Firm Absorptive Capacity and Product Development Design among Automotive Component Manufacturers in Malaysia

Siti Norezam Othman*, Suria Musa**, Mastora Mustafar*** and Norsiah Hami****

Firm absorptive capacity is significant to develop organizational innovation capability. Absorptive capacity is built through accumulation of prior knowledge base and internalization of the knowledge in an organization. For firm in developing countries, relevant prior knowledge base was consisted of basic skills and general knowledge. This paper explored the level of absorptive capacity attained by local automotive component manufacturers specifically in conducting product development design. The evidence accumulated through questionnaires collected from 45 manufacturers indicated that the level of knowledge base in product development and design process and tools was inline to the commitment level of firms to internalize the knowledge base. The findings showed that the knowledge base and commitment in applying the knowledge focused more on detail design phase up to production ramp-up however, they hardly focused on product concept phase, which required innovation. The implication of this study was manufacturers needed to be exposed to product development and design phases that required them to be more innovative such as product concept phase

Field of Research: Absorptive capacity, Product development design, knowledge base

1. Introduction

The changing trend of supply chain strategy, from the disintegration approach between supplier and assemblers toward a more collaborative approach, would impact supplier roles. The responsibility that suppliers have to assume is much larger and greater. Suppliers are assuming a larger percentage of the engineering and manufacturing of modules for the car manufacturers as the carmakers are pushing more manufacturing out to the suppliers (Anon, 2003).

---

* Dr Siti Norezam Othman, College of Business, Universiti Utara Malaysia, Sintok 06010, Kedah,Malaysia. Email: norezam@uum.edu.my

** Suria Musa, College of Business, Universiti Utara Malaysia, Sintok 06010, Kedah, Malaysia. Email: suriamusa@uum.edu.my

***Mastora Mustafar, College of Business, Universiti Utara Malaysia, Sintok 06010, Kedah, Malaysia. Email: mastora@uum.edu.my

****Norsiah Hami, College of Business, Universiti Utara Malaysia, Sinto 05010, Kedah, Malaysia Email: norsiahami@uum.edu.my

Suppliers are expected to acquire technical and design innovation capability. They are responsible for shortening the product life cycle and evaluation, product reliability, and warranty. The basis for selecting suppliers is no longer on nationality but the trend is to move toward choosing suppliers who can supply components of high quality with lower associated cost. International car manufacturers are going for the global market, and so is Proton. The competition for automotive component suppliers has become more intense than before.

The local initiative through product development and design effort undertaken by vendors to boost their technological capability is a start for them to acquire higher level of innovation capability. Despite their involvement in product development and design activities, local vendors' absorptive capacities have not been assessed extensively. Thus, it is fundamental issue to find out their absorptive capacities and their capability to conduct product development and design. The technological knowledge acquired and the extent of knowledge application related to product development and design need to be assessed to find out whether vendors acquire necessary knowledge for them to perform in the product development and design tasks.

2. Literature Review

The concept of absorptive capacity is originated from the macroeconomics field, where it represents the ability of an economy to use and absorb external information and internal resources. Cohen and Levinthal (1990) modified this concept by adding the organizational level and they defined absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it and apply it for commercial ends." Cohen and Levinthal (1990) stated that organization's existing base of knowledge is the key to organizational innovation. The definitions and the use of absorptive capacity concept are used differently such as focusing on wide range of skills dealing with tacit components and modifying the external knowledge gained. However, for the purpose of this study, the concept of absorptive capacity is based upon Kim (1997) definition. According to Kim (1997), relevant prior knowledge base increased firm ability to make sense and to assimilate the new information. Relevant prior knowledge base was consisted of basic skills and general knowledge, which normally pertaining to firms in developing countries. As indicated by Kim (1999), prior knowledge base should be evaluated based upon the degree of task difficulty. In addition to firm knowledge base, effort to internalize the knowledge or intensity of effort, acquired through practices was important and became precedence before being able to solve complex problems. Such effort instigated interaction among members in the organization, whereby exchanged of information as well as conversion and creation of knowledge occurred.

To enable generation of knowledge and innovation, firms should not be viewed as an agent for information processing but they should rather be conceived as a

collection of resources and capabilities as well as their ability to learn, share, diffuse, and create knowledge through interaction (Caloghirou et al., 2004). There are two elements in strengthening a firm's capacity in absorbing technological knowledge from technology transfer; the existing knowledge base, and intensity of efforts made for the development of TCs (Kim, 1999). A firm builds its knowledge base from the existing knowledge that it has. The existing knowledge base enables firms to acquire, adapt, and innovate external technology acquired from foreign sources (Heslop et al., 2001). Thus, in the context of this study, the level of technological knowledge acquired by a firm serves as a basis for knowledge base building.

Knowledge on technology bought or technological knowledge is known as a collection of data that has been added in value through analysing them so that they become meaningful information (Gorman, 2002). The user of information then relates the information acquired to the context, experience, discussion, and interpretation in order to transform it into knowledge. Knowledge can be viewed as a collection of information or rules that can be used to fulfill a certain function (Hertog and Huizenga, 2000).

The building of a firm's knowledge base develops its competencies or capabilities, for instance, an R&D engineer, who previously acquired comprehension on knowledge in developing a powerful power train of an automobile, must have developed the knowledge base in the engine and transmission areas through his experiences over the time. One of the ways that a firm's knowledge base can be strengthened is through facilitating an in-house R&D effort (Kim, 1999). Kim (1999) indicated that the knowledge base or prior knowledge must be accompanied with an intensity of effort in developing a firm's absorptive capacity. Intensity of effort is the energy and time put in by members or an organisation to solve problems in the organisation. The R&D effort must be intensified such that a firm would be able to improve its capability to exploit external sources of technical knowledge (Gambardella, 1992; Mowery et al., 1996; Simango, 2000). A strong knowledge base is a key to successful innovation (Lundvall and Nielsen, 1999).

3. Research Methodology

The study used a quantitative method. The quantitative method is indicated by the statistics method used in the study. This study is an exploratory type of study where the main objective of the study is to explore the extent of vendors absorptive capacity and to find out the level of capability attained by the. It was a cross sectional study where data was collected once at a single point in time. The unit of study under observation in this research is the firm or company. The manager or general manager of the unit that are heavily involved in the transfer of technology was selected to answer the question. The respondents would normally come from the engineering or R&D department. In this study, the unit of

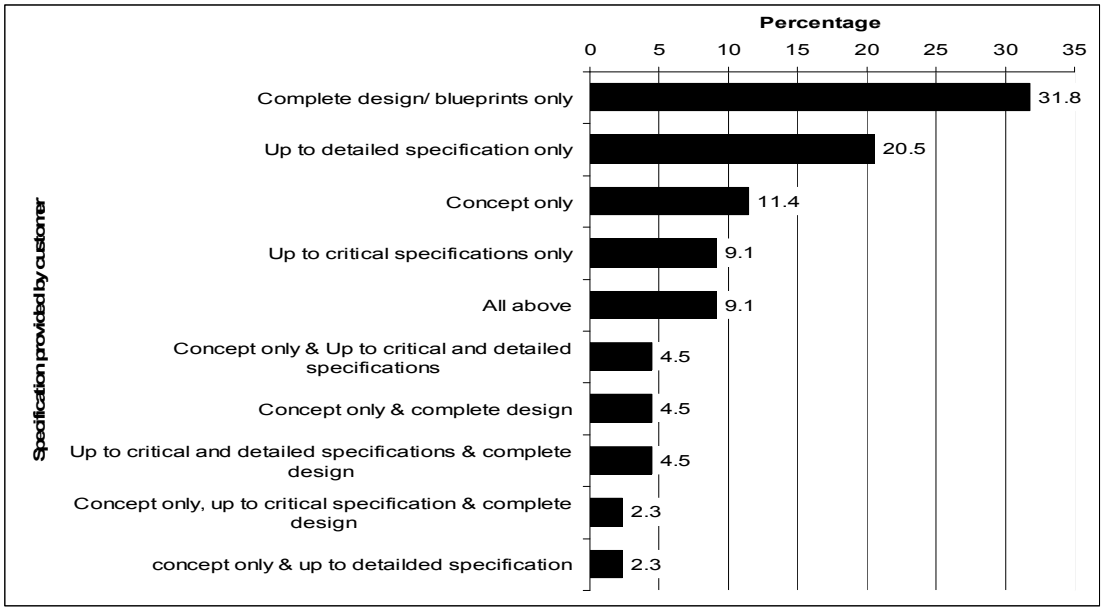
analysis is the automotive parts and component manufacturers that have been dealing with various customers, such as Proton and Perodua.

The initial sampling frame was MIDA Automotive manufacturers Directory 2008 obtained from Malaysia Industrial Development Agency (MIDA). A total population of 220 companies was registered as automotive vendors. The sample size is 113 according to the rule of thumb based upon Krejie and Morgan (Sekaran, 1998). The questionnaire was mailed and self administered to all the suppliers that were supplying the various parts and components to Proton. Furthermore, there was a need to address the small medium enterprises (SME) since the SMEs made up a large proportion of the automotive parts and components industry. Out of 113 companies, 68 companies were no longer at the addresses indicated and no longer in operations while 45 companies returned the questionnaires. For the purpose of this study, the response rate for this study was 39.8 percent.

4. Results of The Study

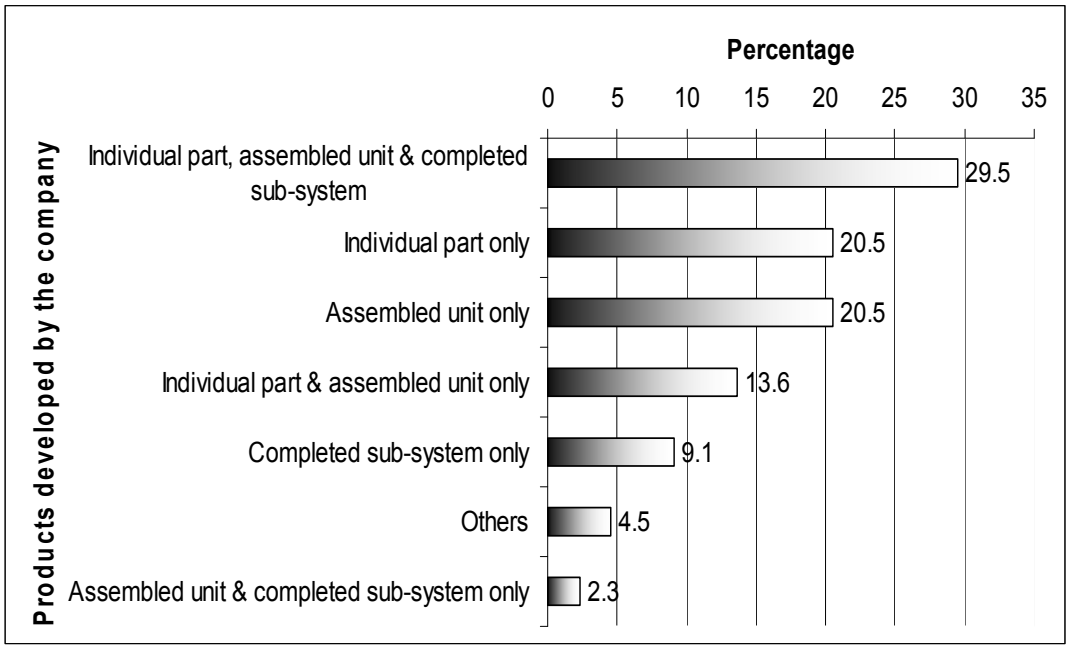
Based on the findings, only 15.6% of the companies did not deal with car assemblers in developing and design products. In contrast, 84.4% of the companies dealt with car assemblers in developing and design products. Results for the types of specification that had been provided by the customer(s) was indicated in Figure 1.1. Most of the companies or 31.8% received specification by the customer in terms of complete design or blueprints and followed by 20.5% of the companies that received specification by the customer until detailed specification only. Nevertheless, the least percent of the companies or 2.3% of the companies had been able to provide the customer(s) from product concept only, up to critical and detailed specifications and complete design. 4.5% of the companies were provided specification under three categories, which were concept only and up to critical and detailed specifications, concept only and up to complete design and also critical and detailed specifications and up to complete design by the customer(s). 9.1% of the companies were provided with critical specifications and all of the specification categories stated in the questionnaire.

Figure 1.1: Specification Provided By The Customer(s)



This analysis was done to identify the various product developed by customers and the results was shown in Figure 1.2. 2.3% of the companies developed assembled unit and completed sub-system only while 4.5% of the companies developed others. 9.1% and 13.6% of the companies developed completed sub-system only and individual part and the assembled unit only for each. 20.5% of the companies developed individual part only and the assembled unit only. Most of the companies or 29.5% of the companies developed individual part, assembled unit and completed sub-system.

Figure 1.2 : Product Developed By The Company



This analysis was made to identify the involvement of the vendors in product development with customer. 26.2% of the companies had been involved for 15 years in product development activities with customer. This was followed by 16.7%, 9.5% and 7.1% with each involvement were 20, 10 and 8 and also 11 years. Nevertheless, some of the companies with 2.4% and 4.8% involved in the range of 2 to 7 years, 17 to 18 years and 23 to 35 years for their product development with customer.

5.1 Firm Knowledge Level In Product Development Design Process (PDD) and PDD Tools

This section will highlight the results related to firm absorptive level in product development design. Descriptive analysis by using mean score was used in this part because of the Likert Scale application. This part was done to identify the level of firm knowledge based on product design and development (PDD). The first five highest mean scores were knowledge in product development and design process;

1) Measuring product development performance (3.62)
2) Project management (3.6)
3) Evaluating early production output (3.42)
4) Cost benefit analysis (3.4)
5) Performance testing (3.36)

These mean scores indicated that companies fully acquired the knowledge in the five areas. On the other hand, the last five lowest mean scores that indicated less acquired by companies were knowledge in

1) Defining major subsystems and interfaces (2.87)
2) Refining industrial design (2.96)
3) Considering product platform (2.98)
4) Obtaining regulatory approvals (3.0)
5) Defining part geometry (3.07)

The low mean scores also indicated that these were the areas which were not exploited by the companies currently. Based on the results, the first five knowledge on tools scored high, which indicated that they fully acquired by companies were

1) Ability to manage project involving product development and design (3.49)
2) Failure mode evaluation analysis (3.49)
3) CAD application (3.4)
4) Basic operating and maintenance knowledge (3.38)
5) Value analysis/ value engineering (3.13)

On the other hand, companies scored less on these last five tools, which were less acquired by companies. These tools were;

1) Taguchi method (2.41)
2) E-business application (2.49)
3) CAM application (2.61)
4) CAD/CAM application (2.66)
5) Design of Experiments (2.78)

5.2 Commitment Level Of Company In Applying The Product Development Design (PDD) Knowledge

Based upon the findings, the mean scores of company's commitment in applying the PDD knowledge were between 2.96 and 3.51. The first five highest mean scores were

1) Measuring product development performance (3.51)
2) Project management (3.50)
3) Cost benefit analysis (3.48)
4) Evaluation on early production output (3.44)
5) Implement design changes (3.44)

While the last five low mean scores in terms of commitment in applying the knowledge were

1) Life testing (2.96)

2) Assessing new technology (3.0)
3) Developing industrial design concept(3.02)
4) Define major subsystem and interfaces(3.04)
5) Obtain regulatory approval (3.05)

5.3 Commitment Level Of Company In Applying Tools Used In Product Development Design (PDD)

In terms of commitment level of company in applying the tools used in PDD, the results indicated that companies scored high mean scores on

1) CAD (3.48)
2) Failure Mode Evaluation Analysis (FMEA) (3.45)
3) Project management (3.44)
4) Basic operating and maintenance knowledge(3.3)
5) DFMA (Design for Manufacturability)(3.16)

Meanwhile, companies scored low in term of commitment in applying tools such as;

1) E-business (2.36)
2) Taguchi method (2.42)
3) CAD (2.79)
4) CAD/CAM (2.9)
5) Design of Experiments (2.93)

6. Discussions

From the research findings, most of the vendors rated high level of knowledge base in project management, product development performance measurement, and early production output evaluation. Project management is rated highest among vendors indicated that they have acquired initial and necessary knowledge in conducting product development and design. Product development and design is conducted in project based. In other words, one project which is done one at a time or in some companies, vendor undertakes product development and design project simultaneously especially when involving more than one customer. In developing and designing product, vendors are required to meet the deadline given by the customer and in some instances, customer requires vendors to deliver in short notice. This situation in product development and design requires vendor to acquire project management knowledge to ensure the activities or tasks undertaken can be accomplished within the deadline given by the customers. This is in line with Owens (2006) who indicated that project management is important for SMEs to ensure development delays can be avoided.

Furthermore, product development performance measurement is the next highest knowledge base attained by vendors. This measurement objective is to evaluate the project deliverables. Product development performance measurement is important to make sure product quality such as specification and requirement provided by customers is met. Other than that, product development performance also is measured in terms of delivery and cost. After product development activities or task are completed, the vendors are assessed in terms of their capabilities of producing product that satisfied customer in terms of quality, cost and delivery. The importance of product development measurement is to ensure vendor will be able to produce quality product prototype faster than other competitors and at a reasonable price. Inability to deliver faster quality and low cost prototype than the competitors will cause vendors to lose business from customers (Ulrich and Eppinger, 2008).

The third highest knowledge base attained by vendors is early production output evaluation. The knowledge is essential because before product is sent for mass production, an evaluation on early production output during the production ramp up phase is to train the work force and to work out any remaining problems in the production processes. The early production output measurement knowledge is important to identify any remaining flaws before production takes place (Ulrich and Eppinger, 2008). In other words, the early production output evaluation knowledge is important because this knowledge will enable product in the production ramp up to be transferred to the ongoing production gradually. From the ranking of the knowledge base attained by vendors, it is apparent that these knowledge bases are essential and most importantly, these knowledge is a subsequent from one knowledge to another knowledge, for example, project management knowledge is required to ensure the product development and design project can be completed within the time frame provided by supplier and within the product development design process, product development performance knowledge is important to evaluate project deliverables and after product is accepted by customer for production, an early production output evaluation knowledge is important so that any flaws or problems with the product production processes before mass production takes place. In early production output, cost benefit analysis is done to ensure the cost effective product is produced.

The knowledge attained by vendors indicated that it is more on management, coordination on product development design project and early production evaluation of product before mass production takes place. Majority of local vendors indicated that customer provides them with complete design or blueprint of the product. There are many indications that can be made due to the research results. Firstly, most local vendors depend on customer complete design or blueprints. In other words, they do not work from scratch, such as developing product concept. Their roles are to follow exactly the blueprints or the drawing supplies to them. By supplying blueprints to the vendors, nothing much in terms of innovation capability can be acquired by them. Their innovating and creativity

capabilities can not be developed any further because they are bounded to follow the drawing provided by customer. This situation depicts that the product development process undergone by them does not show that they involve from the first stage however, they start off with phase 4 (testing and refinement) and phase 5 (production ramp up). In other words, they have limited experiences in developing product from concept, which are essential experiences for them to develop their innovation capabilities.

On the other hand, the knowledge base attained by vendors is very low in defining major subsystem and interfaces. Defining major subsystem and interfaces include the definition of product architecture and the decomposition of product into subsystems and components (Ulrich and Eppinger, 2008). Their inability to define major subsystem and interfaces are due to their design and development focus, which is more on individual and assembled unit compared to complete system. In other words, in automotive industry, each automotive component is less separable from main body (Lee and Lim, 2001). Thus, vendors must have knowledge in ensuring the product developed nicely fit and form a functioning and manufacturability subsystem such as braking system. Product modularization as emphasized by local car manufacturers is still at an infant stage. For instance, Proton has only around 10 or lesser than 20 vendors, who have capabilities in producing complete system such as transmission system (Mohamad, 2008). These vendors have their own in house R&D and in terms of size, they are large companies with resources.

Defining major subsystem and interfaces is in the system level design and to be able to design system, companies need to conduct its own R&D. The ability to conduct R&D is one of the indicators of achievement of innovation capability. In addition to defining major subsystem and interfaces, the next lowest knowledge base attained by suppliers is refining industrial design. To enable vendors to refine industrial design, vendors must involve in the initial stage, which is product concept development. However, local vendors are given complete design of the component and they are required to follow the drawing as instructed by the customer. Nothing much could be done by the vendors as they are required to produce the components exactly according to customer requirement. Finally, the third lowest knowledge base indicated by vendors is the knowledge in product platform. Product platform is the set of assets shared across set of products and allow a derivative product to be created more rapidly and easily, with each product providing the features and functions that cater specific market segment. In practice, local vendors normally design and develop single component and if customer manufactures new model, even though the component is similar, different supplier is granted contract. This practice somehow hampers the ability of vendors to generate derivatives products, which is again a means for firm to develop their innovation capability.

The low or high knowledge bases in these three areas affect their intensity of effort or commitment to utilize the knowledge in workplace. The low commitment

in applying the knowledge bases are also pertaining to the three areas in vendors' knowledge bases; defining subsystem and interfaces that is under the system design level phase, refining industrial design, and product platform. These low commitment in applying the knowledge bases including life testing , which is outsourced to third party since most of vendors do no have their own testing facilities, industrial concept development that is related to industrial design refinement, and finally new technology assessments, which are important for product platform. The three knowledge bases which are least applied require vendors to be creative and innovative. Nevertheless, the high knowledge bases acquired by vendors in project management, product development performance measurement, and early production output evaluation are also reflected in the intensity of effort in applying the knowledge to solve problem by members of the organization such as project management in PDD, measuring product development performance, and cost benefit evaluation.

In terms of high knowledge base in product development tools, the findings also reflect that tools which are scored high are pertained to knowledge base in project management, FMEA and CAD. For instance, tool such as FMEA and CAD are used to measure product development performance. On the other hand, vendors attained low knowledge base in tools such as Taguchi, E-business and CAM application. Taguchi method determines which factors are controllable and which are not, and identify the optimal levels of controllable factors relative to the product performance. This method is to ensure the product has robust design and less likely to fail due to a change in the environment in which it is used. Vendors rated low in Taguchi method and sometimes product designed and developed by them in terms of quality and reliability is lower than the world class standard. Another tool is E-business. Majority of vendors depend on local market and business is done face to face. Investment in E-business is not considered critical to them due to constraint in their ability to export their products to global customers. Finally, CAM application is hardly used in designing and developing project because CAM is used more on process control rather than product.

The results have indicated that the high or low knowledge bases attained in PDD tools is also reflected to the level of commitment in applying them. There is a strong association between level of knowledge base and intensity of effort in applying the knowledge. Vendors absorption capability indicate that the high knowledge base on PDD knowledge and tools is more at lower stream or production compared to innovation while low knowledge base in the knowledge and tools reflects that vendors are lacking of capability in conducting innovation oriented tasks.

7. Conclusions

With due reference to the responding firms, the primary objective of this study is to determine the level of absorptive capacity among firms. The two components of absorptive capacity named firm's knowledge base and

intensity of efforts are measured descriptively. The results of the study indicated the level of manufacturers' knowledge base in product development design process was high in the project management, product development performance measurement, cost benefit analysis and early production output evaluation areas. In terms of companies' level of knowledge base in product development design tools, they have acquired knowledge related to ability to manage project involving product development and design, failure mode evaluation analysis, CAD application, basic operating and maintenance knowledge, and value analysis/ value engineering. In terms of the commitment levels of companies to apply the knowledge in product development design process and tools, the firms have demonstrated their effort in internalizing the knowledge base in product development design and tools, which they have attained. The findings showed that the knowledge base and commitment in applying the knowledge focused more on detail design phase up to production ramp-up however, they hardly focused on product concept phase, which required innovation. The implication of this study was manufacturers needed to be exposed to product development and design phases that required them to be more innovative such as product concept phase

References

Anon, 2003. Profile of the tomorrow supplier, *Report by Ernst and Young* LLP, 2003. 1-18.

Caloghirou, Y., Kastelli, I. and Tsakanikas, A., 2004. Internal capabilities and external knowledge sources: complements or substitutes for innovative performance? *Technovation*. 24(1): 29-39.

Cohen, W. M. and Levinthal, D. A. 1990. Absorptive Capacity: A New Perspective On Learning And Innovation. *Administrative Science Quarterly.* 35(1): 128.

Gambardella, A. 1992. Competitive advantages from in-house scientific research: The US pharmaceutical industry in the 1980s. *Research Policy.* 21(5): 391-407.

Gorman, M. E. 2002. Types of Knowledge and Their Roles in Technology Transfer. *Journal of Technology Transfer*. 27(3): 219-231.

Hertog, J. F. D. and Huizenga, E. 2000. *The knowledge enterprise implementation of intelligent business strategies*. London: Imperial College Press.

Heslop, L. A., McGregor, E. and Griffith, M. 2001. Development of a Technology Readiness Assessment Measure: The Cloverleaf Model of Technology Transfer. *Journal of Technology Transfer*. 26: 369-384.

Kim, L. 1997. *Imitation to innovation: the dynamics of Korea's Technological Learning*. Boston: Harvard Business Press.

Kim, L. 1999. Building technological capability for industrialisation analytical frameworks and Korea's experience. *Industrial and corporate change*. 8(1): 111-116.

Lee, K. and Lim, C. 2001. Technological regimes, catching up and leapfrogging: findings from the Korean industries. *Research Policy*. 30: 459-483.

Lundvall, B., A. and P. Nielsen,1999. Innovation as an Interactive Process: From User-Producer Interaction to the National Innovation System. *Review d' Economic Industrielle*. (88): 67-68.

Mohamad, N. 2008. Collaborative Product Development among Automotive Component Manufacturers in Malaysia, EngD Thesis, Universiti Teknologi Malaysia

Mowery, D. C., Oxley, J. E. and Silverman, B. S. 1996. Strategic Alliances and Interfirm Knowledge Transfer. *Strategic Management Journal* (1986-1998): 17(Winter Special Issue): 77-91.

Owens, J.D. 2007, "Why do some UK SMEs still find the implementation of a new product development process problematical? An exploratory investigation". *Management Decisions*, Vol.45, No.2, pp 235-251

Sekaran, U. 1998. *Research methods for business: A skill building approach.* 2nd edition. New York: John Wiley and Sons.

Simango, C.C.B. 2000. Corporate Strategy R and D and technology transfer in the European Pharmaceutical industry: research findings. *European Business Review*. 12(1): 28-33.

Ulrich, K.T and Eppinger, S.D. 2008. *Product Design and Development*, 4th ed., McGraw Hill: Boston