OPERATIONS AND SUPPLY CHAIN MANAGEMENT
Vol. 5, No. 1, January 2012, pp. 14-26
ISSN 1979-3561|EISSN 1979-3871

# An Exploratory Study on the Critical Success Factors for Design Capabilities Development

**Ana Sakura Zainal Abidin, Rasli Muslimen**
Department of Mechanical and Manufacturing Engineering,
Faculty of Engineering, Universiti Malaysia Sarawak, Sarawak, Malaysia
E-mail: anras_126@yahoo.com, rasna_126@hotmail.com

**Rosnah Mohd Yusuff, Norzima Zulkifli**
Department of Mechanical and Manufacturing Engineering,
Faculty of Engineering, Universiti Putra Malaysia, Selangor, Malaysia
E-mail: rosnah@eng.upm.edu, zimazul@yahoo.com

**Md. Yusof Ismail**
Faculty of Manufacturing Engineering, Universiti Malaysia Pahang, Pahang, Malaysia
E-mail: mdyusof@ump.edu.my

**Nooh Abu Bakar**
School of Graduate Studies, UTM International Campus, Jalan Semarak, Kuala Lumpur, Malaysia
E-mail: noohab@gmail.com

## Abstract

Involvement of suppliers in product development (PD) has made the process leaner and contribute significant impact on the quality, cost and time to market. The suppliers have major influence on the cost and quality of the products, since suppliers account for more than half of the total cost of production. The roles of suppliers have become more important especially those who are involved in PD. The suppliers are able to improve business performance results, productivity, and reputation, thus increasing companies' competitive advantage. To be successful in PD requires certain level of design capabilities (DC), thus huge investment is needed. However, Malaysian automotive market size is considered small and vendors' capabilities are also limited. Since, studies on vendors' DC, particularly, in Malaysia are very limited. An empirical study was conducted to explore on the critical success factors (CSFs) in enhancing vendors DC for Malaysian automotive industry. A series of interviews were conducted on selected automaker and vendors to identify critical success factors (CSFs) that are able to enhance the DC development for Malaysian vendors. There are 10 significant CSFs have been highlighted namely human resource, technology and tools, established processes, financial, culture, technical assistance, prospect market, proximity, top management and focus. The identified CSFs will be considered in developing model of DC development for Malaysian automotive vendors.

**Keywords**: *Vendors, design capabilities (DC), critical success factors (CSFs), Malaysian automotive industry*

## 1. Introduction

The increasing population and living standards have improved buying power, thus increasing market demand. Simultaneously, materials consumption for manufacturing activities also increased. For instance, crude steel production in 1950 was 200 million metric tons and the production tremendously reached six times higher in year 2000 (Chryssolouris et al. 2008). All finite reserves are limited and are gradually decreasing. As a result, when the demand is higher

than production, the price will be higher too. Therefore, manufacturers have to find ways to produce more with less. The issues have urged manufacturers to improve, in all aspects of their apparatus. Many companies have managed to improve their competitiveness via manufacturing productivity improvement technology (Yahaya 2008) like Lean Manufacturing (LM), Quality Assurance (QA), Total Quality Management (TQM), Total Preventive Maintenance (TPM). However, stringent competition has pushed manufacturers to move beyond these, which is up to the product development (PD) stage (Morgan and Liker 2006).

PD has been identified as top three areas that received higher concern from organization to be world-class organization (Goetsch and Davis 2010). The success of PD depends on the level of design capabilities (DC) owned by a company. Currently, manufacturers started to realize the benefits of improving DC as a strategic means of improving business performance. Many researchers found that PD is very important as any decisions made during the PD stage have greater impact on every part of the organization (Stevenson 2009). The process of PD offers maximum fluidity and allows for maximum possible option of changes with minimum risk and cost, before reached to manufacturing stage (Dieter 2000). As the process continues, any changes would cost more and difficult to make (Dieter 2000; Handfield et al. 1999; Morgan and Liker 2006). Improved PD is able to fulfil customers' needs (Handfield and Bechtel 2002; Morgan and Liker 2006), reduce time to market (Afonso et al. 2008), optimize resources used and cost (Afonso et al. 2008; Jilan 2009; Morgan and Liker 2006; Wagner and Hoegl 2006), improve manufacturing processes and simultaneously improve product quality (Afonso et al. 2008). Indirectly the improved process also improves the business performance (Morgan and Liker 2006). Furthermore, to sustain in business, a company must have a product differentiation strategy that can only be gained through DC (Yahaya 2008). DC is a key feature to distinguish successful business (Schiele 2006) and to pursue competitive advantage and sustainability (Stevenson 2009; Townsend et al. 2010).Therefore, improved PD is the correct business strategy (Stevenson 2009) reaching the company's success in marketplace. The benefits of PD are doubtless. Therefore improving the DC will enable tremendous return to the company.

Improved PD also improves the process itself (Handfield et al. 1999) and minimizes risks as it integrates every department including supplier and customers in advance (Dieter 2000; Handfield and Lawson 2007). A car requires for more than 20 000 parts (Oh and Rhee 2008), it is impossible to be manufactured by the automaker alone. Suppliers account for a big amount of the total cost production; over half (Handfield et al. 1999); more than 60% (Oh and Rhee 2008); about 75% (Abdullah et al. 2008). The products supplied by suppliers have direct impact on cost, quality, technology and time to market of new products (Handfield et al. 1999); influence on final price and quality of the product (Oh and Rhee 2008). Previous practices showed that automakers had dominant roles in PD stages. However, to improve the process, those important roles have now been outsourced to suppliers (Doran 2005; Oh and Rhee 2008). Outsourcing level is different between countries as European automakers outsource 50-60% and Japanese automakers are higher than that which is 70-75% of parts and assemblies (Lettice et al. 2010). To date, collaboration between buyers and suppliers is vital in PD, thus supplier involvement in PD (SIPD) is widely practice in automotive industries.

The advantages of the collaboration are remarkable. The collaboration has shortened the duration of PD. Since a car can be segregated to a number of suppliers for different modules and systems. Thus, enables the PD to be run simultaneously. The product quality is improved as the job is awarded to the specific suppliers who know their manufacturing capability and owned the expertise as well. The buyer also can reduce cost of technology investment as it is a practical way to have innovative technology with minimum technological risk by sharing with suppliers (Wagner and Hoegl 2006). Consequently the risk is minimized when costs are shared with suppliers. Automakers also can focus on their core competencies when fewer parts were done in-house (Dieter 2000).

The success of collaboration strongly relies on the relationship between both parties' (Bennett and Klug 2009). Suppliers have been identified as one of the important resources to the automakers

(Handfield et al. 1999); source of innovation (Lettice et al. 2010) and become a competitive advantage to the company (Krause and Handfield 2007; Oh and Rhee 2008). Early suppliers' involvement has significant impact on the products performance; cost, quality, technology (Cousins et al. 2011; Handfield et al. 1999); and project performance as well as time to market (Handfield and Lawson 2007). Simultaneously, these enable automakers to monitor suppliers in advance. This is to ensure quality parts are produced since quality of the parts obtained from suppliers collectively determine the final quality of the product (Binder 2008). When suppliers' roles become more important, their responsibility also gets bigger. The automakers defined the goals and owned ultimate authority towards the success of the goals, meanwhile suppliers will assist on the goals achievement (Handfield and Lawson 2007). Therefore suppliers also need to have sufficient level of DC to support the success of collaboration (Cousins et al. 2011).

Lack of studies conducted on suppliers' development program since prior studies were biased on the manufacturer (Lettice et al. 2010; Oh and Rhee 2008). Even recently, there are some activities exist in Malaysia but very little documentation recorded (Abdullah et al. 2008). In Malaysia, suppliers development planning is more crucial compared to manufacturer since most of them are small medium enterprises (SMEs) and have limited capabilities (Mohamad 2008; Othman 2006; Wad and Govindaraju 2011). The problems become severe in automotive industry, as high technology-based industry involve sophisticated and expensive technology (Wad 2008). DC development itself is a critical process since there are many related stringent components and issues influencing the development strategy. The scenario has urged this study to be conducted with the aim to form a model that is able to assist on DC development for suppliers. The model development begins with exploration of critical success factors (CSFs). The significant CSFs addressed are to ensure the model to be able to fulfil the needs and finally determine the success of the model. In this paper, the authors reported on the identification of CSFs towards DC development based on Malaysia automotive industry.

## 2. Malaysian Automotive Industry

The first Malaysian national automaker, Perusahaan Otomobil Nasional (Proton) was set up in 1983. Proton is fully owned by Malaysian. Therefore, the Malaysian government has strong voice in Proton decision-making. The Malaysian government has implemented rules and policies to secure the local companies in automotive industry. For instance, Localization Policies, Mandatory Deletion Items (MDI), Local Material Content Program (LMCP) and National Automotive Policy (NAP) were introduced to ensure certain percentage of the vehicle manufacture in Malaysia is using local content (Abdullah et al. 2008; Mohamad 2008; Wad and Govindaraju 2011). All policies and rules are applicable to automakers and vendors operating in Malaysia (automotive suppliers are known as vendors in Malaysia). In Malaysia, vendors have different definitions based on their status. According to Malaysian Companies Commission (SSM), a local company is defined as a company registered and operated in Malaysia. The local companies can be divided into three categories; Bumiputra, non-Bumiputra or foreign. Bumiputra represents ethno-majority of prime ethnic Malays (Wad and Govindaraju 2011) and other indigenous ethnic groups in Malaysia (SRM 2005). The majority share (>50%) will determine the status of the company. Hence, the actual Malaysian vendors are those from Bumiputra and non-Bumiputra companies.

Half of the Malaysian vendors solely supply to Proton (Mohamad 2008), with 62.7% of them are SME (MITI 2004). However, in terms of market share, the majority goes to non-SME (Mohamad 2008) especially for high technology-based parts, since SMEs vendors have limited capabilities (Rosli and Kari 2008). Although Malaysia has developed the localization program, many Malaysian vendors were still left behind. During the *Waja* project, Proton had outsourced 17 modules to 19 vendors with 93.3% of them are non-SME (Mohamad 2008) which also represent non-Malaysian vendors. If the situation persists, the Malaysian vendors will not be able to compete, especially with the Asia Free Trade Agreement (AFTA) where they have to compete in the open market fairly with other foreign vendors.

Nowadays, the relationship pattern between buyer-supplier experienced change. Proton has also

followed the trend. Suppliers' responsibilities have to go beyond manufacturing that also include design, development and engineering of components (Abdullah et al. 2008). Even today, automakers expect vendors to provide more complete system rather than individual components (Mohamad 2008) that only can be achieved through sufficient level of capabilities. Therefore, the only potential solution is to have DC. DC can be the companies' competitive advantage (Handfield et al. 1999; Teece 2007; Trappey and Hsiao 2008), enables the company to stand independently and leading the industry (Sturgeon and Biesebroeck 2010). DC is identified as capability that dynamically keeps a company able to sustain towards any challenge (Teece 2007). DC is the strategic ability to favour customers' needs, always increasing the market demand and brings in more profit (Morgan and Liker 2006). DC enables the vendors to determine the price of the product and the ability to design allows them to design according to customers' target prices (Afonso et al. 2008; De Toni and Nassimbeni 2001). The capabilities also facilitate the vendors to scale up business volume (Oh and Rhee 2008) and allow them to create more businesses. Consequently, these will improve their status to be Original Design Manufacturer (ODM) (Oh and Rhee 2008). Therefore, DC can be a strategic weapon to face AFTA or even global competition.

Unfortunately, not many Malaysian vendors own the DC. Even those who have the capabilities are still in-complete, either not up to date with current technology roadmap or without testing facilities (Abdullah et al. 2008). Without sufficient capabilities, the vendors are not able to run the process effectively. The vendors solely depend on external support like technical assistance (TA) to assist the development (Krause and Handfield 2007). To develop DC with limited resources among Malaysian vendors is really a great challenge which requires proper planning and strategy.

## 3. Identification of Relevant CSFs

The CSFs for DC were gathered from prior research conducted in Malaysia and other countries. There were limited studies conducted in Malaysia especially in automotive PD. Therefore, most of the CSFs mentioned were taken from abroad research works and need for careful selection and judgement based on suitability toward Malaysia scenario.

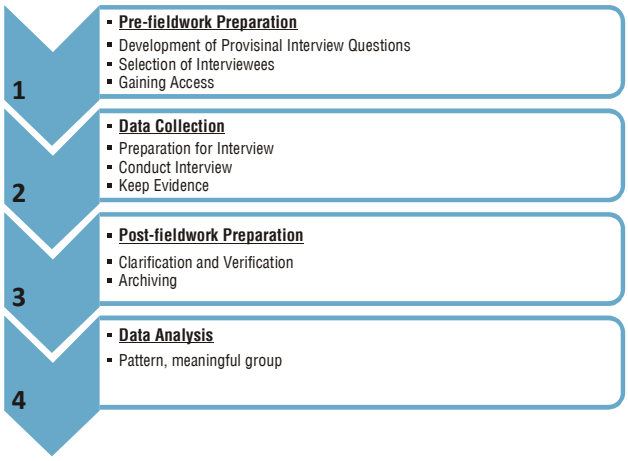
The success of DC development relies on the integration of tangible and intangible factors like, management aspect, decision-making process, technical capabilities, manpower and culture as well. Some samples of DC elements highlighted are from previous researchers such as detailed engineering design process as modelled by Priest and Sanchez (2001). The success of lean PD has integrated three important elements of PD namely process, man and technology (Morgan and Liker 2006). There are also important management issues influencing the new PD decision-making process namely strategic new PD management issues, new PD project management issues, new PD process and structural issues and NPD people management issues (Yahaya and Bakar 2007a) and also many other technologies and tools of PD are highlighted as well. The factors highlighted can be grouped into 12 categories namely *top management commitment and support, financial capability, established processes, manpower, technology and tools, external support, business performance results, market size, proximity, relationship, organization structure and culture* as reported by authors in Abidin et al. (2010).

Basically, the CSFs can be divided into two main groups; first, specific to PD itself and second, other related factors that have indirect influence towards success of the PD. For the first category, there are components of PD like process, manpower, technology and tools to run the PD. The rest of the factors are fall under the influential factors. Some factors have been addressed frequently by different authors that show strong important factors such as process, manpower, technology and tools and business performance results (BPR). Some factors only get a little attention. However, it seems that the factors have some significant values to this research based on the similar environment and nature of industry, in which the author will have to consider the factors.

## 4. Methodology

Multiple case studies via in-depth interviews were employed. Objectives of the interview are to investigate on existing of design activities, to examine

***Figure 1.*** *Flow of interview process*




benefits gained through DC and also identify significant CSFs that able to enhance the DC development for Malaysian vendors. This is an appropriate approach for this study, as there are limited studies conducted on the supplier DC. In-depth interview is able to explore on the actual scenario and latest progress which occur in the industry (Enkel and Gassmann 2010; Kotabe et al. 2007). Since identification of DC for Malaysian automotive vendors involved with many components and issues, thus make it complex and qualitative approach enable significant comprehensive identification and explanation of study (Townsend et al. 2010). The flow of the interview process adapted from (Yahaya 2008) is shown in Figure 1.

During pre-fieldwork preparation, the instruments of this study have been developed from literature review. The prior researches give overview of design activities among the vendors and collaboration of PD between automaker and vendors; thus are used to structure the interview questions. All companies were given the same set of questions, to ensure the consistency between interviews. At the same time, all questions developed were open-ended type, allowing for ample flexibility to explore new findings.

In this study, the respondents are active Malaysian vendors who are tier-1 Proton vendors. There are five established automotive companies from different categories chosen. Diverse set of company categories enable the study to obtain richer ideas and insight from practitioners (Kotabe et al. 2007). Generally, all of the chosen companies are already involved in the design process but they have different roles and different level of capabilities. The interviewees companies' profiles are shown in Table 1.

The interviews involved 11 experts for six interview sessions and the average time taken for each session was about two and half hours ($2^1/_2$ hours). Arrangements for the interview session were

***Table 1.*** *Interviewees' profiles*

| Interviewee | Interviewee Position | Company Status | DC Level | Product |
|---|---|---|---|---|
| PTN A | Section Manager of Strategic Supplier Management | Malaysian OEM | Established whole package of DC | Passenger Car |
| PTN B | Section Manager of Vendor Management Development | | | |
| PTN C | General Manager of Engineering Division | | | |
| PTN D | Head of Product Service Engineering | | | |
| MZ | Manager of Tooling | OEM-subsidiary | World-class DC and aligned with customers' technology | Dies design (engineering and manufacturing), moulds (design and engineering) and stamping |
| DN A | Manager of Engineering Department Foreign-vendor | (73% share owned by parent company | Sufficient DC to conduct in-house design and supported by other branches for testing facilities | Instrument cluster, engine management system, air conditioning system, radiator starter and alternator |
| DN B | Assistant Manager of Engineering Department | | | |
| IG A | Senior Manager of Group R&D | Bumiputra-vendor | Sufficient DC to conduct in-house design and hire consultant for advance analysis software and testing equipments | Sealing system, door module, impact system, exhaust system, under body module, heat management |
| IG B | Assistant Manager of Group Sales & Project | | | |
| IG C | Executive of NPD, Group R&D | | | |
| DL | Senior Manager of R&D Dept. | Non-bumiputra Vendor | Full-range DC and qualified for "Design-in Vendor" by customers | Rear view mirror, power window, column switch, plastic trims and locking systems. |

set earlier, to ensure availability of the interviewees. The objectives of the interview and questions for interview session were given in advance to interviewees via e-mail. The interviews were conducted face-to-face, at least one or maximum three personnel per session. The sessions were recorded and transcribed, to ensure the reliability and traceability of information (Binder 2008). In addition, each transcript, once completed was sent to respective interviewees for content validation. Interviewees responded on any mistaken information, improved and clarified to ensure the validity and reliability of the information (Binder 2008). Interview transcripts were analyzed; direct and indirect answers were determined, those answers that had similar meanings were grouped together. The most appropriate terminologies were used to represent the groups. Repetitive answers or the most frequent answers highlighted between interviews were identified, to show most significant CSFs. However, answers that had least popularity were also considered in this study as long as the points were important or incorporated with prior research.

## 5. Findings and Discussion

The findings and discussion are based on series of interview conducted, as reported in Section 4. Throughout the interview sessions, all of them agree that DC has contributed significant benefits to the company. Besides that they agree that the companies' role affect on how the benefits are significant to them. Those vendors who own the capabilities received a direct impact on their business performance such as bigger market created, improved PD process and product quality, reduced time and production cost, gained trust and confident from customers, knowledge and skills enhancement. Meanwhile, the OEM or buyers also benefited from the vendors' capabilities improvement especially on the final product quality, production cost and development process. The benefits voiced by interviewees are summarized in Table 2.

The interviewees were requested to identify the important CSFs based on their experience and knowledge. There are two ways on how the CSFs were gathered; from direct question and indirect questions. The CSFs can be grouped into 10

***Table 2. Benefits of vendors owned DC based on the companies roles in PD***

| Company | Status/ Role | Benefits of vendors owned design capabilities |
|---|---|---|
| PTN | OEM | - Reduced number of Proton's employees allocated for each project,<br>- Received technology transfer from expert vendors. |
| PTN | OEM | - Shortened development time.<br>- Produce quality products.<br>- Minimize risks of failure.<br>- Sometime, it is economical to outsource rather than developing own capability. |
| MZ | Subsidiary -vendor/ Grey Box | - Development of local capabilities on high degree of precision and accuracy of dies,<br>- Localized dies production.<br>- Product cost reduction. |
| DN | Foreign-vendor/ Black Box | - Trust from customers.<br>- Improved time development.<br>- Able to give immediate feedback.<br>- Better understanding on customers' needs (especially Malaysian customers).<br>- Gained trust and confidence from the parent company. |
| IG | Bumiputra-vendor/ Grey Box | - Immediate decision making.-Cut down cost especially on technical assistance fee (about 40% and more).<br>- Able to fulfil customers' needs.<br>- Better understanding from PD experience.<br>- Expand knowledge through hands on experience.<br>- Able to work independently.<br>- Improved products manufacturability. |
| DL | Non-Bumiputra/ Black Box | - Received more projects from customers. |

categories as shown in Table 3. The description or details of categories are according to the answers given by interviewees. All the CSFs mentioned have direct and indirect influence towards vendors' DC. In addition, those CSFs are also interrelated to each other. For instance is the working culture has a direct influence on human resource skill, experience and knowledge level. Positive working culture is able to develop quality employees, that results on continuous improvement process since skills and knowledgeable workers are able to optimize technology and tools used, finally improving the business performance results.

"X" is marked for each interview session that mentioned the similar meaning factor. The rank of CSFs is shown by the mean of frequency answers mentioned by the interviewees. The technical assistant (TA) is identified as the most critical factor, followed by financial capabilities, human resource, technology and tools, meanwhile top management, culture, prospect market and proximity have carried equal important factors, established processes and finally focus in business. The CSFs are collectively discussed based on the details of interview sessions in the following sub-topics.

### a. Technical assistant (Table 3, item 6)

The most frequent answer gathered from every session is receiving technical assistant (TA) like joint venture activities and technical partner from established companies or parent company. This point is strongly important in Malaysia automotive industry due to several reasons. According to MZ, automotive is a high technology industry and the involvement in this industry is considered as new compared to other established automakers. Therefore, it is important

***Table 3.*** *CSFs for Malaysian vendors DC development*

| CSFs | Description | VE | GP | MZ | DN | IG | DL | (%) | Mean |
|---|---|---|---|---|---|---|---|---|---|
| 1. Human Resource | a. Skillful | X | | | | X | | 0.33 | 0.55 |
| | b. Experience | X | X | X | X | | X | 0.83 | |
| | c. Technical knowledge | X | | | X | X | | 0.50 | |
| 2. Technology & Tools | a. Facility (e.g laboratory, prototype, testing) | X | X | X | | X | X | 0.83 | 0.40 |
| | b. PDCA (Tools) | | | | X | | | 0.17 | |
| | c. Reverse Engineering (Tools ) | | | | | X | | 0.17 | |
| | d. Computer software (e.g CAD/CAE/CAM) | X | | | X | X | X | 0.67 | |
| | e. VA/ VE (tools) | X | X | | X | | X | 0.67 | |
| | f. Database; drawings and standards | | | | X | | | 0.17 | |
| | g. Aligned technology used | | | X | | | | 0.17 | |
| 3. Established Processes | a.ISO certification | X | | X | | | | 0.33 | 0.26 |
| | b. Quality Engineering (APQP) | | | X | | | | 0.17 | |
| | c. Customers involvement | | | X | | | | 0.17 | |
| | d. Employee development program | | | X | X | X | | 0.50 | |
| | e. More attention on planning | | | | X | | | 0.17 | |
| | f. Standard PD processes | | | X | X | | | 0.33 | |
| | g. SIPD | | | X | | | | 0.17 | |
| 4. Financial | a.I nvestment | X | X | X | | X | X | 0.83 | 0.83 |
| 5. Culture | a. Positive culture: hardworking, teamwork | | X | X | X | | | 0.50 | 0.33 |
| | b. Spiritual belief " working is ibadah" | | | | | X | | 0.17 | |
| 6. TA | a. Joint venture/ partner/parent | X | X | X | X | X | X | 1.00 | 1.00 |
| 7. Prospect Market | a. To attract foreign investee/partner | | | X | | | | 0.17 | 0.33 |
| | b. Decision on facilities investment | | | | X | X | X | 0.50 | |
| 8. Proximity | a. Better communication and integration | | X | X | | | 0.33 | 0.33 | |
| 9. Top Management | a. Technical background | | | X | | | 0.17 | 0.33 | |
| | b. Commitment | | X | | | X | X | 0.50 | |
| 10.Focus | a. Focus in business | | X | | | | | 0.17 | 0.17 |

for Malaysian vendors to have assistance from reputable partners since TA is able to shorten the learning process, minimize mistakes and optimize the use of resources. GP also agrees that TA is the fastest way to receive the technology transfer from established experts. DL needs TA to support them to adopt new technology. In addition, IG has different reasons about the importance of having TA. During their early involvement in auto industry, TA enabled them to gain confident and trust from buyer. Gradually they became independent and were able to run on their own. Even today IG also been appointed to be TA for an automotive vendor in India, and recently the company has successfully received "Best Vendor Achievement for Design and Development" award from Maruti groups. Indirectly, it shows that through proper technical collaboration, the company is effectively able to gain the technology within short time and expend the knowledge to higher level. Meanwhile, DN as a Malaysian foreign-vendor has received solid TA from parent (Japan) and other branches as well. DN has also received technical experts from Japan headquarters to guide and assist local engineers especially in Engineering Department; standardize processes; training for new engineers conducted in Japan (headquarters) or at other group company training centre; shared standard and drawing database with other branches; laboratory and testing facilities supported by other branches to ensure the quality design produced as perceived. As a result, DN products are recognized as number one (1) in Malaysia and number two (2) for the whole world level.

### b. Financial capabilities (Table 3, item 4)

The majority of interviewees (83%) think financial capabilities are the most critical factor to success in design. This is due to the importance of the capabilities that have direct influence on design components development, namely human resources, technology and tools, and TA. In addition, the automotive is a high technology industry and require for big investment. According to GP, most of Malaysian vendors have limited financial capabilities, consequently bound their technology development. In addition, MZ highlight that it is difficult to convince Malaysia Bank for loans, due to lack of understanding from public society about the technology, bigger amount of money involved and higher risk faced. Besides, Malaysia automotive market size is considered as small, thus unfavorable on investment decision.

### c. Human resources (Table 3, item 1)

Interviewees commonly agree on this point, since human resources receive the highest attention for design capabilities components. Human resources based on interviewees' point of views are defined as employees who own individual skills to handle relevant tools, sufficient level of technical knowledge background and well experienced to be able to influence their judgment on decision-making during PD process. DL identifies the human resources as one of core capabilities to their R&D activities. Currently, Malaysia's automotive industries are facing serious problems on this matter. One of the crucial barriers to Malaysia DC development is the difficulties to retain experienced workers. There are some related issues to the matter identified, namely low salary, lack of incentives and culture. Companies have spent big amount of money to train employees and expect them to serve the companies in return. However, every time experience workers run away, companies have to recruit new staffs, train and guide them again. Definitely the staffs need some time to groom. Surprisingly, IG has the lowest record of resignation level compared to the other vendors. IG successfully manages to take care of their employees' needs and has developed positive working culture in the company.

### d. Technology and tools (Table 3, item 2)

There is bigger area covered under this category that includes the facilities, computer software, databases that have similar function to library (which consist a collection of drawings and standards to facilitate new PD) and finally the technology and tools used have to be aligned with customers. Technology and tools are important to support PD activities. DL identifies the technology and tools as core component of design capabilities. MZ and DN agree that appropriate technology and tools used like PDCA and APQP are able to determine end-quality of products. Unfortunately, the financial capability has restricted most of local vendors' ability to have a full range of equipment. However, it is a mandatory requirement from OEM that any new design proposed has to be

tested. Therefore, IG has to hire certified consultant to do certain testing works for them. Even it is costly, but is still considerable rather than investing on high cost testing equipment but seldom used (due to the small market size in Malaysia). Meanwhile, DN (foreign-vendor) does not have in-house testing facilities and if necessary, DN will utilize testing facilities at other branches or headquarters. Furthermore, it is important to ensure the technology and tools used by vendors to be aligned with the buyers especially those who are involved in PD (SIPD). Regarding ED's experience, aligned technology, for instance, computer software is able to ensure effective communication and accurate data transfer.

### e. Top management (Table 3, item 9)

The top management plays an important role towards DC development. Since, the DC which is involved with big investment makes it to rely heavily on the top management commitment and support to ease the development planning. DL's main challenge during initial stage to set up DC is to convince top management for financial approval. Meanwhile, IG receives a full commitment from top when a specific amount of their annual profit was allocated for R&D activities. GP has concluded that the top management commitment reflects on the allocation or investment on R & D activities.

### f. Culture (Table 3, item 5)

Culture is a soft element and less tangible. Positive working cultures shown by employees are identified as associated factor to quality human resource (refer to 3.c). Those vendors (MZ, DN and IG) who have parent company or TA from Japan prefer to send their staff for training in Japan. Aside from receiving technical knowledge, they are also exposed to Japanese culture and indirectly build Japanese' positive working culture among local employees. Furthermore, IG (refer to the prior discussion on 3.c) has developed their culture based on Islamic principal.

### g. Prospect market (Table 3, item 7)

In Malaysia, the context of market size is a serious issue. The majority of interviewees agree that DC development requires huge investment. MZ mentions that the prospect market has significant influence in the decision for facilities investment. According to IG, Malaysia has a smaller market, thus restricting the development. Therefore, it is important to create a secured market from the local OEM and penetrate overseas market to ensure the return of investment allocated.

### h. Proximity (Table 3, item 8)

According to MZ and DN, proximity is important for better communication and integration. The nature of automotive industry involved with thousands of components, high precision and complex technology really need frequent face-to-face communication, especially when the current trend of PD in Malaysia is using concurrent engineering and some portions of car design are also outsourced to vendors make the proximity factor to become more stringent. On the contrary, ED has an opposite opinion; the distance is no longer crucial as today's modern IT and communication tools has closed the gap. Contradicting responses on this factor require further investigation to confirm on this CSF.

### i. Established processes (Table 3, item 3)

VE, MZ and DN agree that standardized PD processes is an important CSF. Well-established process can be evaluated or audited periodically through ISO certification like ISO/TS 16949 or ISO 9001:2008 for continuous improvement. Furthermore, some customers have made ISO certification as one of pre-requisite criteria for vendors before being selected for project awarded.

### j. Focus (Table 3, item 10)

The focus in business is only aroused by GP since they have been involved directly to manage Proton vendors. This factor has become severe to them. One of the vendors failure reason noticed is due to lack of focus in business. Vendors are supposed to have simultaneous progress with OEM and put the effort on expanding their automotive business. However, some of them have diversified the profit gained by investing in other business. Therefore, a part of R&D budget has been taken away. As a result, the companies' performances are left behind due to insufficient financial support.

Findings from interview enable authors to determine significant CSFs according to Malaysian automotive scenario. The identified CSFs are then

***Table 4.*** ***Refined CSFs from literature and interviews.***

| CRITERIA | Abbreviation | ELEMENTS |
|---|---|---|
| Business Performance Results (BPR) | K&E | expand knowledge and experience |
| | SP | specialize on product |
| | Trust | good relationship |
| | QCD | quality, cost, delivery |
| | Sales | increase sales |
| | Market | export/bigger market |
| | Time | improve development time |
| | Customers | meet customers' needs |
| | Efficiency | improve efficiency: process, manufacturability |
| | Innovation | Innovation |
| | Technology | technology mastery |
| Top Management (Top) | Commitment | Commitment in PD activities |
| | Planning | strategic management planning |
| Structured Organization (Organization) | Ver&Hor | managing network vertical and horizontal |
| | Team | project team based |
| | Multi | multiple disciplinary background |
| Financial | Capability | financial capability |
| | Allocation | resources allocation |
| Established Process (Process) | Needs | determine customers' needs |
| | PD | front-load PD |
| | St.PDFlow | standardization PD process flow |
| | St.Design | utilize design standardization |
| | St.Manufacture | standardization manufacturing processes |
| | St.Skill | standardization manpower skill set |
| | Decision | decision making process |
| | CPI | continuous process improvement |
| | SIPD | supplier involvement in product development |
| | Communication | communication |
| | IP | IP agreement |
| | Secrecy | secrecy agreement |
| | Ximitate | protection against imitation |
| | Roadmap | matching technology roadmap |
| | Risk | weighing risk |
| | Contingency | contingency plan |
| | HRDev. | human resource development |
| | ISO | ISO certification |
| Human Resources (HR) | Integrator | system integrator |
| | Team | cross functional integrated team |
| | R&Eng | researchers and engineers |
| | Specialize | specialization |
| | Experience | experience |
| | Knowledge | knowledgeable |
| | Skill | skillful |
| Technology and tools (T&T) | Facility | Facilities: laboratory, prototype, testing |
| | IT&Net | IT & networking system |
| | Software | computer software:CAD/CAM/CAE |
| | AlignTech | alignment of technology roadmap |
| | Tool | Tools: QFD,VA/VE, |
| | Database | Database: drawing, standards |
| External support (Support) | Parent | parent company |
| | TA | Technical Assistance |
| | Buyer | buyer |
| | Gov. | government |
| Culture | Positive | Positive working culture |
| | AlignCul | alignment of culture |
| Close Distance | Proximity | close to OEM |
| Prospect Market | Secure | secure market |
| | Bigger | bigger market |

compared with CSFs gathered from literature. After in-depth consideration based on relevant of local scenario and future development of PD the CSFs are then refined and can be summarised as shown in Table 4. Likely, the CSFs from in-depth interview and literature findings incorporate each other.

## 6. Conclusion and Further Research

As a conclusion, the existing of DC among Malaysian vendors was identified and also brings significant influence towards company's business performance results. The Malaysian automotive strategy in developing DC is the exact action that will enhance their capability to compete beyond domestic market (Goetsch and Davis 2010). DC enables the vendors to improve business performance results via product quality improvement, process improvement, customer-buyer relationship improvement, knowledge and skills improvement, cost reduction and business expansion. High quality products without doubt can be accepted by buyers to meet high export standard of customers' satisfaction. That will enable them to penetrate bigger overseas market. In the mean time, it is difficult to compete with global automotive companies. It is advantage if the company is able to offer high quality product with competitive price and innovative product. Thus, DC has been identified as source of innovation. Towards bringing Malaysian automotive industry to international arena, the automotive players need to focus on developing bio technology (Wad and Govindaraju 2011), which is only can be achieved with sufficient level of R&D and DC. Therefore, the strategy in developing DC among Malaysian automotive vendors is not only able to expand market but also sustaining the business. For future work, the identified CSFs from this finding will be considered for developing DC development framework. The framework is expected able to enhance DC development for Malaysian automotive vendors.

## References

Abdullah, R., Lall, M. K., and Tatsuo, K. (2008), Supplier Development Framework in the Malaysian Automotive Industry: Proton's Experience. *Int. Journal of Economics and Management*, 2(1), pp. 29-58.

Afonso, P., Nenus, M., Paisana, A., and Braga, A. (2008), The Influence of Time to Market and Target Costing in the New Product Development Success. *International Journal Production Economics*, 115, pp. 559-568.

Bennett, D., and Klug, F. (2009), Automotive Supplier Integration from Automotive Supplier Community to Modular Consortium. *14th Annual Logistics Research Network Conference,* Cardiff, pp. 698-705.

Binder, M. (2008). The importance of collaborative frontloading in automotive supply networks. *Journal of Manufacturing Technology Management*, 19 (3), pp. 315-331.

Chryssolouris, G., Papakostas, N., and Mavrikios, D. (2008), A Perspective on Manufacturing Strategy: Produce more with less. *CIRP Journal of Manufacturing Science and Technology*, 1(2008), pp. 45-52.

Cousins, P. D., Lawson, B., Petersen, K. J., and Handfield, R. B. (2011), Breakthrough Scanning, Supplier Knowledge Exchange, and New Product Development Performance. *Journal of Product Innovation Management*, 28(6), pp. 930-942.

De Toni, A., and Nassimbeni, G. (2001), A method for the evaluation of suppliers' co-design effort. *International Journal of Production Economics*, 72(2), pp. 169-180.

Dieter, G. E. (2000), *Engineering Design-A Materials and Processing Approach*, McGraXw-Hill International Editions.

Doran, D. (2005), Supplying on a modular basis: An examination of strategic issues. *International Journal of Physical Distribution and Logistics Management*, 35(9), pp. 654-663.

Enkel, E., and Gassmann, O. (2010), Creative imitation: exploring the case of cross-industry innovation. *R&D Management*, 40(3), pp. 256-270.

Goetsch, D. L., and Davis, S. B. (2010), *Quality Management for Organizational Excellence: Introduction to Total Quality*, Pearson Education, New Jersey, USA.

Handfield, R. B., and Bechtel, C. (2002), The role of trust and relationship structure in improving supply chain responsiveness. *Industrial Marketing Management*, 31, pp. 367-382.

Handfield, R. B., and Lawson, B. (2007), Integrating suppliers into new product development. Industrial Research Institute

Handfield, R. B., Ragatz, G. L., Petersen, K. J., and Monczka, R. M. (1999), Involving Suppliers in New Product Development. *California Management Review*, 42(1), pp. 59-82.

Jilan, A. Z. (2009), Tempoh 18 bulan bangunkan Exora. *Utusan Malaysia, Utusan Publication*, Kuala Lumpur.

Kotabe, M., Parente, R., and Murray, J. Y. (2007), Antecedents and outcomes of modular production in the Brazilian automobile industry: a grounded theory approach. *Journal of International Business Studies* 38, pp. 84-106.

Krause, D. R., and Handfield, R. B. (2007), The relationships between supplier development, commitment, social capital accumulation and performance improvement. *Journal of Operation Management*, 25(2), pp. 528-545.

Lettice, F., Wyatt, C., and Evans, S. (2010), Buyer-supplier partnerships during product design and development in the global automotive sector: Who invests, in what and when? *International Journal of Production Economics*, 127(2), pp. 309-319.

MITI. (2004), Signing Ceremony of MOU between SMIDEC, AFM, JAMA & JAPIA on the Technical Experts Programme for the Automotive Industry. MITI, Kuala Lumpur, pp. 1-5.

Mohamad, N. (2008), Parts Suppliers Involvement in Customer's Product Development Activities (PhD Thesis), Universiti Teknologi Malaysia.

Morgan, J. M., and Liker, J. (2006), *The Toyota Product Development System: Integrating People, Process, and Technology*, Productivity Press, New York.

Oh, J., and Rhee, S. K. (2008), The influence of supplier capabilities and technology uncertainty on manufacturer-supplier collaboration: A study of the Korean automotive industry. *International Journal of Operations and Production Management*, 28(6), pp. 490-517.

Othman, S. N. (2006), Transfer and Development of Firm Technological Capability among Automotive Component Manufacturers in Malaysia (PhD Thesis), Universiti Teknologi Malaysia, Kuala Lumpur, Malaysia.

Rosli, M., and Kari, F. (2008), Malaysia's national automotive policy and the performance of proton's foreign and local vendors. *Asia Pacific Business Review*, 14(1), pp. 103-118.

Schiele, H. (2006), How to distinguish innovative suppliers? Identifying innovative suppliers as new task for purchasing. *Industrial Marketing Management*, 35(8), pp. 925-935.

SRM. (2005), Doing Business in Malaysia: Maritime Defence and Security; Marine Related Industries. Sea Resources Management.

Stevenson, W. J. (2009), *Operations Management, Tenth Edition*, McGraw Hill

Sturgeon, T. J., and Biesebroeck, J. V. (2010), Effects of the Crisis on the Automotive Industry in Developing Countries: A Global Value Chain Perspective. The World Bank, Developing Countries, pp. 1-31.

Teece, D. J. (2007), Explicating dynamic capabilities:The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), pp. 1319-1350.

Townsend, J. D., Cavusgil, S. T., and Baba, M. L. (2010), Global Integration of Brands and New Product Development at General Motors. *Journal of Product Innovation Management*, 27(1), pp. 49-65.

Trappey, A. J. C., and Hsiao, D. W. (2008), Applying collaborative design and modularized assembly for automotive ODM supply chain integration. *Computers in Industry*, 59(2-3), pp. 277-287.

Wad, P. (2008), The development of automotive parts suppliers in Korea and Malaysia: A global value chain perspective. *Asia Pacific Business Review*, 14(1), pp. 47-64.

Wad, P., and Govindaraju, V. G. R. C. (2011), Automotive Industry in Malaysia: an Assessment of its Development. *Int. J. Automotive Technology and Management*, 11(2), pp. 152-171.

Wagner, S. M., and Hoegl, M. (2006), Involving Suppliers in Product Development: Insights from R&D Directors and Project Managers. *Industrial Marketing Management*, 35, pp. 936-943.

Yahaya, S. Y. (2008), New Product Development Decision Making Process at Selected Technology Based Organizations in Malaysia (PhD Thesis), Universiti Teknologi Malaysia.

Yahaya, S. Y., and Bakar, N. A. (2007a), New product development management issues and decision making approaches. *Management Decision*, 45(7), pp. 1123-1142.

---

**Ana Sakura Zainal Abidin** received a Bachelor degree in Mechanical Engineering from Universiti Teknologi Malaysia and Masters Degree in Automotive Engineering from Coventry University, England. She joined University Teknologi Malaysia in 2000 as a tutor and in 2002 appointed as lecturer at the Department of Design. In the year 2007, she was joined Universiti Malaysia Sarawak under Department of Mechanical. Presently, she is doing her PhD in Industrial Engineering at Universiti Putra Malaysia. Her research interests are in the areas of product development, automotive engineering, facilities management and decision making.

**Dr. Rosnah Mohd. Yusuff** is a Professor in the Department of Mechanical and Manufacturing Engineering, Faculty of Engineering, Universiti Putra Malaysia. She obtained her first degree from the University of Iowa, USA and her Masters degree from the same University in Industrial Engineering and Management and her PhD from Universiti Putra Malaysia in Manufacturing Systems. Her research areas of interest are ergonomics in systems and product design, work related muscular skeletal disorders, systems modelling, SCM and in Technology management. She has published around 200 papers in journals and international conferences. She is currently an executive council member of Pan Pacific Council on Ergonomics, Vice President of the Malaysian society of Engineering and Technology, editorial committee of Asian Journal of Ergonomics and Asian journal of Science and Technology in Production and Manufacturing Engineering (AIJSTPME). She also represents Malaysia in South East Asia network of Ergonomics (SEANES).

**Dr. Md. Yusof Ismail,** is a Professor in the Manufacturing Department, Universiti Malaysia Pahang. He has working experience in both the Public Works Department as well as with the Ministry of Defence before joining the University as a lecturer. Graduated with a Bachelor's degree in Mechanical Engineering from Bandung Institute of Technology, Indonesia. Master in Industrial Management from Northern Illinois University, USA and a PhD from Dublin City University, Ireland. Lectures in the areas of Quality and Operational Research at the Undergraduate as well as at the Postgraduate level. Is an active Panel member in the accreditation of Engineering Education in the country. Current research interest is in the areas of quality and operational research.

**Dr. Nooh bin Abu Bakar** promoted as Professor in Manufacturing Engineering by UTM in year 2000. He obtained his BSc Mechanical Engineering/Production Engineering from the Brighton University, MSc Production Technology and Management from Aston University, Birmingham and his PhD in Manufacturing Engineering (Expert System) from Loughborough University. He has vast experience in manufacturing engineering, engineering education, executive education, technology management and corporate management. He is a senior member of American Society of Manufacturing Engineering (SME-USA), a member of American Society of Training and Development (ASTD), a member of the Artificial Intelligence Society Malaysia and a former council member of Institution of Quality Management (IQM) and a former council member of Project Management Institute (PMI-Malaysia). Currently, he is the Deputy Dean of School of Graduates Study, Universiti Teknologi Malaysia (UTM) at International Campus Kuala Lumpur.

**Dr. Norzima Zulkifli** is a senior lecturer in the Department of Mechanical and Manufacturing Engineering, University Putra Malaysia. She obtained her BSc Industrial Engineering from University of Alabama, USA, MSc Quality Management from University of Sunderland, UK and PhD from the National University of Malaysia in industrial management. She was Senior Executive in SIRIM Berhad in 1988 before joining University Putra Malaysia. She has very vase experience in Quality Management System consultancy. Her past experiences include helping the SMEs in areas of quality management, production planning and control, entrepreneurship and industrial management which are also her main areas of research.

**Rasli Muslimen** is a lecturer in the Department of Mechanical and Manufacturing Engineering, Universiti Malaysia Sarawak. He received a Bachelor degree in Mechanical Engineering from Universiti Teknologi Malaysia and Masters degree in Competitive Manufacturing from Coventry University, United Kingdom. His research interests are in the areas of productivity improvement technology, manufacturing technology, and engineering management. Currently, he is doing his PhD in Mechanical Engineering at the Department of Manufacturing and Industrial Engineering, Faculty of Mechanical Engineering, Universiti Technology Malaysia.