge of technology and management related aspect of their business. They have also links with end users like the Waja Users Clubs.

3.3.3. Summary

Overall this firm is interesting Type C firms – they have managed to identify a gap in the market (lack of a one-stop shop from design – manufacturing of interior and exterior plastic parts) and develop the firm with these competencies. The challenge of low volumes in the market remains and hence the firms are planning to export. The

firm has the danger of getting 'trapped' in a mature or slow growth sector, despite having exploited technology efficiently. Similar to Y&L have the challenge of maintaining a strong technical team in future – as the MNCs attract most of the talent. In summary have good awareness and scanning abilities – this firm exploits a few external actors for information on technology. But limited linkages even with a technical university in the neighbourhood. Another challenge is also if new firms are allowed to enter the protected market.

3.4. Company A - Case of an American Diversified MNC Parts Supplier

3.4.1. Profile of the Firm

Company A is a Fortune 100 diversified, multi-industrial company with nearly 140,000 employees in 1,300 locations across six continents. The Malaysian unit is part of the automotive business unit of Company A and assemblers and supplies car seats to European luxury car assembler and also to the prominent local car manufacturer and some Japanese assemblers in Malaysia. The Malaysian manufacturing unit has about 700 employees of which about 30 are involved in manufacturing process design (some of whom may be involved in product design also). The firm's annual turnover is about Ringgit 350 million.

3.4.2. Innovation Capabilities Building

Awareness and Search

– Scanning and Monitoring External Technology Events and Trends

The firm does not have formal functions for scanning and monitoring technology related events and trends in the Malaysian operations. The operation in Malaysia is to assemble high tech / high end auto-seats for the luxury segment cars and also for other

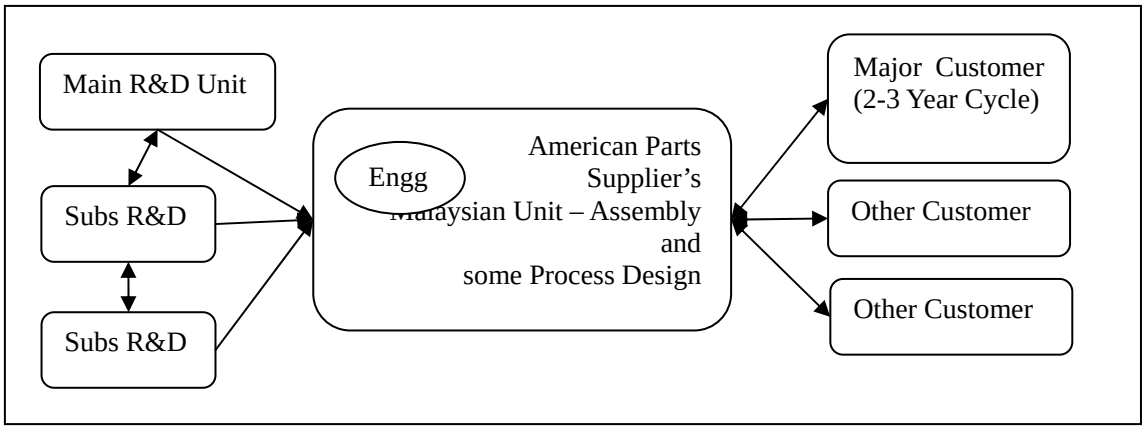
seats.

For the local car manufacturing firm some design work has been undertaken – but for which help is taken from the firm's main R&D unit or from other subsidiary's design or R&D units – requisite technical personnel are deputed to the Malaysian unit for the project and then sent back to their home unit. So the firm itself can be said to have high levels of awareness and scanning (based on its global operations) but not in the Malaysian operations.

Competencies Developed, Technology Strategy + Assessing and Selecting Technology

Whether is information regarding the range of technology options (different machines, suppliers, approaches, etc) or assessing technology options to know that they have chosen the best sources of technology – they depend purely on the firm's head quarters. The competencies here are purely related to assembly of the car seats – with quality testing.

Figure 2: American MNC Parts Supplier Links for Resources



Acquiring + Implementing & Absorbing Technology

All decided by the head quarters – the engineering unit here assists in this matter. Project Management and Risk management capabilities in terms of adopting any

frameworks or systems all come from the headquarters. The TS16949 accreditation is considered to play an important role in acquiring and absorbing technologies.

Exploiting External Linkage and Incentives (like Tax Breaks, Grants etc)

Within Malaysia they do not have any specific links to external source of knowledge for technology development (Universities or other industry related organizations) but all these links are there at the head quarters or probably at other subsidiaries.

3.4.3. Summary

On the surface it appears as a type A firm – or the Malaysian unit is a Type A firm. But if one considers the global operations of the firm it's a much more sophisticated. The links for and investments in technology related activities in the Malaysian unit are weak due to the following reasons (based on the interview) – local market limitations in terms of low volumes and slow product life cycles (design changes in cars are slow as in once in 3 years).

3.5. Company B - Case of a Large Japanese Parts Manufacturer

3.5.1. Profile of the Firm

This company (founded in 1949, is a leading supplier of advanced automotive systems, technologies and components. The headquarters of the firm is based in Japan and it employs more than a hundred thousand people in more than 31 countries all over the globe. This large Japanese parts manufacturer started as a joint venture between the Japanese corporation and its local partners. Today it is the largest automotive components manufacturer in Malaysia, and a major automotive components supplier to national car projects. The Malaysian unit is also an ISO/TS 16949, ISO 9002, and ISO 14001 certified firm from SIRIM (Standards and Industrial Research Institute of

Malaysia). The products manufactured and services offered include, voltage regulators, starter motors, Windshield wiper motors and washer radiators, air conditioners for cars and buses. The firm has about 1,200 employs of which 30 are directly involved in the design function – which is involved predominantly in manufacturing process related work. But there is some application design work that is done at times. 50% of their products are for export markets.

3.5.2. Innovation Capabilities Building

Awareness and Search
– Scanning and Monitoring External Technology Events and Trends

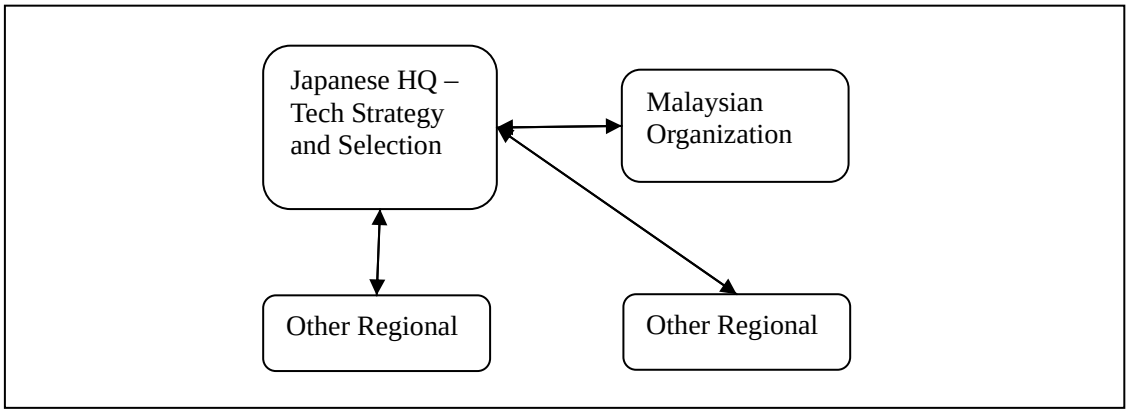
Technological is seen as critical for manufacturing / process design development in order to have high quality and high productivity. JIT systems are critical for their business. QCD factors – quality, customization and delivery affect whether customer firms buy from them. Quality is the order winning factor in their business. The firm's head-quarters which has larger volume business has a larger in-house R&D division that has more formal processes for scanning and monitoring of external technology events. They consider themselves at the frontier in their business.

Competencies Developed, Technology Strategy + Assessing and Selecting Technology

The competencies of this firm are in producing high quality auto parts with lowest possible cost – due to the use of JIT systems. In addition focus is on development of products that are environmental friendly. The technology strategy is developed based on supporting these competencies. But the decisions related to technology strategy and also in assessing and selection of technologies are done at the headquarters. In the Malaysia operations the focus is on manufacturing, testing and quality management.

The technological priorities are towards development of JIT manufacturing systems for all products – to enable highest possible quality with minimum costs.

Figure 3: Hub and Spoke Relationship between HQ and Malaysia



The assessment and selection of technologies – is essential done at the headquarters – and this is usually done in a stage-gate approach. All relevant functions are involved in assessment and selection of technologies and the role of the Malaysian organization is seen in the analogy or hub and spoke – where the headquarters is the hub and Malaysian organization is the spoke.

Acquiring + Implementing & Absorbing Technology

All decisions or systems for acquisition, implementing and absorption of technologies are essentially done at the headquarters or in some of the subsidiaries where there is a significant R&D unit – the role of the Malaysian organization is minimal – in term of the hub and spoke model – the inputs from this organization are considered for acquisition of technologies.

Learning to Build Technological Competencies and Exploiting External Linkage and Incentives (like Tax Breaks, Grants etc)

Learning to build technological competencies are done through formal reports developments, e-mail sharing amongst the subsidiaries and also a periodical conference organized by region. There is an also periodic audit (technical audits) that helps in terms of identifying and capturing learning/knowledge from projects undertaken.

There appears to be very little linkage with external actors for enhancing innovation capabilities. A major barrier as identified in some of the other firms – is low volume of business in the local market and also the slow product life cycle leading to a very less requirement for design work for example – a comment was that the ASEAN market is seen to have a 10 years cycle for cars and hence major changes in product design and related process changes are low.

3.5.3. Summary

As with the other foreign parts/component supplier this firm also identifies the low volume issue and also the slow design change cycle in the market as an issue for developing or setting up of product design capabilities in the Malaysian operations. There is some investment in terms of an engineering division for absorption of technology from the parent/headquarters and to do some developments related to local markets (an example given is that in Malaysian market sometimes design changes are asked to be one on a faster time cycle than the usual 24 month cycles). Several key decisions related to technology strategy and also assessment and selection of technologies etc are not done in this organization – although there is some involvement in the hub-spoke model practiced. The firm sees no need at all for any external

linkages as it (1) the base research is that parent / headquarters and also (2) they see no major research institute / research and development resources in the region to link with.

3.6. Company C - Case of a large Local Car Manufacturer

3.6.1. Profile of the Firm

This is one of the four manufacturing firms in the automobile sector of Malaysia. It was established in early 90's (1993), as a result of a joint venture between Malaysian and Japanese partners. The managing corporation was established in late 2001. Two other joint venture partners of the firm are from the Japanese automotive sector. The manufacturing operations of the Group are managed by XYZ and their plant currently has the capacity to produces 250,000 units per annum on 2-shift cycle. The firm has a few export markets which some Asian countries and UK. The firm has a large domestic market with an extensive sales and service network. The firm employs nearly 10,000 people and the research and development department which started in late 1990s with just a handful of engineers and a manager now has five departments with more than 350 employees.

3.6.2. Innovation Capabilities Building

Awareness and Search

– Scanning and Monitoring External Technology Events and Trends

The firm is seen to be highly active in scanning and monitoring external technology events and trends related to small car manufacturing. They key personnel are involved in visiting and participate regularly in several trade shows and exhibitions, attending training programs to help in awareness building and scanning for new developments in

related technologies. Key factors that affect the firm are lead times, cost and then quality issues. Cost related issues seem critical for the firm.

Competencies Developed, Technology Strategy + Assessing and Selecting Technology

The R&D activities have focused on developing capabilities from basic testing, to design and styling and also process design related developments manufacturing engineering skills. The competencies developed include styling / modeling, concept car development and the ability to undertake major facelifts. There is a separate division called the Perodua Engine Manufacturing Sdn Bhd (PEMSB) which undertakes the assembly of the vehicle engines and also manufacturing of selected engine component parts. The technology strategy has been more towards 'localization' of components of their cars – similar to what is known as the import-substitution strategies in industries in other developing counties.

Acquiring + Implementing & Absorbing Technology

There are five departments within the R&D and they are Product Planning, Styling, Engineering Design, Testing & Experiment and Technical Admin. Within these departments are sections which are assigned specific tasks. The firm has invested some RM97 million in the last 13 years on facilities alone and more than RM1.5 billion on model development. This is to indicate the firm's commitment to the localization policy and in-house development capabilities, as well as the government's aspiration to see local companies enhance their R&D expertise. Also the large R&D division is not only involved in new product design but also plays a role in implementing and absorbing technology transferred from the JV partner and thus helping to further innovation capabilities in the company.

Learning to Build Technological Competencies and Exploiting External Linkage and Incentives (like Tax Breaks, Grants etc)

The firm started with a Japanese link (producing their vehicles) and now is a joint venture with the Japanese manufacturer and several Japanese management practices help in the learning to build technological competencies. The joint venture organization and the large investment in the R&D division is supposed to be critical in learning for building up technological competencies. External linkages are there with universities, but this is more for some small peripheral developments or not for innovation related activities (and not the core engine or related parts development). The main links is with a Japanese car maker through the joint venture and related links that emerge through the partner that help in the learning and development of technological competencies.

3.6.3. Summary

As a national car company, this firm has the responsibility not just to manufacture cars in the Malaysia, but also to develop local capabilities. It's felt by many (including the respondent) that the decision to go into a joint venture with partner was a very good decision made by management from the point of developing innovation capabilities. The R&D division of the firm had to "prove" itself to the JV partner leading to more technology transfer. The firm has emerged as a 'quality' player in the small market segment and also has the largest market share holder. It can be seen as a Type C firm that has exploited technology for its business but need to be more dynamic in terms of a vision for technology for future and also in developing linkages / exploiting external sources for enhancing its innovation capabilities.

3.7. Company D - Case of German Luxury Car Assembler

3.7.1. Profile of the Firm

The luxury car assembler is part of a large German group which is one of the largest producers of premium cars and the world's largest manufacturer of commercial vehicles. In addition the group also has a financial services division with a full range of automotive financial services including financing, leasing, insurance and fleet management.

3.7.2. Innovation Capabilities Building

Awareness and Search

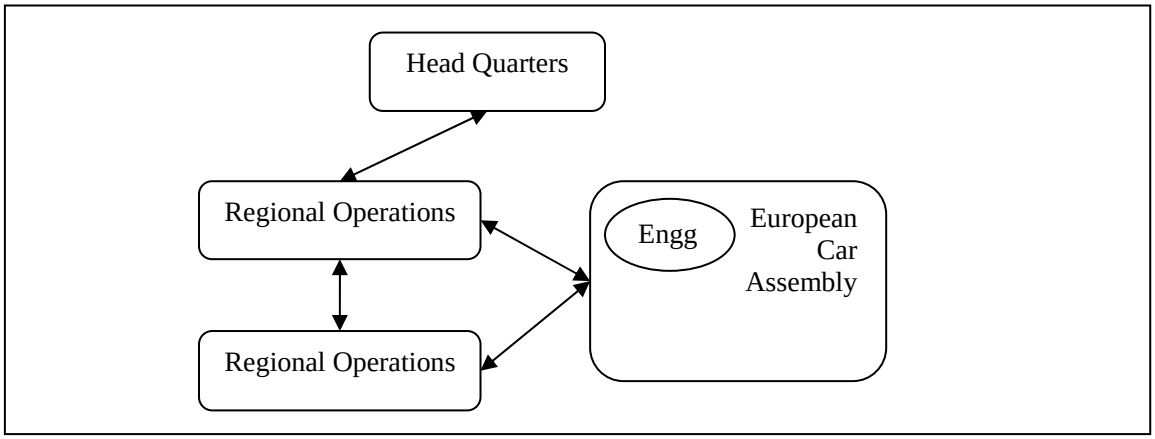
– Scanning and Monitoring External Technology Events and Trends

The firm does not have formal functions for scanning and monitoring technology related events and trends in the Malaysian operations. The operation in Malaysia is to assemble high tech / high end cars which arrive from the headquarters in CKD kits but for which help is taken from the firm's main R&D unit or from other subsidiary's design or R&D units – requisite technical personnel are deputed to the Malaysian unit for the project and then sent back to their home unit. So the firm itself can be said to have high levels of awareness and scanning (based on its global operations).

Competencies Developed, Technology Strategy + Assessing and Selecting Technology

Whether is information regarding the range of technology options (different machines, suppliers, approaches, etc) or assessing technology options to know that they have chosen the best sources of technology – they also depend purely on the firm's head quarters.

Figure 4: European Car Assembler – Links for Resources



Acquiring + Implementing & Absorbing Technology

When a new car model need to be manufactured – the headquarters decides on all the manufacturing and transfers information regarding the process design and personnel to train and implemented in the Malaysian unit. The main skills in the Malaysian operations are testing and quality management. The manufacturing and other process related issues are more or less the same in all places – the only exception in Malaysia is some operations are manual due to low volumes. All technology related decisions are at the headquarters. Project management and risk management capabilities in terms of adopting any frameworks or systems all come from the headquarters. In terms of links with other regional operations – it's more of information sharing of problem solving for particular issues faced in the local plants.

Exploiting External Linkage and Incentives (like Tax Breaks, Grants etc)

Within Malaysia they do not have any specific links to external source of knowledge for technology development (universities or other industry related organizations) but all these links are there at the headquarters or probably at other subsidiaries.

3.7.3. Summary

Again similar to the American MNC, this European car assembly firm appears as a Type A firm – for the Malaysian unit. But if one considers the global operations of the firm it's a much more sophisticated. The links for and investments in technology related activities in the Malaysian unit are weak due to the following reasons (based on the interview) – there is no strong resource base to set up a process or product related design unit in this place – the local market is the reason for the manufacturing / assembly operations here.

3.8. Summary of the Cases 8-10

Two respondents from SMEs that supply parts to the national cars and one to foreign assemblers were interviewed initially. But the common results / findings that emerged from the interview were as follows – all the three could be categorized as Type A firms with no particular technology strategy. They depend on fully on the customer firms that these firms supply to – either on the national car makers and the foreign car assemblers). The product designs are supplied by the 'customer' and they manufacture to specifications – these are classic Type A firms with manufacturing facilities and some amount of quality testing facilities/capabilities

4. Conclusions and Policy Implications

Overall from the discussions with the respondents – the sector itself is dominated by supplier firms that are mostly involved in not so high tech parts like plastic or metal parts and there is little by the way of product innovations and most innovations would

be towards changes in processes. The relatively better innovation capacities are with supplier firms that work with the two national car manufacturing firms Proton and Perodua (which have the full set of the value chain activities involved in automobile manufacturing) – whose mandate includes developing and utilizing parts and components from local firms or made locally. Also the automotive sector has a very large number of firms that are more trading firms – although registered as an auto part or component supplier – they import the products and supply to the consumer/replacement market or even to the OEMs.

While the mandate to 'localize' parts and components is considered helpful to enhance local firm's motivations for developing innovation capacities - an interesting comment from one of the respondents of a part supplier company, is worth mentioning at this point "… it is very difficult to keep costs low in Malaysia due to several factors –dependence on foreign labor and uncertainties in labor policy, lack of a support industries like tools and dies – need to depend on Korea or Taiwan (Malaysian one too expensive and not up to the same quality)." Similar comments were made by another parts supplier also.

Based on the interviews the following has been gleaned –

Awareness: The firms that have been studies seem highly aware of what affects their products and processes – and this seems because of the close link with the 'customer' firm which is usually one of the two main local manufacturers or the locally located assembly firms of foreign cars. Most firms interviewed can be classified as Type B or Type C – interestingly there are both local and foreign firms in Type C category.

The 2 cases that were interviewed (but discarded) and also one of the cases presented (the Auto Seats SME) exemplify Type A firms. According to several

executives a majority of the firms in the industry would be in this category. They are reactive and depend completely on the customer firm (usually a vehicle manufacturer or a tier 1 supplier) to plan their business operations.

Search – Scanning and Monitoring External Technology Events and Trends: The key factors that are considered critical by the respondents in these firms are quality, customization and speed (all this eventually leads to low costs is the view). And the most important aspect is reliability and while currently technology (as in high technology) does not seem extremely crucial (as labor costs are low in the country) but in future there is thought being given to 'technology' playing a role in gaining competitiveness. These firms are regular visitors to exhibitions regionally and more recently locally. They also are heavy users of internet and attend seminars. Here it needs to be mentioned that while labor costs are considered low – there is what the respondents call 'hidden costs' of depending on foreign labor.

Building Core Technological Competencies: In general only three of the seven firms can be said to have a distinctive competitive edge based on technology – developed in-house but benchmarked against internationally competitors – while currently they are focused on cost related or reliability related innovations – for the future they see a bigger role for R&D and internal R&D. Others seem to be more reactive in building these competencies based on the needs of the customer firms.

Technology Strategy: The technology strategy, again, seems to be more reactive and specifically linked to the developments of large "global" automobile manufacturers. The small and medium local firms try to have their business strategy very closely linked to the larger customers and the technology strategy is also developed in these

lines. The foreign players are more sophisticated in this matter but the activity itself is in their parent firms or the head-quarters.

Assessing and Selecting Technology: Information on range of technology options like different machines, suppliers, approaches, etc – is sought from either the large global automotive firms (customer firms) or the national car manufacturer. One of the SME firms sough this information through independent/external consultants.

Acquiring Technology: With the exception of the foreign supplier firm the local SME inputs supplier firms did not have any specific formal processes or mechanisms for acquiring technology from outside not really in terms of a portfolio or approaches - while one respondents from an SME firms stated that the crucial role in technology acquisition and capturing knowledge is heavily influenced by a certain automobile related “standards” organizations (important as they aim to supply to large global players).

Implementing and Absorbing Technology: One of the three SME firms seems quite adept in (a) Project Management Capabilities – from getting a technology to actual product coming out (b) Risk Management Capabilities – is claimed to be vital and is inherent in the project management due to the accreditation by the automotive standards organizations. This adherence to the standards organization also helps to ensure co-operation and communication between R&D engineering, production and marketing and other functions – cross functional expertise is based on the documentation that needs to record the communications between the different units.

Learning – For Building Technological Competencies: While the foreign companies seemed more adept at "learning" aspects as the HQ has systems in place and locally they have a lean engineering team to help in technology transfer from the headquarters – one local SME supplier firm – which can be seen as an "outlier" – seemed to be quite active in terms of having systems in place for learning about technologies and developing competencies (evidenced by their ability to plan and diversity based on such competency development).

Exploiting External Linkage and Incentives: Overall this aspect is extremely weak among the firms studies – there is very little linkages within these firms and also overall the awareness of external options to leverage and improve products or processes appears very limited – be it in the form of linkages with universities, research institutes etc.

To conclude – while many firms can be classified as Type A or Type B some of the local SMEs – particularly those that supply to the national car manufacturers can be classified as TYPE A-B (as in Appendix 1) – this is to indicate that they very aware of the need to change but not yet able to do so – in terms of technological / innovation. While they have secured orders from the national car companies – they are aware of the need to be innovative (in terms of product and/or process developments) to be competitive in the wake of liberalization. These firms seem to be developing capacities in process innovation be it to lower prices and for quality and also for product development in order to be able to supply to other customers locally and in overseas markets.

4.1. Internal and External Factors for Enhancing Innovation

Internal Factors

In general the internal factors that help in enhancing innovation can be seen as the firm's ability and resources committed to gaining awareness of technological developments, specific departments / groups for developing process innovations and/or design functions for being able make improvements in products or even developing new products. In the case of the large (foreign) supplier firms the internal factors that help in innovation are engineering divisions – which have some role in developing applications developments and in more importantly these divisions are for absorbing new technological innovations from parent/HQ). The other 'internal factor' among the large foreign supplier firms can be the links to the head quarters and units/subsidiaries of the company located in other regions.

External Factors

From the interviews/ case studies, factors that help to enhance innovation are as follows – in the case of SMEs they are external consultants hired by the firms and strong links to customer firms or demands from customer firms. In the case of large supplier firms the strongest links are with the customer firms i.e. car manufacturers or assemblers. In the case of supplies to assemblers there is very little innovation related activity – its more production to specifications but in the case of links to local car manufacturer's (as customers) there is some impetus for doing design and developments. There is very little evidence of external factors such as joint ventures, collaborations or linkages with organizations – like academic institutes / universities, research institutes, community organizations / NGOs or for that matter other firms in

the sector – is generally weak. The only exception is one of the large manufacturing firms which has a joint venture for enhancing innovation – product and / or process related.

The links between internal and external factors are fairly clear – the firms (small or large) which have specific engineering / design (R&D) divisions or groups are usually ones which have higher levels of awareness of the need for technological innovations for being competitive – these divisions also help in terms of developing competencies and in the case of one large manufacturer this type of a division has helped to enhance the relationship with the joint-venture partner to transfer technologies and also in developing innovations.

4.2. Overall Conclusions

Support for Innovation: Internal Factors, External Factors and their relationship

All the respondents in firms interviewed unanimously mentioned that although called R&D activities – there was not much real research and development in the firms – there was some product design and development but predominantly it was process design and development activities that were taking place. In the case of the SME firms – the innovation was in processes as the product specifications was a given. The MNCs were seen as the key drivers of innovation as they are perceived to be the "lead" organizations in the market.

The larger foreign players have extensive internal sources of data – databases of key publications in their area of interest, participating in key conferences, intra-group meetings, links to universities at the HQ. Among the local SME firms – while all did use the internet in general – also checked out information on competitors' as a source

of information for innovation. One of them sought more information from a competing Japanese firm against whom they benchmark their processes. Local firms talk about cooperation with suppliers or customers as they main collaborative activities.

There is some evidence of joint ventures (between Malaysian owned firms) in the automobile sector – but only in the case of one large manufacturing firm, that have been interviewed till now. Overall respondents seem not to have considered joint venture (JV) type organization for technological developments so specific policy to support JV form of organizations seem warranted in this sector also. An interesting point is how the SMEs see the role of large foreign players – their planning and development is based on these large foreign manufacturing firms (whose cars are assembled in Malaysia) and the trends set by companies – for example one of the SMEs sees the movement towards 'green techs' by the larger Auto players – and hence is planning to go into that area of business. All these have implications and recommendation for policy will have to be developed.

4.3. Some Initial Ideas for Policy Recommendations

Policy Recommendation 1

Keeping costs low is a critical aspect for the survival of the small and medium firms and as a factor in getting them customers. But the SMEs mention about hidden costs not just in terms of the uncertainties in labor policy but also in the availabilities of supporting industry for innovation activities – e.g. As one of the Type C firms which does design work for interiors mentioned – there is no proper set of suppliers of tools and dies in the country and they have to rely on imports – this adds to their costs. So there seems to be a need to develop support institutions for such needs. A factor that

hinders innovation constantly mentioned is the low volumes and couples with too many players or too much competition in the market – this could be addressed with policy to encourage industry consolidation (Malaysia has had experience with such policy in the services sector).

Policy Recommendation 2 - Sector Specific Support System

There are indications that there are several Type A firms which are SMEs and run as a one man show or by family concerns in the automotive sectors. These firms rely heavily either on the national car makers or on the large MNC customers (usually assemblers) for support in information and also for technical designs (product and process). The case of Type B-C firms in the study show clearly that linkages with outside organizations increases information flow and motivates them to invest in in-house design and engineering functions making them more independent. Unlike the Electronics or Palm Oil sectors – the Automobile sector visibly lacks a support system specific to the sector or even a regional innovation system (a good example is the Continental setting up R&D centre in Penang given the region's electronic industry base with human resource availability, infrastructure and specialized players in the value chain). This leads to the next recommendation.

Policy Recommendation 3 - Investment in Automobile Related Research Centres

Two of the three respondents from the foreign firms (one parts supplier and one car assembler) mentioned that the research and development activities take place either at the "HQ" or on other subsidiaries of the company. The reasons for this was that (1) the volumes in the Malaysian market were not large enough and (2) the changes in product design were also too slow (2-3 years for parts) to warrant a design centre – in the case of the Japanese firm – since they supply to the global market had invested in

manufacturing process design – but they estimate the specific product design changes for the ASEAN automobile market change over a 10 year cycle and hence the does not warrant a product innovation investment. They also mention that there is no strong research centre or university with which they could work with on any specific area also. While Malaysia has been open to FDI it has managed only to get in manufacturing and not in product or process research. So government investments in the existing universities for some dedicated research – or encourage cross sector linkages between electronics and rubber sectors and the firms in the automobile sectors can be considered.

Overall the much criticized policy of national car projects by the Malaysian government, seem to have helped in developing a sector of automotive parts and components firms. While there are indications that several of these firms are passive in terms of innovation activities / capabilities and could be in the danger of not being competitive if they lose their anchor customer – there is anecdotal evidence where firms (small and large) have become competitive and gone into export markets by developing external linkages and internal resource developments thus overcome barriers to limited resources or markets size for innovation.

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APPENDICES

Appendix A: *Firm-Level Innovation in the Korean Economy*, Report for World Bank, Hobday et al. (2001)

SECTION - Not all firms are the same

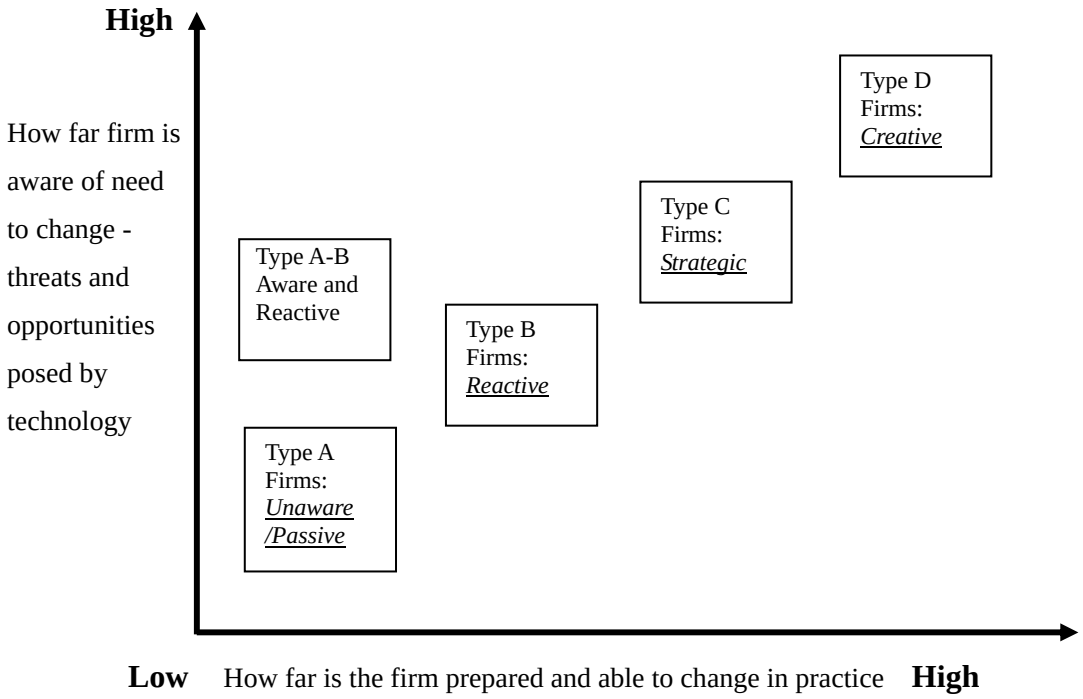
Research has consistently shown that firms, and particularly small and medium-sized enterprises (SMEs) differ widely in terms of their technological capabilities and absorptive capacity. We can represent them on the diagram below which differentiates between:

The degree to which firms are aware of overall need to change (sensitive to competitive forces, etc.);

The degree to which they are aware of what to change and how to go about the process.

Figure A1 provides a simple model which views firms in terms of these two dimensions.

Figure A1: Groups of Firms according to Technological Capability



Type A Firms: Unaware/Passive

These firms can be characterized as being 'unconscious' or unaware about the need for technological improvement. They do not realize or recognize the need for technological change in what may be a hostile environment and where technological know-how and ability may be vital to survival. They do not know where or what they might improve, or how to go about the process of technology upgrading. As such, they are highly vulnerable to competitive forces. For example, if low cost competitors enter - or the market demands faster delivery or higher quality - they are often not able to pick up the relevant signals or respond quickly. Even if they do, they may waste scarce resources by targeting the wrong kinds of improvement.

These companies are weak and ill-prepared in all major areas of technology acquisition, use, development, strategy and so on. A thoroughgoing basic improvement program is probably urgently needed. Help is needed in: enabling these firms to recognizing the need for change (the 'wake-up call'); developing a strategic framework for manufacturing and other activities; identifying relevant and appropriate changes; and acquiring and implementing necessary technologies. They also require assistance in sustaining this process of change over the long-term.

Type B Firms: Reactive

These firms recognize the challenge of change and the need for continuous improvements in manufacturing and other technological capabilities. However, they are unclear about how to go about the process in the most effective fashion. Because their internal resources are limited - and they often lack key skills and experience in technology – they tend to react to technological threats and possibilities, but are unable to shape and exploit events to their advantage. Their external networks are usually poorly developed. Most technological know-how comes from their suppliers and from observing the behavior of other firms in their sector. They may well be 'keeping up' with other firms which may have similar weaknesses and limitations in technological capability. Typically, this group treats symptoms rather than root causes of problems - for example, dealing with bottleneck operations by replacing machinery only to find that the problem gets worse because the root cause is, in fact, in production scheduling.

Overall, these companies have poorly developed capabilities in most areas of technology strategy, search, acquisition and capability building. However, there are some strengths upon which to build.

The needs of this group centre first on the development of a strategic framework for technological change, so that key priority areas can be addressed. Allied to this, are

needs in searching wider for solutions, in exploring new concepts (for example changing production layout rather than simply acquiring new machinery), and in acquiring and implementing new product and process capabilities. In the longer-term, such firms could be expected to develop an internal capability for strategic upgrading and require less and less support.

Type C Firms: Strategic

These firms have a well-developed sense of the need for technological change. They are highly capable in implementing new projects and take a strategic approach to the process of continuous innovation. They have a clear idea of priorities as to what has to be done, when and by whom, and also have strong internal capabilities in both technical and managerial areas and can implement changes with skill and speed. These firms benefit from a consciously developed strategic framework in terms of search, acquisition, implementation and improvement of technology. However, they tend to lack the capabilities to re-define markets through new technology, or to create new market opportunities. They tend to compete within the boundaries of an existing industry and may become 'trapped' in a mature or slow growth sector, despite having exploited technology efficiently within the boundaries of the industry. Sometimes, they are limited in knowing where and how to acquire new technologies beyond the boundaries of their traditional business.

Overall these companies have strong in-house capabilities and think strategically about technology in the medium and long term. In some areas, these firms may be behind the international technology frontier but they have many important strengths upon which to build.

The needs of this group are essentially around providing complementary support to internal capabilities and challenging existing business models. Improving access to specialist technical and marketing expertise, enabling access to new networks of technology providers (for example, overseas sources) can assist these firms to think 'outside' of the industrial box they find themselves in, should the need arise. Such firms may also benefit from occasional, project-based support from consultancy companies or from specialist research and technology organizations, locally or internationally. These firms may benefit from improved access to graduates and from linking up with universities which offer new ideas, access to advanced technology and new skills.

Type D Firms: Creative

Type D firms have fully developed sets of technological capabilities and are able to help define the international technology frontier. In many areas, they take a creative and pro-active approach to exploiting technology for competitive advantage. They are at ease with modern strategic frameworks for innovation and take it upon themselves to 're-write' the rules of the competitive game with respect to technology, markets and organization.

Strong internal resources are coupled with a high degree of absorptive capacity which can enable diversification into other sectors, where their own skills and capabilities bring new advantages and re-define the ways in which firms traditionally compete, or wish to compete. Their technology and market networks are extensive so that they are kept informed about new technological opportunities and remain in touch with suppliers of equipment and ideas.

There are only a few firms in this category and they are generally seen as 'risk takers' although, like most businesses, they tend to avoid unnecessary or uncalculated risks. Some creative firms emerge from traditional and mature sectors to challenge the way business is conducted. For example, Nokia, the Finnish company, moved from pulp and paper into electronics and eventually became a world leader in mobile telecommunications, showing that it was possible to make very high margins in the production of handsets within the developed countries, when most competitors believed it was impossible to achieve this goal (e.g. Ericsson and Motorola viewed handsets as low margin commodity products). Another example is IBM, which transformed itself from being a 'dinosaur' of the computer industry, to one of the fastest growing, most highly profitable information technology companies in the world, capable of leading the advance of 'e-commerce' technology in the late-1990s.

The needs of this group are mainly around complementing existing internal capabilities with outside sources, assessing risks and uncertainties and sustaining their position as a 'rule breaker.' They tend to be open companies which collaborate and learn from partners in the external environment and invest in developing new technologies and resources, for example in leading universities around the world. From time to time projects emerge with threaten to disrupt their existing businesses and they are often in a strong position to convert such threats into new market opportunities. Such firms may need to develop new contacts with specialist groups (domestic and overseas) in order to resolve complex technical problems and generate new opportunities. These companies can be useful contributors to governments as they try to position and develop their national systems of innovation for the future (e.g. the

Singapore and UK Governments often discuss policy with leading industrialists from such firms).