Identifying Factors That Impact Organization Integration On New Product Development Performance: Study the Moderating Effect of Virtuality

FRGS RESEACH

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ABSTRACT

Today's business environment is becoming more turbulent as the rate of change accelerates and new technologies allow information to spread globally almost instantly. Organizations are finding themselves pulled into a vortex of complexity and increased customer demand. Managers are facing even more challengers, and many firms have recently adopted a strategic approach to new product development to create and maintain a competitive advantage. Generally, new product is the important factor in running and developing business. Hence, this research is aimed to identifying the relationships between factors that to make sure the companies can survive among companies across industries in the Malaysia. Those identified factors are concurrent engineering, customer Involvement, Supplier Involvement, integration between NPD teams and overall integration , virtuality, NPD Performance, Product Innovation, Product Quality. Through the mail survey, a total of 120 respondent representing from the manufacturing firms responded. The hypotheses involved were tested using correlation and regression techniques. The multiple regression analysis is use to indicates any significant relationships among the factors on each criterion to new product development. It is believed that results of this study will be beneficial for share holders and directors of companies to apply these new product development concepts. Results shows that OI is positively affecting new product performance (R^2=0.004, F=0.463, p>0.05). The insertion of virtuality has increased the R-square to 0.107 and F=0.6990 and p<0.01. This result suggests that OI and virtuality give a significant effect to new product performance for 10.7 percent. The insertion of virtuality in the equation also give a significant changes to the model (R^2 change=0.103, F change=13.468, p<0.01). Result shows that internal and external integration significantly explained 29.1 percent of new product development (R^2=0.291, F=15.870, p<0.01). Two independent variables are significantly predict new product development, that are concurrent engineering (B=0.321, t=2.420, p<0.01) and customer involvement (B=0.360, t=3.020, p<0.01). Insertion of organization integration as a mediating variable shows that overall model significantly explained new product performance for 29.6 percent (R2=0.296, F=12.096, p<0.01).

ABSTRAK

Dalam persekitaran perniagaan kini menjadi lebih mencabar dengan kadar pertukaran yang cepat dan teknologi baru membenarkan maklumat disebarkan secara global semestinya segera. Organisasi mendapati mereka berada dalam keadaan yang kompleks dan meningkatkan permintaan pelanggan. Pengurus berdepan dengan lebih cabaran, dan banyak firma sejak akhir-akhir ini menggunakan pendekatan yang strategik untuk pengeluaran produk bagi mencipta dan mengekalkan kelebihan persaingan. Secara umumnya, kajian ini dijalankan bagi mengenalpasti perhubungan antara faktor-faktor yang menentukan kejayaan di kalangan syarikat-syarikat semua sektor di Semenanjung Malaysia. Faktor-faktor yang dikenalpasti ialah. Kejuruteraan selari, penglibatan pembekal, integration antara kumpulan produk yang baru, , realiti maya serta prestasi produk yang baru. Melalui kaedah tinjauan melalui pos, sebaakny 120 responden yang mewakili sektor pembuatan yang telah memberikan maklumbalas. Analisis regresi dan korelasi pula digunakan bagi membuktikan kesan yang signifikan yang ditunjukkan oleh keempat-empat faktor ke atas setiap criteria prestasi produck baru. Hasil kajian ini adalah diharapkan dapat memberi manfaat kepada pemegang saham dan ahli lembaga pengarah syarikat-syarikat dan industri dalam mengaplikasikan konsep modulariti dalam pengoperasian syarikat. Ada signifikasi perhubungan antara angkubah bebas, angkakubah moderasi, kepada keseluruhan keupayaan pembuatan, keputusan dari kajian ini menunjukan hubungan yang tinggi kepada pembangunan produk baru. Ujian menunjukan intergrasi keseluruhan ada kesan signifiken yang positif kepada prestasi produck baru (R^2=0.004, F=0.463, p>0.05). Dengan memasukan angkubah realiti maya meningkatkan (R^2 kepada 0.107, F=0.6990 and p<0.00). Keputusan ini menunjukan kesan signifikasi virtualiti kepada prestasi produck baru sebanyak 10.7 peratus (R^2 change=0.103, F change=13.468, p<0.01. Ujian juga menunjukan kesan tinggi angkubah intergrasi luaran dan dalaman menunjukan signifikasi sebanyak 29.1 kepada prestasi produck baru, item saperti kejuruteraan selari (B=0.321, t=2.420, p<0.01) dan penglibatan pelanggan (B=0.360, t=3.020, p<0.01). Memasukan organisasi intergral sebagai angkubah mederasi menunjukan signifikasi positive kepada pembangunan produk baru kepada 29.6 peratus (R2=0.296, F=12.096, p<0.01).

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CHAPTER 1

INTRODUCTION

This chapter introduces innovation and new product development (NPD) in general and its important contribution to the successful development of new product. It also discusses an overview of the significance of collaboration and collective efforts in NPD practices. Last but not least, it discusses the development and growth of Malaysia's overall economy and Malaysian experience in managing innovation and NPD at the national level. Finally, the knowledge gap and the need for this research are established.

1.0 Definitions of innovation

Innovation has been widely discussed in various management and engineering-based literatures. As the need to innovate is increasing from time to time and the increase of competitiveness in the organizational level of manufacturing industry, innovation and new product development (NPD) is believed to be the main distinctive factor to differentiate the sustainability level of one manufacturing firm to another.

Many scholars have come up with several definitions of innovation. One of the most cited definitions is that given by Myers and Marquis (1969):

> "Innovation is not a single action but a total process of interrelated sub processes. It is not just the conception of a new idea, nor the invention of a new device, nor the development of a new market. The process is all these things acting in an integrated fashion."

This definition is similar to what Urabe (1988) highlighted in his article. He emphasized that innovation is a cumulative process rather than a single action or a one-time phenomenon. Many of the previous literatures also tried to provide a comprehensive definition and understanding of innovation in order to minimize the misconception about innovation. The typical words which are being widely used to describe innovation are new ideas, invention, design, and development (Bradbury, 1989). However in most cases, people tend to define innovation and invention with the same characteristics and meaning (Freeman, 1982 & Rickards, 1985). Invention can be defined as the conception of idea for a new or improved process or product (Mat, 2008), whereas innovation is the transformation of those new ideas into the commercial stage which will contribute towards the economy. Hence, it can be said that invention is the sub segment or sub process of innovation.

Several previous scholars were agreed that essentially innovation consists of two stages, namely generation or conception of new ideas and the implementation stage (Bradbury, 1989; Urabe, 1988; Roberts, 1988; Von Stamm, 2008). Based on the above assertion, Trott (1998) proposed a simple equation to further describe the relationship between innovation and invention. Instead of classifying the stage into two, he added a new variable called commercial exploitation to show the importance of innovation in generating potential source of competitive advantage. The following simple equation was intended to avoid any confusion between the two terms, innovation and invention:

Innovation= theoretical conception + technical invention + commercial exploitation

The theoretical conception is the initial stage of innovation. In this stage new ideas are being generated, shared, and discussed to form the basic conception of the new product. Such ideas may arise from marketing and technological knowledge or from experiment (Bradbury, 1989; Urabe, 1988). According to Trott (1998), the process of information gathering during the theoretical conception stage is simply a collection of thoughts and could not be classified as an invention or innovation. Contradict to the above statement; Roberts (1988) suggested that generation of ideas is a form of invention. It means that in his definition of innovation, theoretical conception and technical invention are categorized into a single process rather than two separate courses of action.

Subsequently, after the intellectual thoughts are collected, the implementation process is developed to convert those ideas into a tangible product. This conversion process is what most scholars agreed to be called as invention (Bradbury, 1989; Urabe, 1988; Von Stamm, 2008). During this stage, different people from various backgrounds are working together to combine all information required. Technical aspects play an important role to make the conversion process successful (Trott, 1998). In addition to that, to complete the innovation process, the new marketable product needs to be commercialized. This commercialization stage is very critical to ensure the new product is accepted by the target markets and customers. Every aspects, such as the introduction timing, the region to launch the product, and the potential target markets; must be well-considered. Hence, proper exploitation strategy is inevitable to explore all alternatives to make sure an optimal return on the investment which has been made (Bradbury, 1989).

Furthermore, Nystrom (1990) in his definition of innovation underlined the importance of innovation to generate competitive advantage. Successful innovation would strengthen the existence of an organization to cope with the ever changing future. Schumpeter (1950) with his innovation concept further highlighted that innovation is not solely about technology but also an economic concept. Innovation should engender future profitability as well as to sustain growth through competitive advantage in both domestic market as well as in international trade (Urabe, 1988).

1.1 The importance of NPD to business performance

Global competitiveness is one of the most important issues in manufacturing industry nowadays. Almost every company in this business industry is affected by it and they are looking for new ways to remain aligned and competitive. In recent years, the long term success of some manufacturing firms and organizations has been enhanced by their ability to bring new products onto the market at regular and shorter intervals. However, it seems that a number of issues and deficiencies in the organizational and managerial processes are disregarded here. Indeed, the criteria for competitiveness in the market have been changing continuously. For instance, levels of product complexity, market demands, extent of globalization of markets and degree of consumer awareness (Pawar & Sharifi, 2000). Moreover, introducing new products to the market place remains a key weapon in a company’s battle for competitive advantage; however, a more global competitive environment forced manufacturing industries to develop better products more quickly with greater quality and at reduced cost.

NPD performance can be determined by many indicators. Past literatures have shown many indicators which can be considered as the determinants of NPD success, for instance Montoya-Weisss and Calantone (1994) proposed 72 determinants of NPD success, while Hart (1993) came up with 53 ways to measure NPD success. These determinants can be grouped as financial and non-financial determinants. Among the financial determinants, profitability (Droge, Jayaran, & Vickery, 2004; Koufteros, Vonderembse, & Doll, 2002; Koufteros, Vonderembse, & Jayaram, 2005; Liu, Chen, & Tsai, 2005; Lu & Yang, 2004; Petersen, Handfield, & Ragatz, 2005), sales (Liu et al., 2005; Petersen et al., 2005), and market share (Droge et al., 2004) are the most commonly used in order to measure the NPD performance and success. While product development time and speed (Aronson, Reilly, & Lynn, 2006; Carbonell & Rodriguez, 2006; Hong & Roh, 2009; Lu & Yang, 2004; Liu et al., 2005; Primo & Amundson, 2002; Sherman, Souder, Jenssen, 2000; Swink, 2003), product quality (Gonzalez & Palacios, 2002; Koufteros et al., 2002; Koufteros & Marcoulides, 2006; Lukas & Menon, 2004; Primo & Amudson, 2002), product innovation or innovativeness (Koufteros et al., 2002; Koufteros et al., 2005; Koufteros & Marcoulides, 2006; Lukas & Menon, 2004), and cost efficiency (Hong & Roh, 2009; Petersen et al., 2005; Primo & Amudson, 2002) are among the most popular non-financial NPD measurements.

In order to achieve success in NPD, manufacturing firms often focus on customers' requirements, produce quality-driven products, implement elimination of waste practices, enhance employee involvement, and implement continuous improvement approach for both product and process (Magrab, 1997). Within this context, the role of manufacturing, marketing, and R&D as internal functions of the organizations become more significant. This requires manufacturing firms to change their practices in order to develop products rapidly as demanded by the customers. Therefore, concurrent engineering (CE), an emerging philosophy and methodology, along with the implementation of other external NPD practices, is ideal to fulfill organization's expectations under such circumstances.

1.2 Collaboration and collective efforts in NPD practices

The fundamental of an organization is co-operation and collaboration of its members. The assumed common purpose and shared means in organization extends to teams and sets the grounds for teamwork within it. The primary process in adopting concurrent engineering philosophy is teaming, which involves the assemblage of people with different skills, experiences and perspectives on the product development process. Each of the team members in concurrent engineering team represents the relevant departments and functions.

The concurrent engineering team is composed of experts from engineering, production, marketing and any other functional area which has a vested interest in the development project. The team is formed to work on a specific project and stays together throughout the development of the product. The continuity in team membership underscores the need to establish long-term relationships with the core team members and also with both customers and suppliers or subcontractors. In order to ensure the effectiveness and continuity of the team, members contributing to the design and development of new product should be located close to each other. Collocation of team has been considered as one of the main tools for enabling concurrent engineering, Bergring and Andersin (1994).

Rafii (1995) has defined collocation as:

> "………physical proximity of various individuals, teams, functional areas, and organizational sub-units involved in the development of particular product or process……."

There are several advantages and benefits gained from the implementation of collocated teams. Increased interactions, ease of informal communication, and increase in efficiency of resource use are among the benefits. Through physical and/or virtual collocation of teams, concurrent engineering allows companies to develop a larger range of better products faster and cheaper more than ever.

1.3 Overview of Malaysian manufacturing sector and NPD practices

1.3.1 Historical development: Malaysia's growth and structural change

Since the Malaysian independence in 1957, Malaysia has experienced rapid and sustainable growth. A remarkable development in many sectors has been achieved and they are looking for ways on how to maintain its growth and to be declared as an industrialized country by the year of 2020 as the result of it. Strategies, policies, and regulations are being introduced to bring Malaysia into a higher level of competitiveness in the global environment.

Malaysia started its industrialization strategy in the early 1960's. However, different from other developing countries in Asian region, Malaysia introduced their industrialization strategy as a promotional effort to stimulate investment climate especially to foreign private enterprise (Wheelwright, 1963). By the late 1960's, Malaysia's economic concern was shifted to the expansion of export-oriented industries. Moreover, the expansion of public sector activities as well as growth in primary production significantly contributed to a high level of economic growth in 1970's and early 1980's (Athukorala & Menon, 1999).

The significant growth of Malaysia's economic during the period of 1970's and 1980's was marked by the rapid expansion of palm oil and rubber production. As an agriculture-based country, Malaysia was heavily relied on primary commodities production for exports to sustain its economy. It was noted in this period that the share of the agriculture sector in the gross domestic product (GDP) was 28.5% in 1970 to 26.9 % in 1975 (Ministry of Finance, 2004). On the other hand, manufacturing industry also experienced slight improvement in term of its contribution toward GDP. Resource-based manufacturing such as food, beverages, tobacco, and wood products dominated the composition of manufactured exports. Structural change of the economy was more rapid in the period of 1980's and early 1990's. The dominance of resource-based manufacturing was declined and was replaced by electrical and electronics machinery, appliances, and components. The composition and share of electrical and electronic products in total exports rose significantly from 14.3 % in 1971 to 46.8 % in 1981, and further increased up to 58 % in 1991. This significant transformation was enabled by the growth of foreign direct investment (FDI) in ASEAN region. FDI provided substantial investment to ASEAN countries, especially Malaysia, to facilitate these countries to expand their manufacturing sector. Furthermore, by the late 1980's FDI inflow had changed from production for the domestic market to locate Malaysia as a base for manufacturing for the global market (Athukorala & Menon, 1999).

In the mid 1990's, Malaysian government realized the important of manufacturing sector to compete with other developing countries. From time to time Malaysian manufacturing sector has grown to be the backbone of Malaysian economy. Malaysian manufacturing industry also established themselves as the major contenders to other developing countries. During this time frame, Malaysia also tried to focus on total factor productivity (TFP) growth in order to achieve better performance of manufacturing sector as being emphasized in the Second Industrial Master Plan 1996-2005 (Jajri & Ismail, 2006).

Malaysia experienced several structural changes in the last three decades. Malaysia has transformed from an agriculture-based economy to a manufacturing-based economy. Structural changes in term of share on GDP, employment rate, and export compositions marked Malaysia's transformation (Jajri & Ismail, 2006) as shown in Table X. Malaysia's current concern is to move from production-based economy to knowledge-based economy. Malaysia is now trying to improve their value chain and is stressing on attracting high-technology, high-value added and knowledge-based industries by integrating activities such as R&D, process improvement, and new product development. The industrial development and growth would still be continue as Malaysian government has formed the Third Malaysian Industrial Master Plan 2006-2020 to sustain the growth of manufacturing sector to move forward into the high challenging global environment.

1.3.2 Malaysian manufacturing sector

In 1986, Malaysia introduced their first Industrial Master Plan (IMP) for the period of 1986-1995. This first IMP was formulated to guide the development and transformation of manufacturing sector. As Malaysia had initiated a structural shift from agricultural-based into manufacturing-based economy, the IMP 2 was commenced to enhance the performance of

Malaysian manufacturing industry to be able to cope with the industrialization and globalization. Since the first two plans were introduced and implemented, Malaysia is achieving significant growth in almost every aspect of their manufacturing industry.

Performance of manufacturing industry can be evaluated based on several aspects. Contribution towards GDP, share of total exports, gross output, employment, and value of assets are among the aspects that indicate the overall performance of manufacturing industry. As mentioned in the previous section of this chapter, Malaysian manufacturing industry is increasing its growth in term of its contribution toward GDP. With regards to the share of total exports, manufactured products experienced slight decrease from 78.5% in 1996 to 77.4% in 2005. The main factor contributed to the decline of manufactured exports was the Asian financial crisis in 1998. However, more recent data showed Malaysian manufacturing industry has bounced back from the recession with average annual growth of 11.6% from 1996 to 2005. As a matter of fact, the non-resource based industries managed to contribute good portion of share for the export products, while the resource based products such as chemical, wood, and rubber products were still maintain its contribution in the level of 15% in 2005. On top of that, the overall performance of Malaysian manufacturing industry showed an increased trend in term of gross output, value added, and employment status, as shown in Table 1.1.

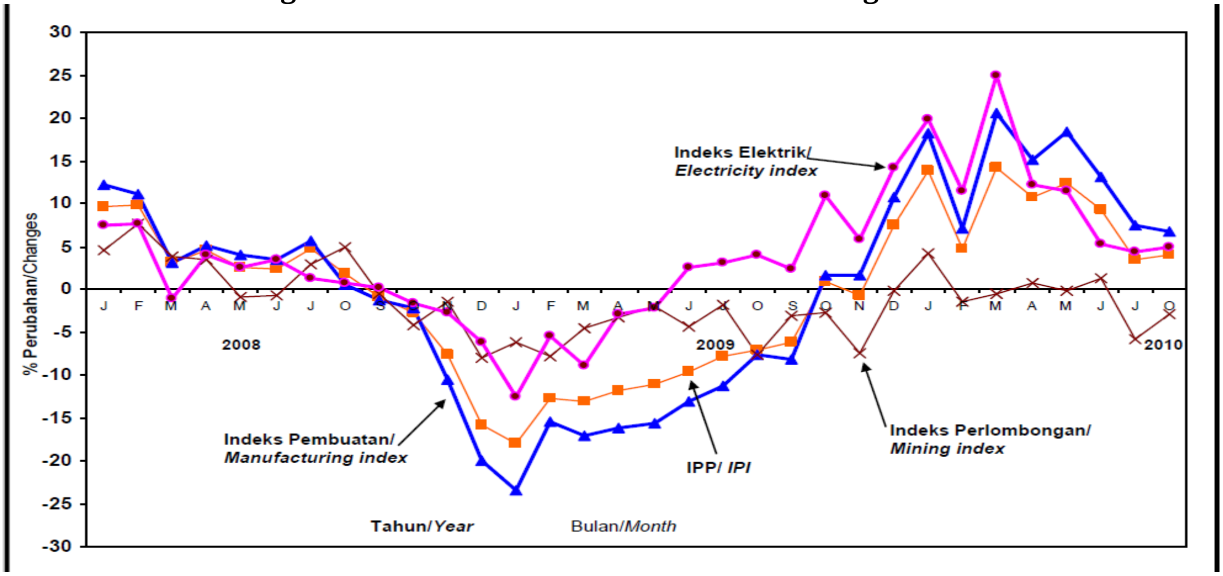
Table 1.0 : Malaysian manufacturing industry's overall performance from 2005-2008

Indicators	2005	2006	2007	2008
Gross output (RM billion)	655.5	710.2	742.9	817.7
Intermediate input (RM billion)	537.3	580.4	600.8	660.5
Value added (RM billion)	118.2	129.8	142.1	157.1
Employment (million persons)	1.68	1.72	1.80	1.77
Value of assets (RM billion)	190.9	193.4	182.6	201.5

Source: Department of Statistic Malaysia

Even though the overall performance of Malaysian manufacturing industry indicated slight improvement for most of the manufacturing indicators in a yearly basis, the industrial production index (IPI) showed the other way around. Although the fluctuation of the index was still within the range in the early 2010, however the graphic proved a gradual decline of production especially for manufacturing sector. This decline is similar to what had been occurred during the end of 2007 and early 2008 as illustrated in Figure 1.1. Therefore, a more integrated approach is important for Malaysian manufacturing industry to address new challenges in order to strengthen its sustainability regionally and worldwide.

Figure 1.1: Growth of IPI and Manufacturing Index



Source: Department of Statistic Malaysia

1.3.3 Innovation and NPD in Malaysia

Innovation and new product development (NPD) is considered as the key ingredient for sustaining competitiveness in the global business environment today. As Malaysia is progressing from an agricultural-based country into a manufacturing-based country, the importance of introducing new product into the market is becoming more crucial.

In the last few decades, Malaysia is getting more concern with the economic role of innovation. Since the capacity and capability to innovate would transform to be the critical driver of future economic growth, Malaysia has introduced several policy efforts to strengthen their national innovation. The Malaysian government is fully aware of the need of a national system to lead all of the actors of innovation, namely society, firms, universities, and government institutions; to collectively improve the fluidity and flow of information and technology. Therefore, the development of National Innovation System (NIS) is very important as a linkage to facilitate exchange of knowledge, which is aimed to reduce market and technology uncertainty.

The NIS can be defined as an innovating agents as well as the enabler that encourage and motivate related parties to perform innovation activities (Rasiah, 1999). The Malaysian NIS is established to deal with knowledge advancement, technology development, and its application in the industrial sector. As highlighted in Industrial Master Plan II, this NIS is expected to stimulate innovation and strengthen the Malaysian manufacturing sector in order to gain a better level of competitiveness.

In addition to that, financing system and fund allocation provided by the Malaysian government bodies and agencies also encourages innovating agents to perform more and more innovation activities as well as new product and process development. Based on a research conducted by Lee and Chew-Ging (2007), the Malaysian government has allocated about RM 250 million in the period of 2000-2005, to support the privates sector for innovation and technology. The funds can be accessed through various grant schemes such as Technology Acquisition Fund, Industrial R&D Grant (IGS), MSC R&D Grant Scheme (MGS), Commercialization of Research and Development Grant (CRDF), and many more. Government support in term of tax incentives are also granted to innovator agents to stimulate and promote innovation and R&D into a new level.

Government support and incentives has encouraged enormous number of manufacturing firms in Malaysia to evolve in becoming a great innovator. A National Survey of Innovation (NSI) which was conducted by Malaysia Science and Technology Information Centre (MASTIC) showed a great portion of manufacturing firms perform R&D activities as well as innovation activities. This national survey was carried out to provide information with regards to the level of innovation activity in Malaysia manufacturing sector. In addition to that, by adopting the Organization of Economic Co-operation and Development (OECD) data collection guidelines and European Union's Community Innovation Survey (CIS) questionnaire design, this survey is also intended to evaluate the current state of technological development in the country.

Based on the data from NSI-4 (MASTIC, 2006), more than half of the respondents are performing innovation activities. Those firms are widely range from radio, television, and communication equipment industry to electrical machinery industry, from textiles to paper products, as well as rubber and plastic product industry. In general, the innovation activities can be classified into two main categories, which are product innovation and process innovation. Most of the manufacturing firms inclusively involve in both product and process innovation. While only small number of them that are solely execute either product or process innovation.

The level of innovativeness among those innovating firms is varied from one another. In the case of developing country in Asia, Malaysia can still be considered as one of the potential main actor for new product development. From the survey it was identified that most of the product introduced by manufacturing firms in Malaysia are categorized under “significantly improve product” and “new or significantly improved methods of manufacturing or producing goods or services” (MASTIC, 2006). Most of these firms rely mostly on internal sources and local partnership to produce such innovative products. Government also plays an important role to provide technical support and consultancy, while some of the firms also benefited the financial support and assistance given by the government for their R&D commercialization.

In relation to the type of ownership and innovation, it was found that about 58% of the innovating firms are 100% locally owned (MASTIC, 2006). On top of that, manufacturing firms who majority of its shares are owned by foreign individual or firm are likely to innovate, as the data illustrated innovating firms are doubled compare to non-innovating firms for this category (Lee, 2004). These findings clearly show an improved in the local small and medium enterprises’ tendency to innovate and compete in the new product development industry regionally and worldwide. Local SME’s are well aware of highly competitive market in current industrial environment. Local firms are pushed by industrialization, while at the same time are pulled by the intense of market growth, in order to strengthen their competitive advantage by continuously improve their products and processes.

1.4 Problem Statement

The information determined by this research is important because of the enormous size of the problem and the consequences of it. The current global environment competitiveness has forced manufacturing firms to redesign their strategy to gain competitive advantage. In the last two decades, fundamental changes in business environment have contributed to make the differentiated organization strategy of new product development obsolete (Lee, 1991).

It would be extremely difficult for manufacturing firms nowadays to just rely on quality, cost, service, and product differentiation in order to achieve their NPD success. They must be able to compete on the basis of new technological feature and product innovation (Verworn, Herstatt, & Nagahira, 2008). On top of that, the ability of a company to bring new product to market faster through reducing the number of defects and more concern on manufacturability aspect has become an increasingly important factor to market success (Kim & Kim, 2009). Thus, acceleration in product development time and product innovation are among the main concern for manufacturing firms nowadays to sustain their market share as well as strengthen their competitive advantage.

New products are increasingly cited as the key to corporate success since 1970s until now. The data obtained during the 1970s showed that 20% of the corporate profits were contributed by new product development (NPD); while in the 1980s, new products accounted for one-third of the overall profits generated (Takeuchi & Nonaka, 1986). The figure then increased to 42% in the period of 1985-1990 (Page, 1993), showing the importance of NPD is increasing from time to time. However, recent studies indicate new product success experienced deterioration. The success rate of NPD is failing to less than 60 % in several countries; 59.8 % in

Japan (Edgett, Shipley, & Forbes, 1992), 59% for USA (Griffin, 1997), and 54.3 % for UK (Edgett et al., 1992). These figures are confirmed by Schilling and Hill (1998) which showed between 33 percent to 60 percent of new products that had been launched fail to generate economic return. Cooper (2005) further affirmed the previous findings and indicates that the failure rate for NPD projects is approaching 33 percent. In another study of Monczka and Trent (1997), it was reported that costs in NPD should be at least pressed to 5-8%, while time-to-market should be reduced by 40-60% in order for company to remain competitive in the market. These percentages suggest there is several issues in NPD that need to be overcome; otherwise the number of failure and unsuccessful product will continue its increasing pattern.

Due to more complex process and structural involve in new product development, the increase of issues related to project management, people management, and structural management is inevitable. These issues are among the main obstacles for manufacturing firms to develop new product on time and produce innovative product since these issues commonly relate to continuous effective operation, technical matters, and efficiency in managing NPD activities (Yahaya & Abu-Bakar, 2007).

Operational effectiveness and efficiency, technical issues, and innovativeness can be accommodated should the structural and strategic integration within an organization is well-executed (Droge et al., 2004; Hong & Roh, 2009; Koufteros et al., 2005). Several studies were done to understand and explain the importance of internal and external integration as the sub-segment of organizational integration to determine the outcome of NPD performance from the uncertainty reduction theory (Gupta, Raj, & Wilemson, 1986), theory of organizational information processing (Daft & Lengel, 1986), and organizational theory (Koufteros et al., 2005). Koufteros et al. (2005) clearly mentioned in their study that the existence of internal and external integration is important to determine the outcome of NPD performance. To be specific, internal integration is the enabler of external integration to achieve high product innovation. While another study conducted by Droge et al. (2004) emphasizes on the impact of strategic integration of internal and external constituents on time-based performance. In order to enhance strategic integration, manufacturing firms must be able to accurately choose the best NPD practices which can accommodate both internal and external necessitates. Thus, an internal NPD practice such as concurrent engineering is compulsory to improve company's overall NPD performance. However, there is a main issue to both theoretical and practical aspects of concurrent engineering that still need to be answered. This issue relates to integration of cross-functional team and level of functional diversity within an NPD. Cross-functional team one of the characteristics of concurrent engineering practice.

According to Handy (1993), issues relating to organizational and external environment alongside with issues associated with organizational leadership, groups, systems and procedures, are among the top factors affecting organizational and team effectiveness in concurrent engineering. Furthermore, the enablers for perceived benefits of concurrent engineering listed by Maylor and Gosling (1998) are introduction and integration of multi-functioned project teams and deployment of collocation teams. Thus, it proves that interaction and collaboration among concurrent engineering team members and collocation of teams, physically or virtually, are still the main determinants for successful implementation of concurrent engineering.

Collocation of teams, according to Bergring and Andersin (1994), has been believed as one of the main tools for enabling concurrent engineering approach. It is used to increase interactions among team members, increase the ease of informal communication, and moreover increase efficiency in using resources. However, as the competitiveness in manufacturing industry getting more intense and the introduction of internationalization concept, the paradigm in adopting "physical collocated product development" activities should be shifted. Physical collocation which is mostly adopted by manufacturing companies may no longer be efficient, especially when it comes to the usage of resources (Rafii, 1995). Business requirements such as product development, changes in service, and globalization approach forced manufacturing firms to apply virtual team collocation, with the aid of advanced electronic communication technology, in order to be closer and more responsive to customer's needs (Henry & Hartzler, 1998). Virtual teaming, a relative recent phenomenon, is becoming increasingly attractive to organizations due to developments in communication technologies. The implications of a remote distributed working environment, though, are not illustrated or experienced extensively. Moreover, as the employment of electronic communication technology in NPD has not received an adequate attention (Koufteros et al., 2005), it is worth to study the impact of electronic communication technology as the enabler of virtual team to NPD performance (Boyle, Kumar, & Kumar, 2006), especially on product development time and product innovation.

In their study, Carbonell and Rodriguez (2006) found that functional diversity has an inverted-U shaped effect on innovation speed. An increase of functional diversity was positively influence innovation speed only when the initial functional diversity is low. In contrast, when the level of functional diversity within a team is high, the innovation speed is decreasing. They also believed that functional diversity negatively influences the shared purpose, collaboration, and an effective group process.

On the other hand, various studies in relation to product innovation contradict with the above statement and support the positive side of high number of functional representative in an NPD team. These studies focus on the advantages gained from an NPD team which consists of great number of functional diversity. Droge et al. (2004) and Akgun, Dayan, and Di Benedetto (2008) confirmed that the greater the functional areas being represented in an NPD team, the higher the ability to acquire, process, and utilize knowledge, which at the end enhance the degree of team's innovativeness and creativity. This contradiction should be explained in more rigorous way in order to assist practitioner in this field to determine which paradigm to follow.

In a broader scope, issue on inadequacy of collaboration and communication should effect the effectiveness of internal-external practices integration. There have been so many queries on how to effectively integrate third parties into the NPD and how to properly link the firm's problem solving effects with the third parties, moreover when the suppliers or customers are geographically distributed.

1.5 Research Objectives

This study will focus on the integration of internal and external practices involved in NPD. It will try to bridge the gap in the existing body of knowledge with regards to NPD practices, especially in manufacturing industry. The general objective of this study is to identify an alternative practical model for internal and external integration and how they positively influence NPD performance. There are several research objectives that this study attempts to achieve, which are to:

1. To examine how internal-external integration namely, concurrent engineering, customer involvement, and supplier involvement affect the performance of new product development.

2. To examine the relationship of organizational integration on new product development performance.
3. To analyze the mediating effect of organizational performance on the relationship between internal-external integration and new product development performance.
4. Analyze the moderating effect of virtuality on the relationship between organizational performance and new product development performance.
5. Investigate the degree of virtuality in new product development practices in Malaysian manufacturing sector.

1.6 Research Questions

In achieving the above objectives, this research addresses the following questions:

1. Is the performance of new product development affected by internal-external integration namely, concurrent engineering, customer involvement, and supplier involvement?
2. Does organizational integration influence new product development performance?
3. Does organizational integration mediate the relation between internal-external integration and new product development performance?
4. Does virtuality moderate the relation between organizational integration and new product development performance?
5. How is the degree of virtuality in new product development practices in Malaysian manufacturing sector?

1.7 Definition of term

Although most of the term in the study can be classified as common new product development term in the product development of manufacturing industries, the following definitions are provided to avoid misinterpretation of their use in within study:-

1.7.1 ORGANIZATIONAL INTEGRATION

Organizational Intergration meaning involvolving information processing, early planning and collaboration between design and manufacturing personnel is important to reduce uncertainty. Early exchange of information and shared of visions, missions, and values should eliminate information gaps among constituents and further less design and manufacturing problems are generated. Thus, integrating internal constituents as early as possible would accelerate product development speed.

1.7.2 CONCURRENT ENGINEERING

The main distinction of concurrent engineering approach with conventional or traditional product development approach is on the execution of its activities. In conventional or traditional product development approach, each activity is done in sequence and controlled by one function at a time.

1.7.4 CUSTOMER INVOLVEMENT

Customer involvement means knowledge for the internal constituents to produce product that customers really demanding. It is believed that close collaboration and relationship with customers would enhance timely responsiveness

1.7.5 SUPPLIER INVOLVEMENT

The effects of supplier involvement meaning product development are expected to enhance both strategic and operational outcomes. The strategic impact includes increased efficiency and effectiveness as well as better access to technological resources and knowledge; while the operational impact relates to lead time reduction, cost reduction, provides alternative solutions on materials, and development of better products.

1.7.6 VIRTUALITY

Virtuality meaning collocation team is formed as a result to new ways of working, being introduced as a reaction to current business requirements. Shift in organizational trends also affect manufacturing firms to start applying virtual collocation team.

1.8 Scope of the Study

Product development is the scheme by which the functional elements of the product are arranged into physical chunks and by which the chunks interact the definition links architecture to system level design and the principles of system engineering. New Product development also has profound implication for how the product is designed, made, sold, used, and repaired. The scope of this study is limited to new product development manufacturer in Malaysia. Identifying the new product development architecture of the manufacturing firm and the study is to explore the role of variable to the product development. The selections of the respondent were based on the assumption that they are the most qualified person to represent the member of the industry. Thus, the following chapter will only examine the proposal theoretical framework within the scope of the study.

1.9 Thesis Structure

This chapter is structured into five chapters. Chapter one provides the introduction, background of the study, problem statements, research objectives, research questions, research significance, definitions terms and organization of the remaining chapters. The literature review in chapter two, addresses the concepts of modularization towards customer demand, manufacturing flexibility, cost, and supply chain in manufacturing sectors. Chapters three contained the research methodology applied. It includes a description of the research design and methodology of study used to empirically test the framework. Chapter four presents and analyzes the results, while discussion and conclusion are in chapter five.

CHAPTER 2

LITERAURE REVIEW

2.0 Introduction

Global competitiveness is one of the most important issues in manufacturing industry nowadays. Almost every company in this business industry is affected by it and they are looking for new ways to remain aligned and competitive. In recent years, the long term success of some manufacturing firms and organizations has been enhanced by their ability to bring new products onto the market at regular and shorter intervals. However, it seems that a number of issues and deficiencies in the organizational and managerial processes are disregarded here. Indeed, the criteria for competitiveness in the market have been changing continuously. For instance, levels of product complexity, market demands, extent of globalization of markets and degree of consumer awareness (Pawar & Sharifi, 2000). Moreover, introducing new products to the market place remains a key weapon in a company's battle for competitive advantage; however, a more global competitive environment forced manufacturing industries to develop better products more quickly with greater quality and at reduced cost.

NPD performance can be determined by many indicators. Past literatures have shown many indicators which can be considered as the determinants of NPD success, for instance Montoya-Weisss and Calantone (1994) proposed 72 determinants of NPD success, while Hart (1993) came up with 53 ways to measure NPD success. These determinants can be grouped as financial and non-financial determinants. Among the financial determinants, profitability (Droge, Jayaran, & Vickery, 2004; Koufteros, Vonderembse, & Doll, 2002; Koufteros, Vonderembse, & Jayaram, 2005; Liu, Chen, & Tsai, 2005; Lu & Yang, 2004; Petersen, Handfield, & Ragatz, 2005), sales (Liu et al., 2005; Petersen et al., 2005), and market share (Droge et al., 2004) are the most commonly used in order to measure the NPD performance and success. While product development time and speed (Aronson, Reilly, & Lynn, 2006; Carbonell & Rodriguez, 2006; Hong & Roh, 2009; Lu & Yang, 2004; Liu et al., 2005; Primo & Amundson, 2002; Sherman, Souder, Jenssen, 2000; Swink, 2003), product quality (Gonzalez & Palacios, 2002; Koufteros et al., 2002; Koufteros & Marcoulides, 2006; Lukas & Menon, 2004; Primo & Amudson, 2002), product innovation or innovativeness (Koufteros et al., 2002; Koufteros et al., 2005; Koufteros & Marcoulides, 2006; Lukas & Menon, 2004), and cost efficiency (Hong & Roh, 2009; Petersen et al., 2005; Primo & Amudson, 2002) are among the most popular non-financial NPD measurements.

In order to achieve success in NPD, manufacturing firms often focus on customers' requirements, produce quality-driven products, implement elimination of waste practices, enhance employee involvement, and implement continuous improvement approach for both product and process (Magrab, 1997). Within this context, the role of manufacturing, marketing, and R&D as internal functions of the organizations become more significant. This requires manufacturing firms to change their practices in order to develop products rapidly as demanded by the customers. Therefore, concurrent engineering (CE), an emerging philosophy and methodology, along with the implementation of other external NPD practices, is ideal to fulfill organization's expectations under such circumstances.

2.2 Overview of Malaysia New Product Development

This study will focus on the integration of internal and external practices involved in NPD. It will try to bridge the gap in the existing body of knowledge with regards to NPD practices, especially in manufacturing industry. The general objective of this study is to identify an alternative practical model for internal and external integration and how they positively influence product development time and product innovation in the context of NPD. The specific issues that we will into are as follows, to evaluate the constructs of concurrent engineering practices to investigate the constructs of supplier integration practices. investigate the constructs of customer integration practices. To investigate the construct of knowledge management practices, To investigate the dimensions in determining virtual team effectiveness., to investigate the relationship between functional diversity and (i) product development time; (ii) product innovation., examine the influence of concurrent engineering on (i) product development time; (ii) product innovation, examining the influence of supplier integration on (i) product development time; (ii) product innovation, to examine the influence of customer integration on (i) product development time; (ii) product innovation, to examine the influence of virtual team effectiveness on (i) product development time; (ii) product innovation,to examine the influence of knowledge management on (i) product development time; (ii) product innovation, to determine the mediating effects of virtual team effectiveness on the relationship of internal-external integration and (i) product development time; (ii) product innovation., determining the mediating effects of knowledge management on the relationship of internal-external integration and (i) product development time; (ii) product innovation, to determine the aggregate effects of direct and indirect paths of exogenous variables on (i) product development time; (ii) product innovation, and finally determining the critical factors that relate to (i) product development time; (ii) product innovation.

2.3 Theoretical New Product Development

The information determined by this research is important because of the enormous size of the problem and the consequences of it. The current global environment competitiveness has forced manufacturing firms to redesign their strategy to gain competitive advantage. In the last two decades, fundamental changes in business environment have contributed to make the differentiated organization strategy of new product development obsolete (Lee, 1991).

It would be extremely difficult for manufacturing firms nowadays to just rely on quality, cost, service, and product differentiation in order to achieve their NPD success. They must be able to compete on the basis of new technological feature and product innovation (Verworn, Herstatt, & Nagahira, 2008). On top of that, the ability of a company to bring new product to market faster through reducing the number of defects and more concern on manufacturability aspect has become an increasingly important factor to market success (Kim & Kim, 2009). Thus, acceleration in product development time and product innovation are among the main concern for manufacturing firms nowadays to sustain their market share as well as strengthen their competitive advantage.

New products are increasingly cited as the key to corporate success since 1970s until now. The data obtained during the 1970s showed that 20% of the corporate profits were contributed by new product development (NPD); while in the 1980s, new products accounted for one-third of the overall profits generated (Takeuchi & Nonaka, 1986). The figure then increased to 42% in the period of 1985-1990 (Page, 1993), showing the importance of NPD is increasing from time to time. However, recent studies indicate new product success experienced deterioration. The success rate of NPD is failing to less than 60 % in several countries; 59.8 % in Japan (Edgett, Shipley, & Forbes, 1992), 59% for USA (Griffin, 1997), and 54.3 % for UK (Edgett et al., 1992). These figures are confirmed by Schilling and Hill (1998) which showed between 33 percent to 60 percent of new products that had been launched fail to generate economic return. Cooper (2005) further affirmed the previous findings and indicates that the failure rate for NPD projects is approaching 33 percent. In another study of Monczka and Trent (1997), it was reported that costs in NPD should be at least pressed to 5-8%, while time-to-market should be reduced by 40-60% in order for company to remain competitive in the market. These percentages suggest there is several issues in NPD that need to be overcome; otherwise the number of failure and unsuccessful product will continue its increasing pattern.

Because of more complex process and structural involve in new product development, the increase of issues related to project management, people management, and structural management is inevitable. These issues are among the main obstacles for manufacturing firms to develop new product on time and produce innovative product since these issues commonly relate to continuous effective operation, technical matters, and efficiency in managing NPD activities (Yahaya & Abu-Bakar, 2007).

Operational effectiveness and efficiency, technical issues, and innovativeness can be accommodated should the structural and strategic integration within an organization is well-executed (Droge et al., 2004; Hong & Roh, 2009; Koufteros et al., 2005). Several studies were done to understand and explain the importance of internal and external integration to determine the outcome of NPD performance from the uncertainty reduction theory (Gupta, Raj, & Wilemson, 1986), theory of organizational information processing (Daft & Lengel, 1986), and organizational theory (Koufteros et al., 2005). Koufteros et al. (2005) clearly mentioned in their study that the existence of internal and external integration is important to determine the outcome of NPD performance. To be specific, internal integration is the enabler of external integration to achieve high product innovation. While another study conducted by Droge et al. (2004) emphasizes on the impact of strategic integration of internal and external constituents on time-based performance.

In order to enhance strategic integration, manufacturing firms must be able to accurately choose the best NPD practices which can accommodate both internal and external necessitates. Thus, an internal NPD practice such as concurrent engineering is compulsory to improve company's overall NPD performance. However, there is a main issue to both theoretical and practical aspects of concurrent engineering that still need to be answered. This issue relates to integration of cross-functional team and level of functional diversity within an NPD. Cross-functional team one of the characteristics of concurrent engineering practice.

According to Handy (1993), issues relating to organizational and external environment alongside with issues associated with organizational leadership, groups, systems and procedures, are among the top factors affecting organizational and team effectiveness in concurrent engineering. Furthermore, the enablers for perceived benefits of concurrent engineering listed by Maylor and Gosling (1998) are introduction and integration of multi-functioned project teams and deployment of collocation teams. Thus, it proves that interaction and collaboration among concurrent engineering team members and collocation of teams, physically or virtually, are still the main determinants for successful implementation of concurrent engineering.

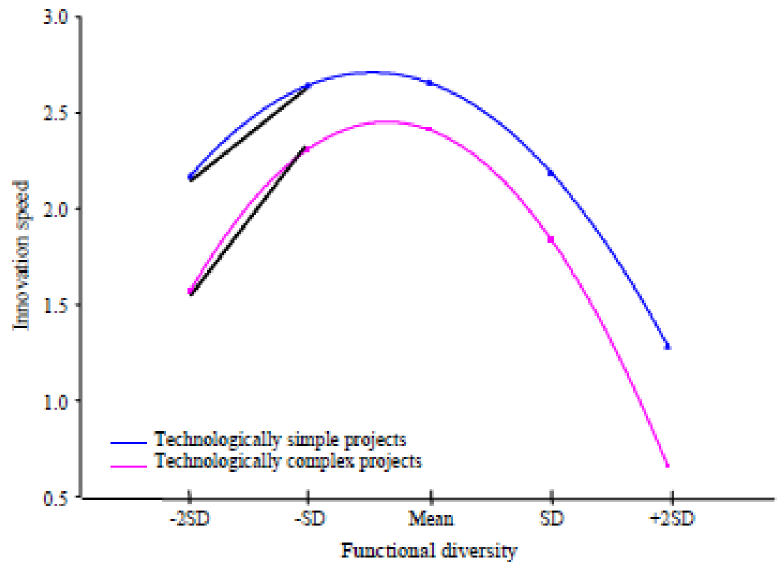
Collocation of teams, according to Bergring and Andersin (1994), has been believed as one of the main tools for enabling concurrent engineering approach. It is used to increase interactions among team members, increase the ease of informal communication, and moreover increase efficiency in using resources. However, as the competitiveness in manufacturing industry getting more intense and the introduction of internationalization concept, the paradigm in adopting "physical collocated product development" activities should be shifted. Physical collocation which is mostly adopted by manufacturing companies may no longer be efficient, especially when it comes to the usage of resources (Rafii, 1995). Business requirements such as product development, changes in service, and globalization approach forced manufacturing firms to apply virtual team collocation, with the aid of advanced electronic communication technology, in order to be closer and more responsive to customer's needs (Henry & Hartzler, 1998). Virtual teaming, a relative recent phenomenon, is becoming increasingly attractive to organizations due to developments in communication technologies. The implications of a remote distributed working environment, though, are not illustrated or experienced extensively. Moreover, as the employment of electronic communication technology in NPD has not received an adequate attention (Koufteros et al., 2005), it is worth to study the impact of electronic communication technology as the enabler of virtual team to NPD performance (Boyle, Kumar, & Kumar, 2006), especially on product development time and product innovation.

However, as presented in Figure 1, Carbonell and Rodriguez (2006) found a gap which showing that the level of functional diversity within an NPD team might limit product development time. In their study, they found that functional diversity has an inverted-U shaped effect on innovation speed. An increase of functional diversity was positively influence innovation speed only when the initial functional diversity is low. In contrast, when the level of functional diversity within a team is high, the innovation speed is decreasing. They also believed that functional diversity negatively influences the shared purpose, collaboration, and an effective group process.

On the other hand, various studies in relation to product innovation contradict with the above statement and support the positive side of high number of functional representative in an NPD team. These studies focus on the advantages gained from an NPD team which consists of great number of functional diversity. Droge et al. (2004) and Akgun, Dayan, and Di Benedetto (2008) confirmed that the greater the functional areas being represented in an NPD team, the higher the ability to acquire, process, and utilize knowledge, which at the end enhance the degree of team’s innovativeness and creativity. This contradiction should be explained in more rigorous way in order to assist practitioner in this field to determine which paradigm to follow.

Figure 1.

Relationship between functional diversity and innovation speed (Carbonell & Rodriguez, 2006)



In a broader scope, issue on inadequacy of collaboration and communication should effect the effectiveness of internal-external practices integration. There have been so many queries on how to effectively integrate third parties into the NPD and how to properly link the firm's problem solving effects with the third parties, moreover when the suppliers or customers are geographically distributed.

Therefore, this study has a theoretical to test the effect of internal-external integration of NPD practices on overcoming structural and collaboration barriers which at the end result in improved product development time and product innovation. It will seek to answer the following questions:

1. What are the constructs involved in concurrent engineering, supplier integration, customer integration, knowledge management practices, and virtual team effectiveness?
2. How is the relationship between functional diversity and (i) product development time; (ii) product innovation?
3. Do concurrent engineering, supplier integration, customer integration, knowledge management, and virtual team effectiveness influence (i) product development time and (ii) product innovation?
4. Does virtual team effectiveness mediate the relationship of internal-external integration and (i) product development time; (ii) product innovation?
5. Does knowledge management mediate the relationship of internal-external integration and (i) product development time; (ii) product innovation?
6. Do the aggregate effects of direct and indirect path of exogenous variables influence (i) product development time; (ii) product innovation?
7. Does the variance in product development time and product innovation significantly explained by concurrent engineering, supplier integration, customer integration, knowledge management, and virtual team effectiveness?

By adopting product concept to economic value chain (Syamil, Doll, & Apigian, 2004), this study will try to provide a theoretical and practical highlight on internal-external integration of NPD practices, particularly in virtual environment, and their impact on product development time and product innovation. Since the majority of previous studies on NPD were conducted in developed countries (Lu & Yang, 2004), Malaysian manufacturing industry is chosen for the setting of this study to narrow the geographical imbalances of NPD literatures (Yahaya & Abu-Bakar, 2007). In developing countries like Malaysia, new product development practices and their impact on new product development success have not received great attention. Therefore, this study is dedicated to the development and expansion of new product development in newly industrializing economies.

The intense competition has forced manufacturing firms to explore the best practices that suite their needs. Successful firms must be able to cope with the competitive environments. One of the sustain power to be competitive is by involving all constituents in new product development as early as possible (Koufteros, Vonderembse, & Doll, 2001). This means that effective new product development requires a good integration and collaboration between internal and external participants (Koufteros et al., 2005).

Several empirical studies support the positive effect of strategic integration on new product development performance. Koufteros et al. (2005) conducted a study among discrete-part manufacturing firms and confirmed the importance of internal and external integration. Droge, Jayaram, and Vickery (2000) in their study of NPD in automotive supplier industry also affirmed the significant causal relationship of synergistic integration which includes cross-functional team, and new product development performance. Further in a more recent study (Droge et al., 2004), they found that both internal and external integration are related to time-based performance and in turn significantly result in higher financial performance.

In the context of time-based performance and innovativeness, adequate communication and collaboration between internal-external participants is among the primary importance. A well-structured information processing enables internal and external participants to share knowledge and interpretation (Daft & Lengel, 1986). In addition to that, knowledge management implementation and electronic communication technology assist the NPD team to engender creativity and innovation (Akgun et al., 2008).

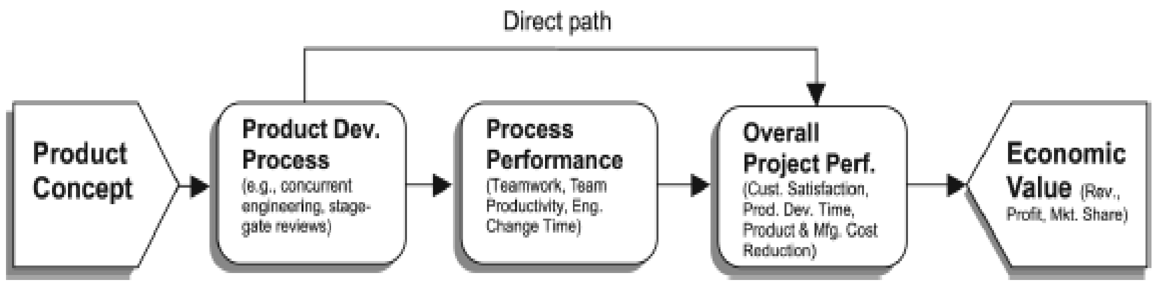
The perceived need for integration in product development is explained in uncertainty reduction theory (Gupta, Raj, & Wilemon, 1986). Since the existence of uncertainty in new product development is unavoidable, the need of integration among product development practices is compulsory to support the NPD team in order to cope with the fuzziness of their task environment. Furthermore, organizational theory also propose the integration of internal and external parties as a structural mechanism that firms employ to deal with the information processing requirements for developing and launching new product. Recent study of integration in new product development by Koufteros et al. (2005) indicate that internal integration acts as an important predecessor of external integration. However, neither uncertainty reduction theory nor organizational theory discusses the internal-external integration of NPD practices where the constituents are geographically distributed.

In order to investigate the existing gap of those theories, this study generates a model which is generated from product concept to economic value chain (Syamil et al., 2004) which is presented in Figure 2. Product concept to economic value chain is a causal chain of product development, starting from product concept and ending with economic value. This chain of categories of variables reflects the importance of process performance, i.e. teamwork, team productivity, and engineering change time, to intervene the relationship of product development process and overall project performance. Thus, this study emphasizes on the effectiveness of virtual team to mediate the correlation of internal-external practices integration and NPD performance. However, product concept to economic value chain does not particularly focus on the strategic integration among parties involved in the project.

Therefore, this study also would like to emphasize on the limitation of this model and concentrate on the internal-external integration of NPD practices.

Figure 2.

Product concept to economic value chain diagram (Syamil et al., 2004)



1.1 Internal integration: Concurrent engineering

Increasing pressure in the market, especially in manufacturing industry, demands organizations to shift their approach for product development into a more systematic and integrated approach in order to stay ahead of the competitors and concurrent engineering provide the necessities for manufacturing firms to improve their competitiveness and achieve the desired expectation.

Concurrent engineering allows integration of several functions as well as breaking the organizational boundaries, which is impossible to be practiced using the traditional engineering method. Experts from various functional disciplines are integrated during the actual design phase and tradeoffs related to productivity, testability, and serviceability are made in real time (Turino, 1992).

Concurrent engineering has been a notably internal integration process in NPD practices. Droge et al. (2004) expose concurrent engineering as one of the "design process integration" along side design for manufacturability, standardization, and computer aided design/ computer aided manufacturing. In a more recent study, Koufteros et al. (2005) also put concurrent engineering as the internal integration which acts as an antecedent to external integration.

2.4 Concurrent work-flow

The main distinction of concurrent engineering approach with conventional or traditional product development approach is on the execution of its activities. In conventional or traditional product development approach, each activity is done in sequence and controlled by one function at a time. On the other hand, concurrent engineering enables various activities to be done in parallel or simultaneously. This concurrent work-flow allows early release of information (Koufteros et al., 2001) in order to provide ease for the manufacturing team members to detect problems during the early stage while the product design is in progress. According to Cooper (1988), simultaneous activities require cross-functional team and intense information processing in order to achieve its goals. Further, this approach reduces time-consuming rework and reduces uncertainty.

2.5 Product development team

The primary process in adopting concurrent engineering philosophy is teaming, which involves the assemblage of people with different skills, experiences and perspectives on the product development process. Each of the team members in concurrent engineering team represents the relevant departments and functions.

The concurrent engineering team is composed of experts from various functional areas such as engineering, production, marketing, and R&D which has a vested interest in the development project. The team is formed to work on a specific project, and stays together throughout the development of the product. The continuity in team membership underscores the need to establish long-term relationships with the core team members and also with both customers and suppliers or subcontractors.

As cited in Koufteros et al. (2001) there are several advantages of involving people with different expertise in NPD practice. Functional diversity enables the team to produce more creative solutions (Osborn, 1957), make better decisions (Davis, 1973), and improve the implementation of decisions and increase commitment (Cohen & Ledford, 1991; Hoffman, 1979). High functional diversity within a product development team also engenders transfer of knowledge and ideas, as mentioned by Fischer (1980). Therefore, it shows the positive relationship between functional diversity and product innovation if the communication within the product development team is well-structured. With respect to product development time, there is a contradiction of findings among scholars. Carbonell and Rodriguez (2006) found the relationship among functional diversity and innovation speed is in inverted-U shape. On the other hand, Putnam (1985), Whitney (1988), Raturi, Meredith, McCutcheon, and Camm

(1990), Fleischer and Liker (1992), and Ulrich, Sartorius, Pearson, and Jakiela (1993) (as cited in Koufteros et al., 2001) believed that greater level of functional diversity in a product development team would result in shorter manufacturing lead time.

In order to ensure the effectiveness and continuity of the product development team, members contributing to the design and development of new product should be located close to each other. Collocation of team has been considered as one of the main tools for enabling concurrent engineering (Bergring & Andersin, 1994). According to Kim and Kim (2009) and Boyle et al. (2006), in current virtualized coordination era, physical collocation is still relevant since it is complicated to manage the communication process for geographical separated team and it may inhibit the process of NPD. However these studies are more on product quality as NPD success determinant, while the impact of virtual collocated team on product development time and innovation is still abstract and need further investigation.

Involvement of internal and external constituents during the initial stage of new product development is critical. As stated in theory of organizational information processing (Daft & Lengel, 1986), early planning and collaboration between design and manufacturing is important to reduce uncertainty. Early exchange of information and shared of visions, missions, and values should eliminate information gaps among constituents and further less design and manufacturing problems are generated (O’Neal, 1993). Beside structural purposes, early involvement of constituents also benefits the team to select and integrate the technological resources. The study of product development in the context of internationalization conducted by Hong and Roh (2009) suggest that organizational and technology integration is achieved should constituents are involved early during the initial stage of new product development.

2. External integration: Customer and supplier integration

Customer and supplier integration is a vital additional constituent in new product development practices. A lot of past studies include both customer and supplier involvement as predictors to new product development performance (Droge et al., 2000; Droge et al., 2004; Gonzalez & Palacios, 2002; Koufteros et al., 2005; Langerak & Hutlink, 2008; Petersen, Handfield, & Ragatz, 2003; Petersen, Hansfield, & Ragatz, 2005; Ragatz, Handfield, & Scannell, 1997; Ragatz, Handfield, & Petersen, 2002; Sherman et al., 2000; Song & Di Benedetto, 2008). Customer integration is critical in today's business, especially those that closely related to high degree of innovativeness. The presence of customers in new product development team provides a good understanding of current customers' requirements out there in the market. Moreover, customer involvement gives extra knowledge for the internal constituents to produce product that customers really demanding. It is believed that close collaboration and relationship with customers would enhance timely responsiveness (Drickhamer, 2002). According to Koufteros et al. (2005), customer integration positively effect product innovation, especially in high equivocality environment. Further, the information and market knowledge generated by customers would contribute to higher quality and cycle time reduction (Sherman et al., 2000).

2.7 INTERNAL INTEGRATION

In order to enhance strategic integration, manufacturing firms must be able to accurately choose the best NPD practices which can accommodate both internal and external necessitates. Thus, an internal NPD practice such as concurrent engineering is compulsory to improve company's overall NPD performance. One of the most influential enablers for perceived benefits of concurrent engineering is integration of cross-functional teams and deployment of collocation teams (Maylor & Gosling, 1998).

As cited in Koufteros et al. (2001) there are several advantages of involving people with different expertise in NPD practice. High functional diversity within a cross-functional team engenders transfer of knowledge and ideas. Moreover, Droge et al. (2004) and Akgun, Dayan, and Di Benedetto (2008) confirmed that the greater the functional areas being represented in an NPD team, the higher the ability to acquire, process, and utilize knowledge, which at the end enhance the degree of team's innovativeness and creativity.

Furthermore, the involvement of internal constituents such as R&D, manufacturing, and marketing personnel during the initial stage of new product development is critical. As stated in the theory of organizational information processing, early planning and collaboration between design and manufacturing personnel is important to reduce uncertainty. Early exchange of information and shared of visions, missions, and values should eliminate information gaps among constituents and further less design and manufacturing problems are generated. Thus, integrating internal constituents as early as possible would accelerate product development speed. The study of product development in the context of internationalization conducted by Hong and Roh (2009) suggest that organizational and technology integration is achieved should constituents are involved early during the initial stage of new product development. Based on the above, the following prepositions are offered:

2.8 EXTERNAL INTEGRATION

Along side internal integration, customer integration is also one of the critical elements in new product development. It is a valuable way to achieve new product success (Gales & Mansour-Cole, 1995; Gruner & Homburg, 2000). The presence of customers at every stage of new product development would benefit companies in many ways (Callahan & Lasry, 2004; Gales & Mansour-Cole, 1995). New product ideas, enhanced product development effectiveness, market uncertainty reduction, and reduced time to market are among the benefits arising from close customer partnership. On top of that, customer integration also positively effect product innovation, especially in high equivocality environment (Koufteros et al., 2005).

In line with customer integration, supplier integration plays an important role in better execution of product development activity. The effects of supplier involvement in product development are expected to enhance both strategic and operational outcomes. The strategic impact includes increased efficiency and effectiveness as well as better access to technological resources and knowledge; while the operational impact relates to lead time reduction, cost reduction, provides alternative solutions on materials, and development of better products. In addition, supplier closeness would also result in boundary-spanning synergetic integration which accommodates manufacturing firms to generate its own knowledge capital (Droge et al., 2000). This knowledge capital is important to minimize time involved in new product development. Thus, external constituents such as customer and supplier play a pivotal role in cross-functional team, especially when it comes to idea generation and product concept. Hence the following prepositions are offered:

2.9 Supplier integration

The impact of supplier integration has been widely investigated by scholars. There are many advantages of bringing suppliers early into the new product development (Hartley et al., 1997). According to Monczka and Trent (1997) in their study of US manufacturers, it was found that suppliers need to be early integrated into the NPD team since 50% of the cost of good sold is generated from purchase of materials.

In the supplier integration, there are two kinds of approach that lead to supplier strategic collaboration, which are supplier development and supplier partnership (Droge et al., 2000; Droge et al., 2004; Koufteros et al., 2005). Both of this approach is important predictors to NPD time minimization. Supplier development relates to the practice of assessing and evaluating the supplier's performance as well as providing facility for the supplier personnel to improve their capability (Droge etal., 2000; Droge et al., 2004). On the other hand, supplier partnership is closely related to early involvement of suppliers into the NPD process to provide useful thoughts and ideas to product design and access to technology capabilities (Droge etal., 2000; Droge et al., 2004).

Furthermore, Petersen et al. (2005) used three critical factors as the antecedent to successful supplier integration. These three factors; detailed supplier assessment, technical assessment, and business assessment, are generated from previous researches and have effectively explained the success of supplier integration to NPD process in various industries. Selecting the right supplier is the most critical aspect that needs to be assessed and both technical and behavioral aspects should also be considered since the partnership with supplier is along-term basis partnership. Beside that, the degree of supplier involvement in establishing technical performance measures and targets is also significant in ensuring the success of supplier integration. The technical elements being assessed include quality, reliability, and functionality. Other elements such as cost, schedule, pricing, and other business variables are also critical with respect to the continuation of the project. Supplier need to be highly involved in determining the measures and targets of business performance. Both technical and business performance targets must be clearly defined and agreed right at the initial stage of supplier integration.

Should all of the critical factors above being assessed and other structural and contextual supporting tools such as buyer and supplier’s top management commitment, shared education and training, and reward sharing (Ragatz et al., 2002) are applied, successful supplier integration should be achieved. In addition, supplier closeness would also result in boundary-spanning synergetic integration which accommodates manufacturing firms to generate its own knowledge capital (Droge et al., 2000). This knowledge capital is important to minimize time involved in new product development.

2.10 Virtual team effectiveness

Centralized collocated product development is no longer efficient in globalized manufacturing and trade world (Rafii, 1995). Centralized collocated team such as physical collocation team should be switched to a more widespread group of people, thus, virtual collocation team becomes the preference to manufacturing firms nowadays. Globalization is one of the main drivers of virtual collocation team. Paradigm shift forced by current global competitiveness has promoted virtual collocation team becoming a solution to product development. Duarte and Snyder (1999) stated that virtual collocation team is formed as a result to new ways of working, being introduced as a reaction to current business requirements. Shift in organizational trends also affect manufacturing firms to start applying virtual collocation team. According to Haywood (1998), mergers, acquisitions, downsizing, and outsourcing are the examples of organizational trends which contribute to the rapidly growing trend in implementing virtual team. Furthermore, cross organizational product development and significant changes in products and services are also the main drivers for virtual team.

Other factors contribute to the success of virtual team that have been identified are those which closely related to the common characteristics of virtual teams. As concluded from several studies from the past, there are at least five key factors contributing to the effectiveness and failure of virtual team. The key factors include: (1) Clarifying objectives (Earnhardt, 2009; Horwitz, Bravington, & Silvis, 2006); (2) the use of communication technology (Duarte & Snyder, 1999; Earnhardt, 2009; Horwitz at al., 2006); (3) team forming (Earnhardt, 2009: Horwitz, Bravington, & Silvis, 2006); (4) trust (Earnhardt, 2009); and (5) leadership (Duarte & Snyder, 1999).

Another important aspect in making virtual collocation team applicable is the rapid development of technologies. Advanced electronic communication media allows the virtual team to perform effectively and efficiently. A study of 462 new product development teams found that electronic communication media use results in positive NPD team effectiveness (Kock, Lynn, Dow, & Akgun, 2006). Electronic communication media also facilitates the development of virtual team. On top of that, the use of virtual collocation team allowing higher return on investment due to decrease in cost of bandwidth (Haywood, 1998), drastically reduce travel time and cost, and engender creativity and originality among team members (Bergiel, Bergiel, & Balsmeier, 2008).

2.11 VIRTUAL INTEGRATION

Virtual teaming, a relative recent phenomenon, is becoming increasingly attractive to organizations due to developments in communication technologies. Due to the recent trend towards corporate restructuring, change in business requirements such as cross organizational product development, and intense competition in manufacturing industry, firms are forced to work with others which are often dispersed across space, time, and organizational boundaries. In specific, shift in organizational trends affect manufacturing firms to start applying virtual collocation team. According to Haywood (1998), mergers, acquisitions, downsizing, and outsourcing are the examples of organizational trends which contribute to the rapidly growing trend in implementing virtual team. Another important aspect in making virtual collocation team applicable is rapid development of technologies. Advanced technology and communication tools allow the virtual team to perform effectively and efficiently. They also facilitate the development of virtual integration and allow higher return on investment due to decrease in cost of bandwidth.

Based on the past literatures, there are five key predictors in effectively integrating internal and external NPD constituents into a virtual team. The five factors include clarity of objectives, communication technology usage, team forming, mutual trust, and proper leadership (Duarte & Snyder, 1999; Earnhardt, 2009).

Leader of the virtual team must be able to clearly communicate the objectives of the NPD project. Roles, expected contributions, and boundaries must also be well-specified, otherwise miscommunication would occur in the latter stage of product development, which in turn would prolong the product development time. Moreover, communication among internal and external constituents is more difficult to organize in geographically separated team. Thus, technology for communication and collaboration across distance becomes an important facet of managing and studying virtual teams. Virtual teams need to have the ability to adapt and shape communication technologies to their specific purposes to be success. Because of the nature of virtual teams that does not allow frequent informal face-to-face interaction, highly structured communication among team members become inevitable. The communication among participants should be clear and in constant manner to ensure the information is well-received by everyone. Rapid development of communication technologies nowadays, such as internet and other sophisticated tools, provides the ease to make virtual teams become possible. Those advanced communication technologies include internet, electronic mail, video conferencing, bulletin boards, and groupware.

Virtual teams could be formed from infinite pool within the organization and from external organizations. The involvement of suppliers and customers in the team would increase the challenge of virtual team formation. However, if all of the factors mentioned above is properly executed and implemented, integration of internal and external constituents into a virtual team should accelerate NPD time. On top of that, virtual integration of internal constituents and customers improve the output of knowledge creation as well as knowledge distribution (Nambisan, 2002). Nambisan (2002) also stated that virtual integration supports the implementation of knowledge acquisition and knowledge creation. Advanced communication technologies enable internal constituents and customer to interact and collaborate intensively which trigger innovative and creative ideas. Virtual integration effectiveness is expected to significantly mediate the relationship of internal-external integration and NPD time.

2.12 Knowledge management and New Product Development

Knowledge gained from either internal or external constituents should be managed properly, thus knowledge management is strongly advised to be implemented especially in a high uncertainty market environment. Knowledge management relates to the ability of a firm to search, obtain, create, and share knowledge which results in higher competitive advantage and improved product performance (Jiang & Li, 2008). Since the main objective of knowledge management is to enhance knowledge innovation, it is important for firms to explore and utilize both tacit and explicit knowledge effectively. Since knowledge management involves activities which relate to collecting and transferring information, there are four main activities in knowledge management; knowledge obtaining, knowledge refining, knowledge storing, and knowledge sharing (Liu, Chen, & Tsai, 2005).

Several prior studies have been conducted in order to explore the importance of knowledge management in new product development practices. Moorman (1995) found that market information significantly reduced uncertainty, while Akgun et al. (2008) indicate that team intelligence would engender creativity, and higher functional diversity within a team would result in better knowledge activities effectiveness. Further, highly implemented knowledge management practices affect NPD performance positively (Akgun et al., 2008; Liu et al., 2005). In addition, Jiang and Li (2009) in their recent studies on knowledge management among 127 German partnering firms, where knowledge management was employed as intermediaries, suggest that knowledge sharing and knowledge creation lead to innovative performance. Another study of R&D integration and knowledge integration of past projects also determine the importance of knowledge integration on product development cycle time (Sherman et al., 2000). Interestingly, Badrinarayanan & Arnett (2008) propose that knowledge management should positively enhance decision quality and decision speed in the context of virtual team.

2.13 Product innovation

According to Koufteros et al. (2001), product innovation can be referred as the capability of organizations to introduce new products and features. Thus, new product development success is very much depended on the ability of firms to generate new features or innovative product. Continuous innovation is required for manufacturing firms to be able to cope with fast technological change and to meet customers' needs and expectations (Blackburn, 1991).

The success of new product can not be separated from proper development of innovation strategy. As indicated by Cooper and Kleinschmidt (1987), as well as Olson, Orville, Walker, Ruekert, and Bonner (2001), innovation strategy significantly relates to cross-functional team and NPD performance. In addition, the extensive communication and shared value of functional representatives involved in cross-functional team enhance concurrent activities in new product development. Through the aid of computer technology, cross-functional teams are able to share information rapidly and reduce equivocality. Beside for the purpose of information sharing and communication, computer technology is also favorable to support the team to produce innovative product (Senderson, 1992). Therefore, concurrent engineering is also positively influence product innovation (Koufteros et al., 2002; Koufteros et al., 2005; Koufteros et al., 2006).

2.14 New product development (NPD) time

NPD time is among the NPD success determinants that receive a great attention from practitioners in this industry since its criticality in product development. NPD time can be divided into two phases; the pre-launch phase and the production and market launch phase (Droge et al., 2000). The pre-launch phase is the early stage of NPD where product concepts, idea generation, technical and financial assessments, marketing plan development, and testing are accomplished. Whereby, the production and market launch phase is a more time consuming stage where the production ramp-up and commercialization of product are occurred. The ability of firm to accelerate these two phases should improve profitability by allowing development and manufacturing cost advantages (Gonzalez & Palacios, 2002).

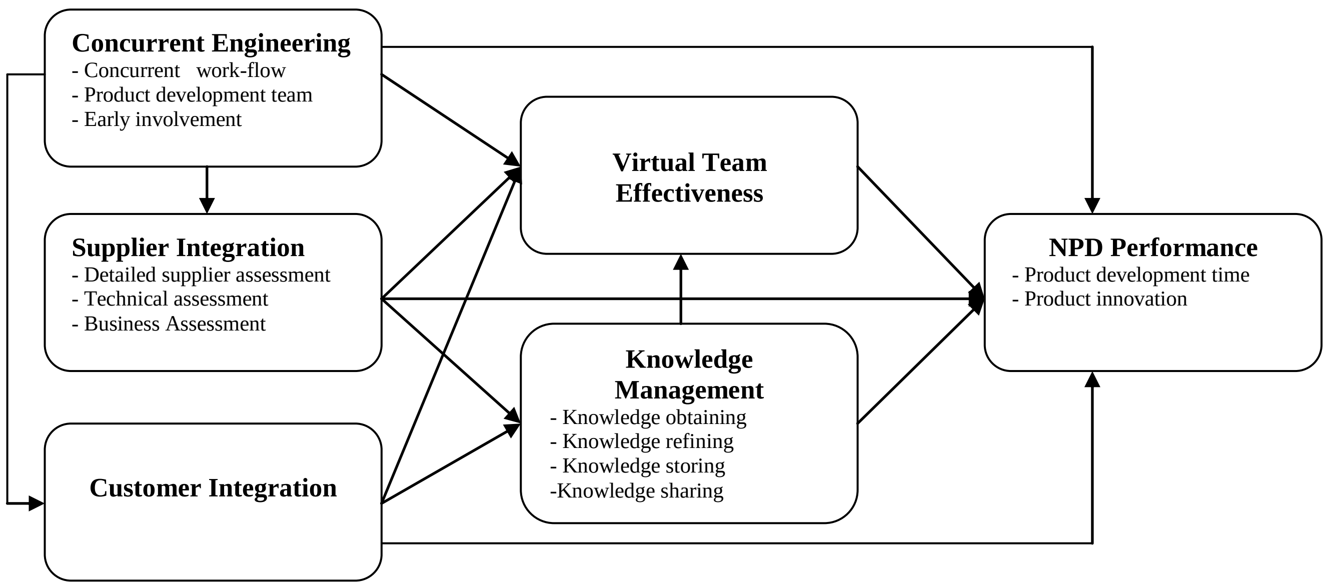
Faster product development and early introduction of product provide a great advantage for manufacturing firms, particularly in term of competitiveness. Internal integration, such as concurrent engineering, and external integration such as supplier and customer integration positively correlate to product development time. Droge et al. (2004) suggest the importance of early involvement of both internal and external parties through extensive communication during idea generation and conceptual stage. This early involvement, as supported by Clark and Fujimoto (1991) and Wheelwright and Clark (1992), helps to accelerate the overall process of product development time.

Another study conducted by Carbonell and Rodriguez (2006) indicate staff-related and structural-related factors such as team proximity or collocation and functional diversity, which usually engage in internal-external integration, also explain the variance of product development time. Team proximity or collocation is positive and significant in explaining innovation speed particularly in technologically complex project. While for functional diversity, an increase of functional diversity accelerates innovation speed only at low level of functional diversity.

Theoritical framework for this study based from study by Droge et.all (2004) are as follows.

Figure 3.

Theoretical framework



Source : Droge et.all 2004

2.17 Summary

This chapter starts with introduction section, followed by virtuality as moderating variables, organization integration as intervening variable, external and internal integration as independent variables and new product development performance as dependent variables. Based on the result of literature review, several conclusions seem reasonable. There is evidence showing that those factors are vitally important to show the relationships between organization integration , external and internal integration, virtuality, toward new product development performance The literature also discovered that virtuality moderates the relationship between organization integration and new product development performance. After a discussion on literature review, a framework of the relationship of virtuality, organization integration, external and internal integration toward new product development performance were developed. Four groups of hypotheses are to be tested from the framework. The next chapter is devoted to discussing the methodology of the study.

CHAPTER 3

RESEARCH METHODOLOGY

The purpose of this chapter is to present the methodology used to test the hypotheses in this research. An explanation of the process from the identification of item measures to the assessment of survey results has been included. The chapter consists of a methodological overview and discussion of item measure development, questionnaires development, and survey administration.

3.1 Introduction

The main aim of this study is to investigate the relationship between, concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development.

As the data for this study was collected at a single point in time, as mentioned by (Zikmund, 2000; Sekaran, 1992) the study is a cross sectional study in that time horizon. This is an appropriate strategy because the main focus of the study is to explain the factors which contribute to new product development concept in the manufacturing sector.

The study was conducted in a two phases, phase 1 is a pilot study to examine the re-ability of the instrument and phase 2 is main study using the revised instrument to examine the relationship among the variables. A survey method using questionnaires was chosen for data collection. According to Zikmund, (2000) the selection of the survey approach design was done according to the following reasons:- The individuals will be the unit of analysis interest in collecting original data from a population which is too large to observe or interview; Measuring the perception of the individual; Lower cost of time and money; minimize the personal bias in providing a greater degree of objectivity; Usefulness of testing the hypotheses.

The use of survey method precludes the ability to establish the causal priorities of the independent and dependent variables, as provided by Nichoff, (1990). Table 5.0 demonstrates an outline of the methodology that has been applied for this research. The discussion of methodology addresses four sections including item measure development, questionnaire development, survey management and data analysis. Data analysis is discussed in chapter 4.

Item measures that were identified and variously developed are included in the study. Most item measures were based on previous research instruments whether following the prior design or with several adjustments. Some measures were specifically developed for this research.

Table 2.0: An overview of Research Process

ITEM MEASURE DEVELOPMENT
concurrent engineering, organizational integration, customer involvement, supplier involvement, virtuality new product development.

↓

QUESTIONNAIRE DEVELOPMENT
Construction of Initial Questionnaire Pilot Test

↓

SURVEY ADMINISTRATION
Survey Plan Survey Implementation Response Analysis

↓

DATA ANALYSIS
(Chapter 4 and 5 FINDINGS ,DISCUSSION AND CONCLUSION)

The development process of questionnaire will be described later. In this research, each aspect of the survey process, from developing the questionnaire to survey administration, was assured to lead the possible responses to the questionnaire. Furthermore, a pilot test included to obtain the best possible questionnaire.

Survey administration was done by several sub-steps including survey planning, implementation, and post-survey analysis. The research design, sampling frame and sampling size were chosen and determined. A multiple ways were applied in conducting the mail survey. Analyses of post-survey results include aggregate respondents' profile and responds rate analysis.

The final step of the methodology is data analysis. Data obtained from the survey was analyzed by using appropriate statistical methods in order to test all research hypotheses. Validity and re-ability assessments were generated as well. The results of data analysis were summarized separately in Chapter 4.

3.2 Item Measurement Development

Measures for 10 items for concurrent engineering, 4 organizational integration, 7 customer involvement, 7 supplier involvement, 4 for overall integration and 17 virtuality , 6 for NPD success, 4 for NPD speed and 4 product innovation were largely identified. These items were formed based on the literature. The process resulted in multiple item measures for each construct. The questionnaires are adopted with modification to local requirement from (Parente, 2003; Lau Antonio et. al. 2007).

3.2.1 Concurrent Engineering Measurement

There are six item of concurrent engineering, which will cover each of the items in concurrent engineering and topics in this scope. Items for concurrent engineering were developed following from, Koufteros, Vonderembse, & Jayaram (2005). Furthermore, a multi source has been used as indicated in Table 2.1

3.2.2 Customer Involvement Measurement

Through a focused literature search, six items are deemed vital across these studies which were identified customer involvement in product manufacturing sectors. In developing survey items for the factors, a multi sources has been used as indicated in Appendix A (2). The new items were also developed in order to operational several factors. Items for concurrent engineering were developed following, Sherman, & Davis-Cooper (1998)

3.2.3 Supplier Involvement measurement

This study measures seven item of supplier involvement**.** For each item, the measurement were identified and developed using eight elements to ensure an adequate coverage of the new product manufacturing flexibility. Items for each criterion were developed following (Koufteros, Vonderembse, & Jayaram (2005) ,Sherman, Souder, & Jenssen (2000). A multi source has been used as indicated in table 2.1.

3.2.4 Virtuality Measurement

In this study, it measures seventeen items of virtuality. All the items were identified and developed to make sure they will cover the virtuality measurement. Items for each item were developed following, Chudoba, Lu, Watson-Manhein, & Wynn (2003). A multi source has been used as indicated in Table 2.1.

3.2.5 New product development Measurement

There are five item of New product development**,** which will cover all the factors in new product development and each of the items was identified. Items for each factors were developed following, Koufteros, Vonderembse, & Jayaram (2005), Carbonell & Rodriguez (2006); Lukas & Menon (2004). A multi source has been used as indicated in Table 2.1..

3.2.6 Overall Integration Measurement

There are four item of overall integration, which will cover all the factors in **overall integration** and each of the items was identified. Items for each factors were developed following, Millson & Willemon (2002). A multi source has been used as indicated in Table 2.1.

3.3 Questionnaire Development

A mail questionnaire was used to obtain information from designated respondents. This means of gathering information is commonly used in organizational research because it offers many advantages. According to (Gilbert, 2001; Sekaran, 1992) mentioned that it allows researcher to obtain a substantial amount of information from a sample that is widely dispersed geographically at minimal costs. Furthermore, besides promise confidentiality, it also allows respondents to complete the questionnaires at their own convenience with ample time, as noted by (Miller et. al. 2002; Gilbert, 2001).

In spite of its advantages, there are some potential risks when researchers choose to use mail survey. According to Gilbert, (2001) mail surveys usually have a low response rate, and one cannot be sure if the data obtained are biased because the non-respondents may be different from those who did respond, as suggested by (Miller et. al. 2002; Sekaran, 1992). However, this research used some effective techniques to mitigate this risk, as reported by Sekaran, (1992) such as providing the respondent with introductory letter, self-addressed, stamp return envelopes, keeping the questionnaires as short as possible and make telephone follow-up.

3.3.1 Construction of Initial Questionnaire

Writing good questions is an important step for the success of a mail survey. In this study, the questions are short and straight to the point by using simple and specific words. Almost all the questions were closed-ended with ordered response choices. Each question provides a range of response choices representing a continuum from the lowest level to the highest level of single concept. Respondents answered the question by finding the most appropriate level on the continuum. Compared to open-ended questions, this kind of question is less demanding and easier for respondent to answer, and they also facilitate coding and analysis of responses by the researcher.

The questionnaire developed in this study consisted of four main sections; the personal information, company profile, implementation all the variables in the company, and finally if they not implement product modularity in the company. The second section was intended to determine fundamental issues, including the size of the company, type of industry, experience and also the position of the respondents in their company. The major part of the questionnaires comprised the new product in manufacturing section derived from a focused literature search. Four major factors believed to be crucial for manufacturing firms were proposed (Carbonell & Rodriguez (2006); Lukas & Menon (2004).

For each of the factor, a number of items or statements were carefully formulated using Likert scale. Likert scale is used to measure a wide variety of latent constructs, particularly in social science research. The majority of the product modularity research studies discussed in chapter two utilize. Likert scales to measure various factors. In this section, the scales ranged from '1' which means 'strongly disagree' to '5' means "strongly agree" which show the degree of level commitment applying the modularity concept or process. '2' refers to "disagree". '3' refers to "neutral", '4' for "agree" and '5' refers to "strongly agree". Respondent were asked to indicate their agreement or disagreement with the statements as they though it was currently practices.

The third section of the questionnaire also comprised the concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development that also derived from a focused literature research. All the major factors believed to be crucial for all this section was also proposed (Carbonell & Rodriguez (2006); Lukas & Menon (2004). The items also used Likert scale. Likert scale which was given as '1' refers to "not applied" to '4'means "fully applied". "2" refers to less applied, and "3" refers to "partially applied". All the items show the degree of application for customer demand, manufacturing flexibility, cost, and supply chain. Respondent were asked to indicate their agreement or disagreement with the statements as they thought it was currently practices.

The intended respondent for the questionnaire was an individual at the selected company who was a Technical Manager, Production Manager, Quality Assurance or others qualified in new product development process. It was crucial that the data and information comes from those who have good understanding in production of the company. The questionnaire also presented in English language.

3.3.1.1 Source of Questionnaires

Table 2.1 Source of Questionnaires

• **Concurrent Engineering**	1. Much of process design is done concurrently with product design. 2. Product development activities are concurrent. 3. Product development group members share information. 4. Product development group members trust each other.	Koufteros, Vonderembse, & Jayaram (2005)

	5. Product development employees work as a team. 6. Product development group members seek integrative solutions. 7. Purchasing managers are involved from the early stages of product development. 8. Process engineers are involved from the early stages of product development. 9. Manufacturing personnel is involved from the early stages of product development. 10. Various disciplines are involved in product development from the early stages.	
• **Customer Involvement**	1. We typically rely on the user to help us define and clarify that user's needs in developing our new products. 2. We visit our customers to discuss product development issues 3. During the development of our products, we often have the users try out whatever we have developed up to that point. 4. We typically try to put working prototypes in the user's hands as early as possible in our development efforts. 5. We proficiently review customer reactions to early product designs.	Souder, Sherman, & Davis-Cooper (1998)
	6. We study how our customers use our products. 7. Our product development people meet with customers	Koufteros, Vonderembse, & Jayaram (2005)
• **Supplier Involvement**	1. Our component suppliers often place some of their personnel on our development teams.	Sherman, Souder, & Jenssen (2000)

	2. Our suppliers do the product engineering of component parts for us. 3. Our suppliers develop component parts for us. 4. Our suppliers develop whole subassemblies for us. 5. Our suppliers are involved in the early stages of product development. 6. We ask our suppliers for their input on the design component parts. 7. We make use of supplier expertise in the development of our products.	Koufteros, Vonderembse, & Jayaram (2005)
• **Overall Integration**	1. NPD team and other organizations attempted to avoid creating problems for each other during the NPD process. 2. NPD team and other organizations were perceived to have mutual new product goals. 3. NPD team and other organizations appeared to work smoothly together to develop a new product. 4. NPD team and other organizations acted as a unified group during the development of a new product.	Millson & Willemon (2002)
• **Virtuality**	1. Work at home during normal business days. 2. Work while travelling, for example, at airports or hotel. 3. Collaborate with people in different sites or geographies. 4. Collaborate with people you have never met face-to-face. 5. Work extended days in order to communicate with remote team members. 6. Collaborate with people in different time zones. 7. Collaborate with people who speak different native languages or dialects than your own. 8. Collaborate with people from different cultural backgrounds. 9. Work on projects that have changing team members. 10. Work with teams that have different ways	Chudoba, Lu, Watson-Manhein, & Wynn (2003)

	to track their work. 11. Work with people that use different collaboration technologies and tools. 12. Collaborate with people from different business groups or departments. 13. Work at different sites. 14. Have professional interactions with people from outside the organization. 15. Participate in real-time online discussions, such as chat or instant messaging. 16. Meet with people via video-conferencing tools. 17. Work with mobile devices.	
• **NPD Success**	1. Overall, this project met or exceeded sales expectations 2. This project met or exceeded profit expectations 3. This project met or exceeded return on investment expectations 4. This project met or exceeded overall senior management's expectations 5. This project met or exceeded market share expectations 6. This project met or exceeded customer expectations	Cooper & Kleinschmidt (1987)
• **NPD Speed**	1. This project was developed and launched faster than the major competitor for a similar product 2. This project was completed in less time than what was considered normal and customary for our industry 3. This project was launched on or ahead of the original schedule developed at initial project go-ahead 4. Top management was pleased with the time it took us from specs to full commercialization	Carbonell & Rodriguez (2006); Lukas & Menon (2004)

• **Product Quality**	1. Our capability of offering products that function according to customer needs over a reasonable lifetime is 2. Our capability of offering a high value product to the customers is 3. Our capability of offering safe-to-use products that meet customer needs is 4. Our capability of offering reliable products that meet customer needs is 5. Our capability of offering durable products that meet customer needs is 6. Our capability of offering quality products that meet customer expectations is 7. Our capability of offering high performance products that meet customer needs is	Koufteros, Vonderembse, & Jayaram (2005)
• **Product Innovation**	1. Our capability of developing unique feature is 2. Our capability of developing new product and feature is 3. Our capability of developing a number of new features is 4. Our capability of developing a number of new products is	Koufteros, Vonderembse, & Jayaram (2005)

3.3.2 Pilot Test

Following the responsible survey research practice, as noted by Sekaran, (1992), the instrument was tested, through the administration of a pilot study, to assess the wording and preliminary information on the validity and reliability of measured items for each research variables. A total of 30 initial questionnaires were distributed to a range of industries in manufacturing firms in Malaysia.

3.3.3 Validity

In an attempt to ensure that the measures developed are reasonably good, it must meet two main criteria; validity and reliability. Validity refers to the extent to which the instrument measures what it supposed to measures while reliability refers to the consistency of this measurement instrument, as mentioned by Sekaran, (1992). Following the pilot test, the analysis was focused on the content validity and reliability assessment. Content validity was the first criteria established. Content validity is always subjectively evaluated by the researcher, as noted by Sekaran, (1992). The survey was piloted to academicians and practitioners who verified its content.

In this research, opinions from managers that have experiences about modularity process in manufacturing firms were collected and analyzed. Some concern was expressed on wordings of the questions either need change or add several words to provide more understanding. For examples, they commented about the fonts which they advised to make it bigger, and they suggested preparing the questionnaires in two languages, so that respondents can understand the question properly.

3.3.4 Reliability

Another test that has been done in pilot survey was Cronbach's Alpha. A classical measure of reliability, Cronbach's Alpha was used to examine the internal consistency and reliability of the items within each scale. Cronbach's Alpha is a reliability coefficient that reflects how well items are correlated to one another. Cronbach's Alpha is computed in terms of the average inter-correlation among the items measuring the concept. The closer the Cronbach's Alpha is to 1, the higher the internal consistency reliability, as stated by Sekaran, (1992).

3.4 Survey Administration

The success of a survey is not merely depended on the quality of the questionnaires but also considered on how the survey activities are administrated. Thus, this section will discuss the survey plan and its implementation that was done for this research.

3.4.1 Survey Plan

The survey plan will describe the determination of the targeted populations and respondents, and the design of survey sampling.

3.4.2 Targeted Population

The purpose of this research is to determine the status of new product development in manufacturing firms. The research was focused in Malaysia manufacturing. In an attempt to complete the research, manufacturing companies across a large range of industries such as electrical and electronic, steel production, engineering supporting, machinery and equipment and others were studied. The classification of this industry was followed by Federation of Malaysian Manufacturers (FMM) according to FMM Directory 2009, Malaysian Industries and Association of Proton Vendor.

3.4.3 Unit of Analysis and Targeted Respondent

In this research, the unit of analysis is the organization. Each respondent was chosen to represent a company. Considering this matter, the targeted respondent should be someone who is familiar with the operations of the company and someone that manage the operation in the company. As mention earlier, the person should include the Technical Manager, Production Manager, Quality Assurance Manager or someone similar.

3.4.4 Sampling Frame and Sample Size

The sampling frame is a list of targeted population members from which a survey sample will eventually be drawn. The list used in this study contained 250 manufacturing companies in Malaysia, which are registered in Federation of Malaysian Manufacturer (FMM) and Association of Proton vendor. As this research pertains to populations within identifiable geographical areas for example, state, an area sampling procedure will be done. The sample size in this research was determined by using the table provided by Sekaran, (1992). Based on this table, a number of 150 companies need to be selected as a sample in order to represent the overall population which is 350 companies. Then, a sample of members from each state was drawn using a proportionate random sampling procedure. The members drawn from each company were proportionate to the total number of companies in Malaysia. This sampling procedure assures that each company has equal chance of being chosen as the sample. Moreover, Lau et. al. (2001) stated that generalization can only be drawn when random samples are used. Then, the samples sizes are drawn by using a simple random sampling procedure which assures each company has equal chance of being chosen as the sample.

3.4.5 Survey Implementation

A number of techniques involved in implementing the survey. Firstly, a cover letter is attached together with the survey to describe the objectives of the study and to assure informants that their answers are private and confidential. According to Galbreath, (2004) informed that personalization of cover letters and assurance of confidentiality is positively associated with response rates. Furthermore, the cover letter is using the letter head of College of Business, Universiti Utara Malaysia. Lastly, Galbreath, (2004) showed that subjects are more likely to give unbiased responses when their anonymity is assured. Thus, all informants were assured anonymity.

3.4.6 Item Descriptions of Questionnaire Section

Part	Measures	Number of Items
Section I	Personal Information	3
Section II	Company Profile	6
Section III		
Part I	Concurrent Engineering	10
Part II	Customer Involvement	6
Part III	Overall Integration	4
Part IV	Supplier Involvement	7
Part V	Virtuality	17
Part VI	New Product Speed	4
Part V11	NPD Success	6

3.4.7 Method of Data Analysis

The data collected through questionnaire was coded and analyzed using Statistical Package for the Social Science (SPSS) version 17.0. An overview of the analysis was described before the actual finding was discussed.

Preliminary test were undertaken to determine the response rate, descriptive statistics, validity and reliability of the study constructs. Response rate was determined by computing frequency and percentage of response based on feedback received. Descriptive statistical analysis included frequencies and percentage were used to present the main characteristics of sample. Factor analysis and reliability analysis were used to assess the construct validity and reliability of the independent variable of customer demand, manufacturing flexibility, cost, and supply chain and dependent variables of product modularity. The result of response rate, descriptive statistics, factor analysis and reliability analysis are reported to the following chapter.

3.4.8 Multiple Regression Analysis

Multiple Regression analysis is a form of general linear modeling. A multivariate statistical technique was used to examine the relationship between a single dependent variable and a set of independent variables. This application is useful for hypothesis to explain the variance of the four independent variables on a single dependent variable.

There are four important statistical assumptions for multivariate technique to representing the requirements of the underlying statistical theory. They are normality, linearity, homoscedasticity and multicollinearity, as stated by Hair, (2006). The series of graphical and statistical tests directed towards assessing the assumptions underlying the multivariate techniques revealed relatively little in terms of violations of the assumptions. Where violations were indicated, they were relatively minor and did not present any serious problems in the course of data analysis.

3.5 Summary

In this chapter, the focus of the discussion has been on the research methodology used in this study. It encompasses six main topics namely the research design, measurement of instruments, questionnaire design, pilot study, data collection and data analysis. It also describes the process of checking the content validity and reliability of the construct instruments based on pilot study. The next chapter will present the results of main study followed by some discussions on how these outcomes compared to those of prior studies.

CHAPTER 4

ANALYSIS AND FINDINGS

4.1 Introduction

The objective of this chapter is to present, interpret and discuss the result based on the data analysis and testing of hypotheses formulated in this study. This included the descriptive summary of respondents in respect to general information captured by survey instrument. Sample frequency and percentage are used to show the general distribution of the respondent's profile. Before proceeding in the main analysis, factor analysis and reliability analysis are used to assess the goodness of measures. The chapter comprises the main results of hypotheses tested and the discussion with respect to the degree to which the data do or do not support the hypotheses.

4.2 Rate of Return

Questionnaires were posted at the end of Jun 2011 to 250 manufacturing companies representing 59.5 % of the total population of 420 manufacturing companies located in Malaysia. After two months, a total of 120 completed questionnaires were returned. A total 130 manufacturing companies are not responded which represent 40.0%. The response rates obtained is considered good return as previous studies in the same field give the low rate of response associated with mail surveys, as noted by (Franke, 2006; Kassicieh, 2002; Mishra, 2004). Furthermore, Malhotra et. al. (1998) stated that it is important to reach a response rate that is greater than 20 percent.

Table 3.0: Total Number of Questionnaire Distributed and Collected

Number of Questionnaire Sent	Completed Reponses	Undeliverable	Non Respondent	Percentage Responses
200	120	-	80	60.0

4.3 Respondent Profile

This section provides background information of the respondents who participated in the survey. The section consists of background of the respondents, such as gender, race, education, position, and working experience. While, the other section is the background of company, including nature, type of company, age, and size. A total of 120 respondents participate in this study. The general information of the sample is explained in the following subsection.

4.3.1 Background of the Respondents

120 respondents were selected as the respondents in this study. The majority of them representing are male (97.5%). While, for the race in the company, 51.7 percent are Malay, 48.3 percent are Chinese. Most of the respondents have at least obtained a bachelor degree (95.8%), followed by Masters Degree (4.2%).

The survey questionnaire was addressed to Director, General Manager, Manager or equivalent. Thus, the respondents hold variety of positions such as Quality Manager, Technical Manager, Production Manager, and Operation Manager. All the respondents were knowledgeable in product development process or they have a common understanding with the concept of new product management. Each group represents personnel, who understand about product modularity process of their respective facilities. Table 7.0 shows the respondent positions. The rest of the respondents are from the positions at the same percentage are Production Manager (23%) and Technical Manager (76.7%). It shows that majorities of respondent's are other positions. There is no significant discrepancy among the percentage or number of respondents in each the four groups. This result indicates that the questionnaires were completed by the proper individuals.

Respondents were grouped into four categories for years of working experience less than one year, between one and five years, between six and ten years and more than ten years. The majority of the respondents who are made up 45.0% (54) have working experience between six and ten years in the current position. Table 7.0 also shows 66 respondents equal to 55% employed between one and five years.

Table 4.0: Background of the respondents

	Frequency (n)	Percentage (%)
Gender		

Male	117	97.5
Female	3	2.5
Race		
Malay	62	51.7
Chinese	58	48.3
Education		
Master	5	4.2
Bachelor	115	95.8
Position		
Quality Manager	1	8
Technical Manager	92	76.7
Production Manager	23	19.2
Operational Manager	4	3.3
Working Experience		
1-5 years	66	55.0
6-10 years	54	45.0

N=120

4.3.2 Background of the Company

Table 8.0 presents the background of the companies that the respondents are currently in. From the descriptive statistical analysis in table 8.0, it showed that the others types were the dominant industry representing (62.0%). The next largest companies are the electric and electronic (88.3%), followed by electric and electronic (88.3%),

Table 8.0 also shows the five types of companies representing 120 respondents. This includes Malaysian owned, Multi-National companies, joint venture, foreign owned and others. More than 90 percents are the Malaysian company, while 9.2 percents national. It is also found that majority (88.3%) employees of the companies were aged between 6- 10 years and 8.7 percents of the companies are over 20 years. The minor aged (8%) is between 0 to 5 years in the company responses.

Table 5.0 summarizes the companies' sizes. The respondents were asked to indicate the number of people employed in their companies. Their responses, classified into four groups, are shown in table 8.0. As can be seen, 59 companies (49.2%) had employed 101 to 250, and 46 companies (38%) had employed 50 to 100. The remaining companies surveyed had employed less than 50. No case missing in number of employees data.

Table 5.0: Background of the companies

	Frequency (n)	Percentage (%)
Nature		
Electric and electronics	14	11.7
Machinery and equipment	106	88.3
Company Ownership		
Malaysia owned	109	90.8
Multi-National company	11	9.2
Years		
0-5 years	1	8
6-10 years	106	88.3
11-15 years	1	0.8
16-20 years	12	10.0
Sized		
Less than 50	15	12.5
50-100	46	38.3
101-250	59	49.2

N=120

4.4 Data Analysis

The research data was analyzed using SPSS (version 17.0) statistical software. The data was examined to see whether it fulfilled the main assumptions before the hypothesis testing was carried out. The data was examined to test the validity and reliability of the measurement instrument. The assumptions were examined using methods as mentioned in Chapter 3, as suggested by (Coakes 2005; Hair et. al. 2006).

4.4.1 Test for Validity

Before conducting the main analysis, a validity test was performed with all the items tapping in the independent variables and dependent variables that are included in the study. The validity test was conducted based on the data collected from 150 cases which are no respondents are outliers among the respondents. Therefore, established statistical tools such as factor analysis helped determine the construct adequacy of measuring device, as mentioned by Cooper et. al. (1998). A principal components factor analysis with varimax rotation was performed on the 32 items that assessed the implementation of product modularity and its factors (refer table 9.0). The statistical test result (KMO = 0.866, Bartlett Test of Sphericity = 1154.526, Significance = 0.000) indicated that the factor analysis method was appropriate. Thus, the 32 items were reduced to five factors with eigenvalues greater than 1.0, which were retained for subsequent analysis. The resultant factor structure explained 64.54 percent of the item variance, which was an acceptable figure. The five factors and the loadings are listed in Table 9.0.

The factor analysis result indicated that the value of Kaiser-Meyer-Olkin (KMO) was found to be acceptable. Founded that this value is more than 0.5, it can be suggested that the factor analysis test had proceeded correctly, and the sample used was adequate, as noted by Hair, (2006).

Factor 1, which was labeled as new product development, was composed of seven items and accounted for 40.01 per cent of the variance. The items in this factor were similar to the original dimension. Factor 2 comprised of six items that related to the concurrent engineering of the industries and accounted for an additional 8.01 percent of the variance. Factor 3 was labeled customer involvement*y* and comprised eight items. It accounted for an additional 6.38 percent of the variance. Factor 4 was a supplier involvement factor that contained six items. It accounted for the additional 9.68 percent of the variance. Factor 5 was interpreted as a organization intergration. It accounted additional 4.94 percent of the variance and contained five factors.

As indicated in Table 9.0, each variable account for over 54 percent of variance as explained by the respective item sets. The KMO value for product modularity, customer demand, manufacturing flexibility, cost, and supply chain are 0.866. All the KMO values are acceptable, as noted by Hair, (2006). Thus, the results of the scales used in the study measure the proposed construct appropriately.

Table 6.0: Factor Pattern for New Product Performance

Factor Pattern for each variable and construct item

Item	Factor Loading	% of variance
Factor 1: New Product Development Performance		
New Product Success		
1. Overall, this project met or exceeded sales expectations	.791	***55.74***
2. This project met or exceeded profit expectations	. 855	
3. This project met or exceeded return on investment expectations	.687	
4. This project met or exceeded overall senior management's expectations	.752	
5. This project met or exceeded market share expectations	.697	
6. This project met or exceeded customer expectations	.681	
NPD Speed		
1. This project was developed and launched faster than the major competitor for a similar product	.824	***73.46***
2. This project was completed in less time than what was considered normal and customary for our industry	.891	
3. This project was launched on or ahead of the original schedule developed at initial project go-ahead	.883	
4. Top management was pleased with the time it took us from specs to full commercialization	.829	
Product Quality		
1. Our capability of offering products that function according to customer needs over a reasonable lifetime is	.673	***56.18***
2. Our capability of offering a high value product to the customers is	.808	
3. Our capability of offering safe-to-use products that meet customer needs is	.773	
4. Our capability of offering reliable products that meet customer needs is	.605	
5. Our capability of offering durable products that meet customer needs is	.771	
6. Our capability of offering quality products that meet customer	.807	

expectations is		
7. Our capability of offering high performance products that meet customer needs is	.785	
Product Innovation		***70.70***
1. Our capability of developing unique feature is	.682	
2. Our capability of developing new product and feature is	.870	
3. Our capability of developing a number of new features is	.884	
4. Our capability of developing a number of new products is	.908	
Factor 2: Virtuality		***62.64***
1. Work at home during normal business days	.758	
2. Work while travelling, for example, at airports or hotel	.704	
3. Collaborate with people in different sites or geographies	.754	
4. Collaborate with people you have never met face-to-face	.836	
5. Work extended days in order to communicate with remote team members	.790	
6. Collaborate with people in different time zones	.695	
7. Collaborate with people who speak different native languages or dialects than your own	.739	
8. Collaborate with people from different cultural backgrounds	.672	
9. Work on projects that have changing team members	.652	
10. Work with teams that have different ways to track their work	.689	
11. Work with people that use different collaboration technologies and tools	.803	
12. Collaborate with people from different business groups or departments	.763	
13. Work at different sites.	.791	
14. Have professional interactions with people from outside the organization	.733	
15. Participate in real-time online discussions, such as chat or instant messaging.	.781	
16. Meet with people via video-conferencing tools	.615	
17. Work with mobile devices	.779	

Factor 3: Overall Integration		***42.12***
1. NPD team and other organizations attempted to avoid creating problems for each other during the NPD process	.780	
2. NPD team and other organizations were perceived to have mutual new product goals	.687	
3. NPD team and other organizations appeared to work smoothly together to develop a new product	.663	
4. NPD team and other organizations acted as a unified group during the development of a new product	.407	
Factor 4: Concurrent Engineering		***55.73***
1. Much of process design is done concurrently with product design.	.823	
2. Product development activities are concurrent.	.486	
3. Product development group members share information.	.497	
4. Product development group members trust each other.	.727	
5. Product development employees work as a team.	.698	
6. Product development group members seek integrative solutions.	.826	
7. Purchasing managers are involved from the early stages of product development.	.748	
8. Process engineers are involved from the early stages of product development.	.853	
9. Manufacturing personnel is involved from the early stages of product development.	.547	
10. Various disciplines are involved in product development from the early stages.	.641	
Factor 5: Customer Involvement		***59.69***
1. We typically rely on the user to help us define and clarify that user's needs in developing our new products.	.545	
2. We visit our customers to discuss product development issues	.716	
3. During the development of our products, we often have the users try out whatever we have developed up to that point.	.713	
4. We typically try to put working prototypes in the user's hands as early as possible in our development efforts.	.678	
5. We proficiently review customer reactions to early product designs.	.601	
6. We study how our customers use our products.	.799	
7. Our product development people meet with customers	.795	
Factor 6: Supplier Involvement		***71.80***
1. Our component suppliers often place some of their personnel on our development teams.	.767	

2. Our suppliers do the product engineering of component parts for us .930
3. Our suppliers develop component parts for us. .933
4. Our suppliers develop whole subassemblies for us. .932
5. Our suppliers are involved in the early stages of product development. .761
6. We ask our suppliers for their input on the design component parts. .784
7. We make use of supplier expertise in the development of our products. .671

Table 7 Results of Factor Analysis

Variable	KMO	Initial Eigenvalues	% variance explained
NPD Success	0.847	3.345	55.744
NPD Speed	0.817	2.938	73.461
Product Quality	0.874	3.933	56.181
Product Innovation	0.793	2.828	70.700
Virtuality	0.898	8.436, 2.214	49.621, 13.022
Overall Integration	0.571	1.685	42.125
Concurrent Engineering	0.848	4.545, 1.028	45.448, 10.284
Customer Involvement	0.791	3.135, 1.044	44.780, 14.914
Supplier Involvement	0.776	3.404, 1.622	48.632, 23.169

4.4.1 Test for Reliability

Reliability is an assessment of the degree of consistency between multiple measurements of variables, as provided by (Hair, 2006). The most common reliability measure is Cronbach's Alpha (α). The reliability test was performed with all the items tapping in the independent variables and dependent variables included in the study. Thus, the reliability tests were conducted based on the data collected from 150 cases.

Cronbach's Alpha for the entire variable was re-examined based on the responses of the data main study. The Cronbach Alpha from 0.730 to 0.932 indicates that all scales are acceptable. Alpha values greater than 0.60 are suggested as being adequate for testing the reliability of factors, as noted by Sekaran, (1992). From the results obtained, it can be concluded that this instrument has high internal consistency and is therefore reliable.

Respondents were asked to evaluate their perception towards five point Likert scale statements. The internal consistency was tested to test the reliability of the data. The internal consistency for each variable in this study is shown in the Table 11.0. It is observed in Table 11.0 that the internal consistency for all dimension were ranged from 0.812 to 0.862, which indicated the high reliability. These results show that the data are reliable and can be use for further analysis.

Table 8.0: Internal Consistency of the Variables

Test for Reliability	
Variables/Factor	Cronbach's Alpha (∂)
Concurrent Engineering	0.863
Customer Involvement	0.785
Supplier Involvement	0.812
Overall Integration	0.530
Virtuality	0.934
NPD Speed	0.871
Product Quality	0.867
Product Innovation	0.862

Test for Normality

Statistical methods are based on various underlying assumptions. One common assumption is that a random variable is normally distributed. In many statistical analyses, normality is often conveniently assumed without any empirical evidence or test, but normality is critical in many statistical methods. When this assumption is violated, interpretation and inference may not be reliable or valid. The first important assumption to be met is normality. The assumption of normality is a prerequisite for many inferential statistic techniques such as skewness and kurtosis. Normality test refers to the shape of data distribution for each variable and its correspondence to normal distribution. Thus, the skewness and kurtosis tests being objective methods of testing the normality were carried out (Coakes, 2005).

In statistics, normality tests are used to determine whether a data set is well-modeled by a normal distribution or not, or to compute how likely an underlying random variable is to be normally distributed. There are two ways of testing normality that are graphical and numerical methods.

4.4.2 Numerical Methods

Numerical or statistical methods present summary statistics such as skewness and kurtosis, or conduct statistical tests of normality. Graphical methods are intuitive and easy to interpret, while numerical methods provide objective ways of examining normality. Results of normality test using numerical method in shown in Table 12.0. It is found that value of Skewness for all variables are between -1.7 to -0.70, while the values of Kurtosis are ranged 1.1 to 2.3. According to Park, (2008), a normally distributed random variable should have skewness and kurtosis near zero and three (or -3 if values are less than zero), respectively. Thus, it can be concluded that this set of data is normal distributed.

Table 9.0: Test of Normality using Numerical Methods

Variables/Factor	Skewness	Kurtosis
Concurrent Engineering	0.406	-1.333
Customer Involvement	0.224	-1.258
Supplier Involvement	0.724	1.090
Overall Intergration	0.120	-1.058
Virtuality	0.120	0.773
NPD Success\	0.432	0.842
NPD Speed	0.467	-1.211
Product Quality	0.565	-1.103
Product Innovation	0.381	-1,248
NPD Performance	0.269	-0.338

Note: ** $p<0.01$

To reconfirm the testing on normality of the variables, the Kolmogorov-Smirnov test was conducted. Table 12.0 shows that, the both value of Kolmogorov statistic Shapiro-Wilk eare less than one. Both values are normally distributed at significance level of 0.01. Therefore it can be concluded that data is within the normal distribution.

4.4.3 Graphical Methods

Graphical methods visualize the distributions of random variables or differences between an empirical distribution and a theoretical distribution, for example the standard normal distribution. Among frequently used descriptive plots is Histogram with the normality curve. The histogram graphically shows how each category (interval) accounts for the proportion of total observations and is appropriate when N is large. The empirical distribution of the data (the histogram) should be bell-shaped and resemble the normal distribution. Figure 7.0 to Figure 11.0 shows the histogram of all variables. It is visualized in the figures that the histograms are bell-shaped, indicating a normal distribution.

Figure 4.0: Histogram of Product Development

Figure 5.0: Histogram of Concurrent Engineering

Figure 6.0: Histogram of Supplier Involvement

Figure 7.0: Histogram of Overall Integration

Figure 8.0: Histogram of Virtuality

4.4.4 Test for Linearity and Homoscedasticity

The other assumption is linearity and homoscedasticity. The linearity of the relationship between dependent and independent variables represent the degree to which the change in the dependent variables is associated with the independent variable. In linear regression, it is important to fill the assumptions of normality, linearity and multicollinearity. Normality assumption has been fulfilled and discussed in previous section. Multicollinearity test using VIF is shown in Table 13.0, and shows that the VIF statistic are less than 5.0, while tolerance statistics are less than 1.0. These values indicate that the model is free from the multicollinearity problem. Figure 12.0 shows the P-P plot to test the linearity of the model. It is observed that the data is linear. Hence, the assumption of linearity is filled.

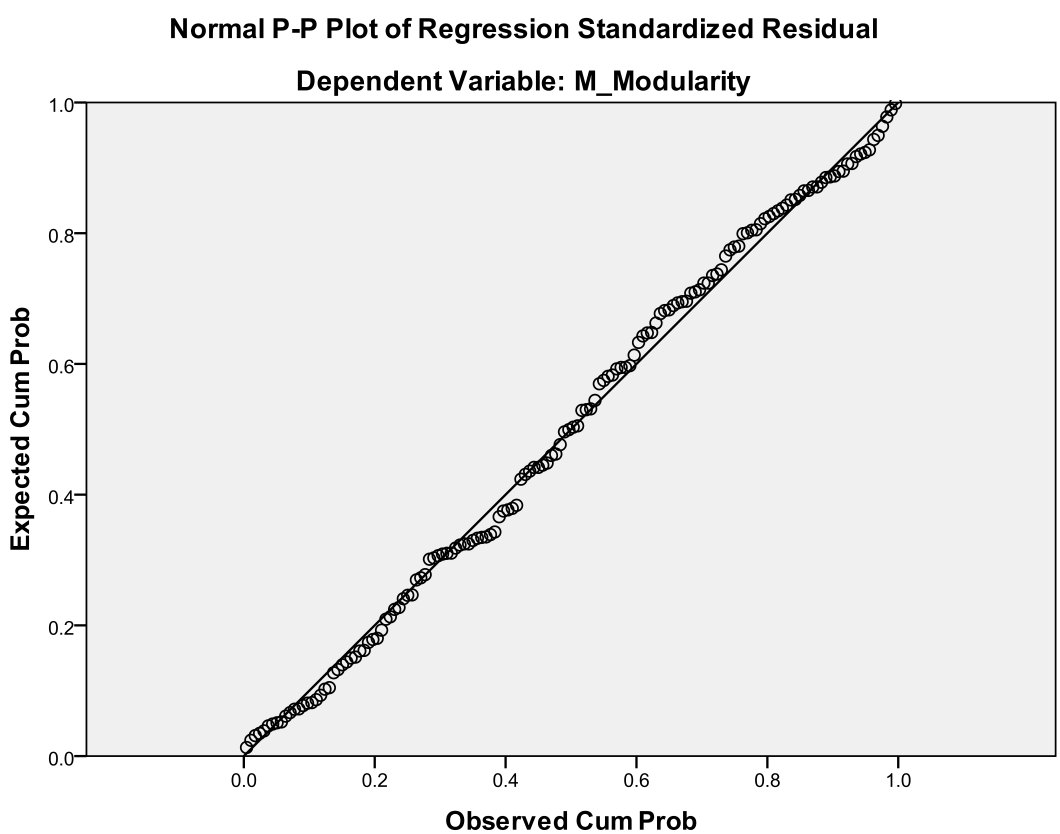


Table 10.0: Testing Multicollinearity (Tolerances and VIF values)

Independent Variables	Tolerance	Variance Inflation Factors (VIF)
Concurent Engineering	0.544	1.838
Customer Involvement	0.529	1.889
Supplier Involment	0.838	1.196
Overall Intergraton	0.860	1.163
Virtuality	0.995	1.005
R^2	**0.243**	
F	**21.492**	
Sig	**0.000**	

4.5 Descriptive Analysis

Descriptive analysis examines statistical description of variables in the study. Statistics such as mean and standard deviations are used as descriptive statistics in this study by calculating for independent variables and dependent variables. These scores highlight the respondents' feedback obtained from the data collected through the questionnaires. The result obtained show that some effort need to be focused on developing the companies' ability to incorporate the important factors in their practice to ensure the success of practicing the product modularity in manufacturing. Therefore, correlation analysis and regression analysis were carried out to emphasize this successful implementing of modularity product.

This section will evaluate the level of respondents agreement towards entire variables tested in this study. Respondents were asked to indicate their agreement towards the statements of the variables, using the five points Likert scale. Means score for each variable were then computed to determine to level of their agreement. The levels are categorized into three groups as follows:

1.00 to 2.33 = Low

2.34 to 3.66 = Moderate

3.67 to 5.00 = High

Table 11.0: Descriptive Statistic of Variable

Variables	Mean	Standard Deviation
Concurent Engineering	5.5000	0.34810
Customer Involvement	5.4381	0.39232
Supplier Involvement	3.9546	0.90388
Virtuality	3.8701	0.65485
Overall Integration	5.6312	0.31080
NPD Success	5.4056	0.37407
NDP Speed	5.1854	0.54858
Product Quality	5.2821	0.45796
Product Innovation	5.1500	0.59090
NPD Performance	5. 2738	0.43522

Concurrent Engineering

The descriptive analysis results for concurrent engineering are shown in Table 15.0. All 120 companies were found to implement product development process in their activities. The agreement and commitment level among the companies towards product development is high (mean=5.50, sd=0.348). Most of the respondent agreed that product used Product development group members share information concept that can achieve higher variety (mean=5.58, sd=0.496) and their company adopts a high degree of Product development group members trust each other.(mean=5.57, sd=0.78). However, respondents' commitments are moderate in the statement " *Product development employees work as a team*." (Mean=5.37, sd=0.566).

Table 12.0: Level of commitment towards Concurrent Engineering

	Mean	sd	Level
Concurent Engineering	5.50	0.348	High
Much of process design is done concurrently with product design.	5.42	0.544	High
Product development activities are concurrent.	5.54	0.005	High
Product development group members share information.	5.58	0.496	High

Product development group members trust each other.	5.57	0.514	High
Product development employees work as a team.	5.37	0.566	High
Product development group members seek integrative solutions.	5.39	0.598	High
Purchasing managers are involved from the early stages of product development.	5.38	0.488	High
Process engineers are involved from the early stages of product development.	5.61	0.490	High
Manufacturing personnel is involved from the early stages of product development.	5.59	0.494	High
Various disciplines are involved in product development from the early stages.	5.55	0.500	High

4.5.2 Customer Involvement

Table 16.0 illustrates the descriptive analysis of customer involvement. It is found that respondents' agreements towards Customer Involvement are high (mean=5.46, sd=0.33). Their agreements are high for each statement about customer demand. The highest mean score can be found in the statement " During the development of our products, we often have the users try out whatever we have developed up to that point "(mean=5.44, sd=0.548).

Table 13.0: Descriptive Analysis for Customer Involvement

	Mean	sd	Level
Customer Involvement	5.46	0.388	High
We typically rely on the user to help us define and clarify that user's needs in developing our new products.	5.31	0.671	High
We visit our customers to discuss product development issues	5.33	0.637	High
During the development of our products, we often have the users try out whatever we have developed up to that point.	5.44	0.548	High
We typically try to put working prototypes in the user's hands as early as possible in our development efforts.	5.40	0.614	High
We proficiently review customer reactions to early product designs.	5.43	0.576	High

We study how our customers use our products.	5.53	0.51	High
Our product development people meet with customers	5.52	0.594	High

4.5.3 Supplier Involvement

Descriptive analysis for Supplier Involvement and its items can be found in Table 17.0. Overall, level of agreement towards Supplier Involvement is high at mean=5.43 and sd=0.968). Respondents also perceived the high agreement towards all items in this variable, with the lowest score 2.19 “Our suppliers develop whole subassemblies for us”. and to highest score 4.40 “Our suppliers are involved in the early stages of product development”.

Table 14.0: Descriptive Analysis for Supplier Involvement

	Mean	sd	Level
Supplier Involvement	5.43	0.968	Moderate
Our component suppliers often place some of their personnel on our development teams.	5.44	0.754	High
Our suppliers do the product engineering of component parts for us	2.32	1.670	Low
Our suppliers develop component parts for us.	2.26	1.611	Low
Our suppliers develop whole subassemblies for us.	2.19	1.621	Low

Our suppliers are involved in the early stages of product development.	5.42	0.643	High
We ask our suppliers for their input on the design component parts.	5.39	0.910	High

4.5.4 Virtuality

Descriptive analysis to examine respondents' agreement towards virtuality and all items is shown in Table 18.0. It is found that respondents' agreement towards virtuality is also high (mean=3.87, sd=0.654). They were also perceived that collaborate with people from different business groups or departments (mean=4.47, sd=0.907).

Table 15.0: Level of commitment towards Virtuality

	Mean	sd	Level
Virtuality	3.87	0.654	Moderate
Work at home during normal business days	3.54	1.044	Moderate
Work while travelling, for example, at airports or hotel	3.58	0.941	Moderate
Collaborate with people in different sites or geographies	3.75	0.901	Moderate
Collaborate with people you have never met face-to-face	3.18	1.097	Moderate

Work extended days in order to communicate with remote team members	3.33	1.079	Moderate
Collaborate with people in different time zones	3.72	0.918	Moderate
Collaborate with people who speak different native languages or dialects than your own	3.62	0.909	Moderate
Collaborate with people from different cultural backgrounds	3.68	1.004	Moderate
Work on projects that have changing team members	4.06	0.83	Moderate
Work with teams that have different ways to track their work	3.74	0.912	Moderate
Work with people that use different collaboration technologies and tools	4.47	0.907	Moderate
Collaborate with people from different business groups or departments	4.43	0.764	Moderate
Work at different sites.	4.41	0.825	Moderate
Have professional interactions with people from outside the organization	4.52	0.799	Moderate
Participate in real-time online discussions, such as chat or instant messaging	4.36	0.828	Moderate
Meet with people via video-conferencing tools	4.16	0.860	Moderate
Work with mobile devices	3.25	1.190	Moderate

4.5.5 NPD Speed

Respondents perception towards NPD speed were also high (mean=5.18, sd=0.548). This can be referred in Table 19.0. Overall, they were highly perceived that major suppliers are highly committed to the whole assembly process with regards to quality and reliability (mean=5.18, sd=0.548). Respondents were also highly agreed that this project was developed and launched faster than the major competitor for a similar product (mean=5.21, sd=0.697).

Table 16.0: Level of commitment towards NPD Speed

	Mean	sd	Level
NPD Speed	5.185	0.548	High
This project was developed and launched faster than the major competitor for a similar product	5.21	0.697	High
This project was completed in less time than what was considered normal and customary for our industry	5.16	0.622	High
This project was launched on or ahead of the original schedule developed at initial project go-ahead	5.01	0.750	High
Top management was pleased with the time it took us from specs to full commercialization	5.37	0.484	High

4.5.6 NPD Product Quality

Respondents perception towards product quality were also high (mean=5.28, sd=0.457). This can be referred in Table 19.0. Overall, they were highly perceived that major suppliers are highly committed to the whole assembly process with regards to quality and reliability (mean=4.19, sd=0.65). Respondents were also highly agreed that frequently cooperate with the major suppliers in order to resolve problems whenever and unexpected situations arise (mean=0.417, sd=0.64).

Table 17: Level of commitment towards NPD Quality

	Mean	sd	Level
Product Quality	5.28	0.457	High
Our capability of offering products that function according to customer needs over a reasonable lifetime is	5.22	0.633	High
Our capability of offering a high value product to the customers is	5.24	0.648	High
Our capability of offering safe-to-use products that meet customer needs is	5.41	0.510	High
Our capability of offering reliable products that meet customer needs is	5.49	0518	High
Our capability of offering durable products that meet customer needs is	5.21	0.417	High
Our capability of offering quality products that meet customer expectations is	5.18	0.637	High
Our capability of offering high performance products that meet customer needs is	5.23	0.614	High

4.5.6 NPD Product Innovation

Respondents perception towards product innovayion were also high (mean=5.15, sd=0.590). This can be referred in Table 19.0. Overall, they were highly perceived that major suppliers are highly committed to the whole assembly process with regards to quality and reliability (mean=4.19, sd=0.65). Respondents were also highly agreed that frequently cooperate with the major suppliers in order to resolve problems whenever and unexpected situations arise (mean=0.417, sd=0.64).

	Mean	sd	Level
Product Innovation	5.15	0.590	High
Our capability of developing unique feature is	5.42	0.602	High
Our capability of developing new product and feature is	5.12	0.712	High
Our capability of developing a number of new features is	5.05	0.732	High
Our capability of developing a number of new products is	5.02	0.756	High

4.6 Hypotheses Testing

Four hypotheses were formulated and tested in this study. There are four variables considered for these study, hypotheses (H1, H2, H3, and H4) were formulated to test the relationship between each of the variables and new product development performance. Therefore, all the hypotheses were tested using Pearson correlation analysis.

4.6.1 Relationship between Variables

A Pearson correlation analysis was performed between the new product development and concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development. Hypotheses H1, H2, H3, and H4 were tested using this method. This section will examine the relationship between product development as dependent variables and all independent variables (concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality). This section will also test the hypotheses developed in the earlier section. Overall, there are five hypotheses to be tested. Pearson correlation analysis is employed to test all of the hypotheses.

4.6.1 Testing Hypotheses 1

Pearson correlation analysis result to examine the relationship between concurrent engineering and overall intergration (OI**)** is shown in Table 18.0. It is found that the pearson (r) is 0.304 and significant value of 0.000. These values show that they are significant positive relationship between concurrent engineering and Overall Integration. This figure is the statistical evidence to accept H1.

Table 18.0: Relationship between concurrent engineering and overall intergration (OI)

	OI (r)	Sig.
Concurrent engineering	0.304	0.001

H1: There will be a positive relation between Concurrent engineering and overall intergration (OI)

4.6.1.2 Testing Hypotheses 2

Table 19.0 summarized the Pearson correlation analysis to determine relationship between Supplier Involvement and Overall Intergration. It is found in Table 21.0 that there is a small value of r, that is less than 0.1 (r=0.077) and p was greater than 0.05. Hence, it is concluded that there is no significant relation between supplier involvement and overall integration. This result fails to support H2.

Table 19.0: Relationship between Supplier Involvement and Overall Intergration

	Overall Intergration (r)	Sig.
Supplier Involvement	0.077	0.05

H2: There will be a positive relation between Supplier Involvement and Product Development (not supported)

4.6.1.3 Testing Hypotheses 3

Table 19.0 shows that there is a significant relationship between Customer Involvement and Overall Intergration (r=0.418, p<0.01). ‘p’ value is less than 0.05, Positive ‘r’ shows the positive relationship between both variables. Hence, H3 is also being accepted.

Table 19.0: Relationship between Customer Involvement and Overall Intergration

	Overall Intergration (r)	Sig.
Customer Involvement	0.418	0.000

H3: There will be a positive relation Customer Involvement and Overall Intergration

4.6.1.4 Testing Hypotheses 4

Pearson correlation of Overall Integration and Product Development is shown in Table 20.0. It is found that r value is 0.516, and significant at $p<0.01$. This finding shows the significant relationship between Overall Integration and Product Development. Hence, H4 can be accepted.

Table 20.0: Relationship between Overall Integration and Product Development

	Product Development (r)	Sig.
Overall Integration	0.516	0.000

H4: There will be a positive relation between Overall Integration and Product Development

The results from this section have successfully support all four hypotheses developed in previous chapter. Overall integration was found to have a significant relationship with concurrent engineering and customer involvement. While new product development performance was found significantly associated with overall integration.

4.7 Effect of Independent Variables towards Product Development Performance

This section examines the effect of each independent variable that concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development. This section will also answer all of the research questions developed in Chapter 1. To examine the effect of variables to another variable, simple linear regression in applied.

4.7.1 Effect of Concurrent Engineering towards Overall Integration

Table 21.0 is the summary of simple linear regression analysis to evaluate the effect of Concurrent Engineering towards Overall Integration. It is found that customer demand is 48.2 percent of product modularity (R^2=0.482, F=137.615, p<0.01), showing the significant effect. Customer demand was also found to significantly predicted product modularity (B=0.799, t=11.731, p<0.01).

Table 21.0: Effect of Concurrent Engineering towards Overall Integration

	R^2	F	B	t
Concurrent Engineering	0.482	137.615**	0.799	11.731**

4.7.2 Effect of Customer Involvement to Overall Integration

Customer Involvement was found to have a significant effect to Overall Integration for 26.9 percent (R^2=0.269, F=54.483, p<0.01) (refer table 22.0). It also significantly predict product modularity (B=0.677, t=7.381, p<0.01). Any changes Customer Involvement in will affect Overall Integration.

Table 22.0: Effect of Customer Involvement to Overall Integration

	R^2	F	B	t
Customer Involvement	0.269	54.483**	0.677	7.381**

4.7.3 Effect of Supplier Involvement to Overall Integration

Simple regression analysis used were to examine the effect of Supplier Involvement to Overall Integration is summarized in Table 23.0. Supplier Involvement is found to effect Overall Integration for 17.4 percent (R^2=0.174 F=31.246, p<0.01). It is also found that cost is significantly predicted product modularity (B=0.533, t=5.590, p<0.01).

Table 23.0: Effect of Supplier Involvement to Overall Integration

	R^2	F	B	t
Supplier Involvement	0.174	31.246**	0.533	5.590**

4.7.4 Effect of Concurrent Engineering to New Product Performance

Table 24.0 shows that Concurrent Engineering has significantly explained New Product Performance for 26.6 percent (R^2=0.266, F=53.672, p<0.01). Further inspection also shows that supply chain has predicted product modularity (B=0.899, t=7.326, p<0.01).

Table 24.0: Effect of Concurrent Engineering to New Product Performance

	R^2	F	B	t
Concurrent Engineering	0.266	53.672**	0.899	7.326**

4.7.6 Effect of Customer Involvement to New Product Performance

Table 25.0 shows that supply chain has significantly explained product modularity for 26.6 percent (R^2=0.266, F=53.672, p<0.01). Further inspection also shows that supply chain has predicted product modularity (B=0.899, t=7.326, p<0.01).

Table 25.0: Effect of Customer Involvement to New Product Performance

	R^2	F	B	t
Customer Involvement	0.266	53.672**	0.899	7.326**

4.7.6 Effect of Customer Involvement to New Product Performance

Table 26.0 shows that supply chain has significantly explained product modularity for 26.6 percent (R^2=0.266, F=53.672, p<0.01). Further inspection also shows that customer involvement has predicted new product performance modularity (B=0.899, t=7.326, p<0.01).

Table 26.0: Effect of Customer Involvement to New Product Performance

	R^2	F	B	t
Customer Involvement	0.266	53.672**	0.899	7.326**

4.7.7 Effect of Supplier Involvement to New Product Performance

Table 27.0 shows that supply involvement has significantly explained supplier involvement for 26.6 percent (R^2=0.266, F=53.672, p<0.01). Further inspection also shows that supplier involvement has predicted new product performance (B=0.899, t=7.326, p<0.01).

Table 27.0: Effect of Supplier Involvement to New Product Performance

	R^2	F	B	t
Supplier Involvement	0.266	53.672**	0.899	7.326**

4.8 Summary of Hypotheses Testing

Four hypotheses were developed and tested in this study. Summary of the hypotheses testing is illustrated in Table 28.0. The findings have supported and accepted all of the hypotheses.

4.9 Multiple Regressions

This section will examine the effect of concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development.

. The analysis is done using the regression model as below:

$$Y= \partial + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta X_{5\,+}\, e$$

Where:

Y = New Product Performance

X_1= new product development

X_2= supplier involvement

X_3= overall integration.

X_4= concurrent engineering

$X_{5\,=}$ virtuality

∂=Constant

B=coeffecient

e=standar error = 0

It is found in Table 28.0 that these four variables were highly explained product modularity for 54.6 percent (R^2=0.546, F=43.628, p<0.01). The results also suggest that only three variables that can be used to predict new product development, that are concurrent engineering (B=0.523, t=7.150, p<0.01); customer involvement (B=0.313, t=3.170, p<0.01); supplier involvement (B=0.199, t=2.278, p<0.05). concurrent engineering, customer involvement and overall integration were found to have a significant positive effect towards new product development. This overall model shows that virtuality is less predictor of new product product development.

Table 28.0: Effect of Independent Variables to New Product development

Variables	B	t	Sig.
Concurent Enginering	0.232	7.150	.000
Customer Involvement	0.313	3.170	.002
Supplier Involvement	0-.033	-0.434	.665
Overall Intergration	0.199	2.278	.024

R^2	0.546
F	43.628
Sig.	***0.000***

4.9.1 Mediating effect of organizational integration on the relationship between internal-external integration and new product development performance.

This section attempts to answer Research Objective 4 (RO 3) that 1s to analyze the mediating effect of organizational integration on the relationship between internal-external integration and new product development performance. Model 1 is an effect of internal and external integration to new product performance, while Model 2 is the role of overall integration as a mediating variable.

Model 1 shows that internal and external integration significantly explained 29.1 percent of new product development (R^2=0.291, F=15.870, p<0.01). However only two independent variables are significantly predict new product development, that are concurrent engineering (B=0.321, t=2.420, p<0.01) and customer involvement (B=0.360, t=3.020, p<0.01). Insertion of overall integration as a mediating variable in Model 2 shows that overall model significantly explained new product performance for 29.6 percent (R2=0.296, F=12.096, p<0.01), an additional 0.5 percent in R^2 compared Model 1. However, this is not a significant changes compared to Model 1 when F change = 0.840, and significant F change >0.05. Overall integration is also fail to predict new product performance (B=-0.028, t=-0.916, p>0.05). It is concluded that overall integration is not mediate the relationship between internal and external integration towards new product performance.

Table 29.0: Mediating effect of organizational integration on the relationship between internal-external integration and new product development performance

Variables	B	t	Sig.	Tolerance	VIF
Model 1:					
Concurrent Engineering	.321	2.420	.017	.544	1.838
Customer Involvement	.360	3.020	.003	.529	1.889
Supplier Involvement	.009	.228	.820	.836	1.196
R^2 = .291					
F=15.870 ($p<0.01$)					
Model 2:					
Overall Integration	-.028	-.916	.361	.972	1.029
R^2=.296					
F =12.096 ($p<0.01$)					
R^2 change=.005					
F change=.840 ($p>0.05$)					

4.9.2 Moderating effect of virtuality on the relationship between organizational performance and new product development performance

This section will attempt to examine Objective 4 that is to analyze the moderating effect of virtuality on the relationship between organizational performance and new product development performance. Three step hierarchical regression was adopted to test the model. Model 1 is the relationship between OI and new product performance. Model 2 is the insertion of virtuality as a moderating variable in the equation. Model 3 is an insertion of interaction between OI and virtuality (OI x virtuality) in the equation.

Results in Table 31 shows that OI in Model 1 is not significantly affected new product performance (R^2=0.004, F=0.463, p>0.05). The insertion of virtuality in Model 2 has increased the R-square to 0.107 and F=0.6990 and p<0.01. This result suggests that OI and virtuality give a significant effect to new product performance for 10.7 percent. The insertion of virtuality in the equation also give a significant changes to the model (R^2 change=0.103, F change=13.468, p<0.01). Further inspection in Model 3 shows that the interaction between OI and virtuality did not bring any significant changes in the equation (R^2=0.109, F=4.713, p<0.01). These results suggest that virtuality is not moderate the relationship between OI and new product performance.

TABLE 29.1: Moderating effect of virtuality on the relationship between organizational performance and new product development performance

Variables	B	t	Sig.	Tolerance	VIF
Model 1:					
Organizational Integration (OI)	-.024	-.681	.497	1.000	1.000
R^2 = .004					
F= .463 (p>0.05)					

Model 2:					
Virtuality	.214	3.670	.000	.992	1.008
R^2=.107					
F = 6.990 ($p<0.01$)					
R^2 change=.103					
F change= 13.468 ($p<0.05$)					
Model 3:					
OI x Virtuality	-.031	-.498	.619	.011	93.496
R^2=.109					
F =4.713 ($p<0.01$)					
R^2 change=.002					
F change= .248 ($p>0.05$)					

Table 30.0: Summary of Hypotheses Test

Hypothesis	Method of Analysis	Results	Summary
H1 There will be a positive relation concurrent engineering and overall integration.	Pearson Correlation	r=0.694 p<0.01	Supported
H2 There will be a positive relation between customer involvement and. overall integration	Pearson Correlation	r=0.519 p<0.01	Supported
H3 There will be a positive relation between supplier involvement and overall integration.	Pearson Correlation	r=0.418 p<0.01	Supported
H4 There will be a positive relation between overall integration and new product development	Pearson Correlation	r=0.516 p<0.01	Supported
H5 There is positive mediating effect of organizational performance on the relationship between internal-external integration and new product development performance.	Multiple Regression	r==0.04 p<0.05	Supported
H6 There is positive moderating effect of virtuality on the relationship between organizational involvement and new product development performance	Multiple Regression	r = 0.107 p<0.01	Supported
H7 There is positive effect of organizational involvement x virtuality in new product development performance practices in Malaysian manufacturing sector.	Multiple regression	r = 0.109 p<0.01	Supported

4.10 Summary

This chapter presents the basic profile of the survey respondents such as gender, race, and education, types of company, types, years, size, position and experience. The results of the main effects provide support for the hypotheses that customer demand, manufacturing flexibility, cost, and supply chain are positively associated with product modularity. Specifically, the study found that independent variables had a significant positive impact on product development. For multiple regression analysis it is indicated that concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality. in explaining new product development. This chapter has successfully answered all research questions and tested the hypotheses developed. Overall, this chapter has supported all hypotheses. Further discussion on this finding will be found Chapter 5.

CHAPTER 5

DISCUSSION, RECOMMENDATION AND CONCLUSION

5.1 Introduction

This chapter will have a deep discussion on the findings in Chapter 4. The discussion will include the findings from frequency and descriptive analysis, followed by inference analysis from Chapter 4. This chapter also discusses conclusion and the recommendations of this study. The first section contains the discussion of findings, examining the research question, and recommendation of the study. Next, it is followed by implication, limitations, and lastly conclusions of this study.

5.2 Discussion of Findings

This study is to identify empirically the new product development in manufacturing companies, across industry in the Malaysia. The rationale of the study stems from the major consideration, that is, the emerging concern of share holders of the manufacturing companies and the directors of the companies in this industry in particular to develop product modularity manufacturing in economy downturn. Having this in mind, 75 questionnaire was developed to measure the new product development in manufacturing firms, as provided by (Koufteros, Vonderembse, & Jayaram (2005), Souder, Sherman, & Davis-Cooper (1998), Sherman, Souder, & Jenssen (2000). The data was collected using postal summary method from random samples discussed in Chapter 3. One hundred and twenty respondents participated in the study, and this accounted for 60.0% response rate.

Concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality are the variables towards new product development. The descriptive analysis based on the respondents' perception of new product development in manufacturing companies showed that manufacturers took a lot of effort in concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development. The findings of the study are presented to answer research questions and research objectives. The study examines the direct relationship between independent variables, moderating variables and new product development. The following sections discuss the findings of each research objective.

5.2.1 Correlation Analysis

The first research objective is to study the effect of concurrent engineering, supplier involvement and customer involvement toward organization integration product modularity. The findings in this study show that, all the independent (which we term as internal and external integration) variables could bring significant positive relationship on new product development. The correlation tables in the previous chapter indicate that all the two independent variables, knowingly as internal integration and external integration (concurrent engineering, supplier involvement, customer) , moderated by variables (,virtuality, and organization integration) were positively correlated as previous researchers who have studied in new product development process, this is mention by Cooper & Kleinschmidt (1987). Carbonell & Rodriguez (2006); Lukas & Menon (2004)).

The correlation coefficients between all the variables and the new product development indicate the strength of the relationships among them. From the above discussion, we can recapitulate that in economy downturn, the shareholder, managers and engineers must focus and develop a new product development in term of concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development. to make sure their firm and company still in the right track during economy slowdown.

5.2.2 Frequency Analysis

120 respondents were as respondents in this study. Most of them have obtained higher education and from managerial position in the company. They are majority have been with the companies for between 5 to 10 years. From these backgrounds, respondents are able to answer the questionnaire properly as they were asked about company's activities.

5.2.3 Descriptive Analysis

Descriptive analysis to examine the level of companies' commitment towards new product development found that all companies implement new product development in their activities either small or big involvement. The commitment from the companies are high with mean score is more than 3.67. Respondents perceived that new product development concept can achieve a higher variety. They also perceived that their company implements a high degree of new product development in production.. This study also found that the companies perceived a high agreement towards all variables. Level of agreement towards concurrent engineering is the highest compared to other variables. It is followed by organizational integration, customer involvement, supplier involvement, and virtuality towards new product development. This finding shows all this variables is the most important factor to implement new product development in the production process.

5.2.4 Multiple Regression Analysis

The hypotheses are concerned with the investigation of the simultaneous effects of the four independent variables on the new product development. The result of hypotheses reveal that all the variables, which are concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality explain the variance in of new product development. In this respect, the results have provided sufficient evidence to infer that the independent variables, moderating, variables and intervening variables are significant determinants of new product development in manufacturing companies, but virtualiti have minimum impact to new product development. From the results of the multiple regression analysis, all variables had significant effect on new product development. These findings are consistent with previous studies in the area of new product development in organization (Koufteros, Vonderembse, & Jayaram (2005) that suggest external and internal intergradations, and organization integration was shown to be important factors in enhancing and developing the new product development process. Without this approach, companies cannot survive in this economy situation. To develop the new product development performance process, it depends on independent variables as discuss.

It is clear that companies should be ready in implementing the concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development. to achieve the manufacturing capabilities. These are important for companies to develop the new product development process, which require sufficient capabilities. This finding confirms that companies' able to perform the new product development process in manufacturing. These elements are desired to ensure that the new product development run well and achieve the desired levels.

Besides, the significant relationship of all variables on overall manufacturing capabilities, the results of this study indicate concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development. achieving new product development process. Based on the results, it is confirmed that concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality are essential in new product development performance process. This finding is consistent to the earlier findings by previous studies, which highlight the important role of concurrent engineering for new product development concept product development team (Koufteros et. al. 2001; Fischer, 1980). Thus, to achieve the high degree of new product development performance and win the other competitors, companies and firms must ready to share understanding with other parties, to carry out some knowledge about concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality in manufacturing.

A study by (Droge et al., 2000; Millson & Willemon 2002, Droge et al., 2004; Gonzalez & Palacios, 2002; Koufteros et al., 2005; Langerak & Hutlink, 2008) found that external and internal integration are integral in developing new product development performance. This indicates the positive relationship between external and internal integration items and the new product development.

5.3 Examining the Research Questions

Research Questions tend to examine the effect of concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development implementation. Simple linear regression analysis results show that these variables have significantly affected and can be used to predict new product development process.

5.4 Recommendation for Further Research

The study has showing the relationship of concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development.. From this study, it provides good information that can be used in guiding to develop new product in manufacturing. All these information was beneficial to our lovely country, Malaysia.

Furthermore, from this study, it can provided an information for Malaysia to be a guideline in create a mission of manufacturing sector to be an important contributor and being a land mark for being a competitive global country. All the information can be used in all variety of economy and Malaysia doesn’t wait for a long time to take a plan to move forward. Other than that, every state in Malaysia especially an industrial state, can used this information to continue focusing on enhancing the capabilities of manufacturing sector, to meet competitive global state and keep up their value chain using their resources-based view to grow. This guideline helps them to go faster than other competitors.

Besides that, this research helps a ministry of finance to make a good policy and create a mission on Malaysia Plan to further move all sectors of economy especially manufacturing sector. From the policy, this study also help Federation of Manufacturing Malaysia (FMM) as a Factory Association of Malaysia to help give these information to all factory in Malaysia, including all manufacturing sector like electric and electronic, machinery and equipment, and others. This information can be valuable to all this factory and firm to apply in economy downturn.

Future research may be extend to include other variables that would account for the new product development and manufacturing, and widen the scope of the current research. Furthermore, new product manufacturing considered for this research was at least one process or the whole manufacturing capabilities. There are several companies perform only certain process of new product development in manufacturing. Therefore, it could not cover all the important issues with regard for the new product in manufacturing. It is suggested that a comparative study should be conducted between different sectors to determine whether there are significant in the differences sectors. Thus, using multiple data sources by different sectors will present how they develop new product in their situation. This would further support the claim on generalizing manufacturing product capabilities.

Finally, new product manufacturing capabilities takes a long period of time. Companies go through drastic changes and modification in the modularity product manufacturing. Therefore, to examine the effects, a longitudinal study is suggested. The advantage of longitudinal study is that it can track changes over time. For an in-depth study, other types of studies can be used such as qualitative studies (as opposed to quantitative data gathered through questionnaires) where data collected through observation or interviews, and another type of research involve in-depth in case study.

5.5 Implications of the Study

The results from the study offer several implications in developing firms' new product development. A number of theoretical and practical implications have merged from this study. The findings on the main and interacting effects from this study have extended beyond the results of other previous studies and thus have contributed new information to the body of new product development process research. First, this study demonstrates the relationship of concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development.

. The present study focuses on independent variable to bridge the gap in predicting and developing the new product development in the Malaysia context. Based on correlation analysis, the result suggests that manufacturers with higher efforts of concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development are more likely to report more success in developing the new product development. Next, the results also highlight the importance of having strong factors for new product development. From the managerial point of view, the findings from this research suggest that companies need to concern new product development in term of concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development. This requires the companies' efforts to adopt related customer involvement, organizational integration supplier involvement into their organization to enhance the new product development in manufacturing and develop the high degree of new product manufacturing in driving their companies to compete with other competitors.. Besides, this study also points out that multiple relationships help to focus and assess the important factors that must be focused in developing manufacturing capabilities. For instance, the companies should focus on, customer involvement, organizational integration supplier involvement and in developing the new product development. customer involvement, organizational integration supplier involvement will assist manufacturers in utilizing at optimum level due to operation attained from diversity of technology. Therefore, companies become more competent and sustainable in any economy recession. This study found evidence to support the hypotheses. This reveals that customer involvement, organizational integration supplier involvement measures are an important function of firm cooperative action. The findings confirmed the studies by (Schilling, 2000; Todorova et. al. 2002) which organization integration and virtuality plays the intermediary role and firm should pay more attentions for this part.

Manufacturers need to develop customer involvement, organizational integration supplier involvement to ensure the success in developing modularity product manufacturing. This study show strong association of customer involvement, organizational integration supplier involvement for to develop new product development.

5.6 Limitations

This study had to face several limitations considered to be normal as many other empirical studies. First, the data and information had to be gathered from the manufacturing companies that are currently registered with the Federation of Malaysian Manufacturers across industry in the Malaysia, by investigating the perception on their experience of practicing the core manufacturing capabilities. However, we managed to collect 150 of the 250 samples. Therefore, it is difficult to say that the sample correctly represents all the major practices of modularity product manufacturing and the result may not apply to other sectors in the economy.

Second, the present study focuses at one or the whole of new product development done by companies. Consequently, some companies perform only certain new product in their manufacturing. Therefore, the companies should be aware of the contribution of each factor on developing new product in manufacturing.

Finally, a cross-sectional data was used in this study, which limits interferences with regards to causality between the independent variables and the dependent variables.

5.7 Conclusions

This study has successfully answered all research questions and has tested all hypotheses. The findings give the empirical evidence that new product development is influenced by customer involvement, organizational integration supplier involvement. It is hope that this study will give significant references to industries, academicians and students in the same fields.

The first objective of this study is to study whether concurrent effect to the organization integration. Our first conclusion was the factors have significant relationship with organization integration. This is due to the manufacturers who did not focusing improvement in their operation. The second objective of this study is to examine the effects of customer involvement toward organization integration . Our second conclusion is that customer involvement explains the beneficial for the manufacturer and customer that they can get through the implementation of product modularity. The third objective of this study is to understand the linkage between supplier involvement toward organization integration. The conclusion found that organization integration interacted with customer involvement customer demand, supplier involvement for the success developing of new product development. The fourth objectives are to evaluate the significant of organization integration toward new product development. The final conclusion found that organization integration ,virtuality give beneficial to the manufacturer to help in their operation and maximize the cost involved with supplier.

In sum, the contribution of this study rests on the identification of concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development by Malaysia’s manufacturers. Thus, the present study presents adequate theoretical justification for the use of and manufacturing experienced concurrent engineering, organizational integration, customer involvement, supplier involvement, and virtuality towards new product development and provides a more comprehensive assessment of the relationship between these variables.

THE IMPACT OF ORGANIZATIONAL INTEGRATION ON NEW PRODUCT DEVELOPMENT PERFORMANCE: MODERATING EFFECT OF VIRTUALITY

Dear Respondent,

I would like to extend this research invitation to your organization and would be very grateful if you are willing to participate in this research project. This questionnaire is designed to study the impact of organizational integration on new product development (NPD) performance with the moderating effect of virtuality. The information given in these questionnaires will remain strictly confidential. This research is being conducted as a fulfillment to complete the Doctor of Philosophy (PhD) program.

Introduction

This survey forms parts of a study on the implementation of NPD practices in manufacturing companies. The aim is to study the overall integration of internal and external constituents involved in NPD and further investigate its impact on NPD performance. The information obtained will be useful in devising suitable approaches that will benefits manufacturing companies. All responses given will be treated with the utmost confidence. The results will be used for research purposes only and no attempt will be made to identify any individual or organizations in any publications. As a token of appreciation, we would like to offer you the final report of the survey and sent to all interested participants.

Instructions

1. Most of the questions in this questionnaire required you to circle the options that best represent your opinion. In some instances, you are required to tick [/] or write your answers in the appropriate response space.
2. There are no rights or wrong answers. Thus, we would appreciate your honest and complete response to help us understand your views better. In some of the questions you may find it difficult to choose an answer. It may feel like neither option describes you perfectly or that more than one option suits you. If this happens, guess which option suits you better.
3. The questionnaire is divided into six sub-sections. You are asked to fill in all the sections. It will take approximately 15-20 minutes to complete.
4. Please send the completed questionnaire in the free post envelope provided. Please make sure you seal it. We would be very grateful if you could return the completed questionnaire <u>within 7 days in the enclosed envelope.</u>
5. If you need assistance on how to fill in the questionnaire or further information about this research, please contact;

Dr Amlus Bin Ibrahim,
College of Business,
Universiti Utara Malaysia,
06010 Sintok
Kedah, Malaysia
Telephone: 012-4626184

SECTION 1: PERSONAL INFORMATION

The following questions are about your personal background. Please (/) and fill in the blank the response the best describes your preference.

1. Gender

    1. Male ☐
    2. Female ☐

2. Race:

    1. Malay ☐
    2. Chinese ☐
    3. Indian ☐
    4. Other (please specify): ______________________

3. Highest education qualification:

    1. Master degree
    2. Bachelor Degree
    3. Diploma
    4. Other (please specify): ________________________

SECTION 11: COMPANY PROFILE

In this section we would like to know about your organization in general.

Company Profile

1. Nature of your business:

- [ ] Electric and electronics
- [ ] Textiles or apparel
- [ ] Machinery and equipment
- [ ] Petrochemical and polymer
- [ ] Steel production
- [ ] Others: (please specify):__________

2. Is the company a ___________________________

- [ ] Malaysia owned
- [ ] Joint venture
- [ ] Multi-National company
- [ ] Foreign owned
- [ ] Others: (please specify): _______________________

3. Number of years in this business:

- [ ] 0 - 5 years
- [ ] 16 - 20 years
- [ ] 6 - 10 years
- [ ] Over 20 years: (please specify):___
- [ ] 11- 15 years

4. Size of the company (approximate number of employees):

- [ ] Less than 50
- [ ] 101 – 250

☐ 50 – 100 ☐ More than 251

Department Information

1. What is your position in this company?

☐ Director ☐ Senior Manager

☐ General Manager ☐ Production Manager

☐ Others: (please specify): ______________________

2. Number of year of experiences in this company?

☐ Less than 1 year ☐ 6 – 10 years

☐ 1 – 5 years ☐ More than 10 years

Years estimate: (please specify) _________

SECTION III: INTERNAL-EXTERNAL INTEGRATION

In this section, we are trying to determine the level of internal and external integration being implemented in your company. Internal integration is represented by concurrent engineering, while external integration is represented by both customer and supplier involvement. Please indicate your level of agreement or disagreement to which you believe your company has the feature described by the statement. Circle the number between 1 and 7 to show how strong your belief is.

	Concurrent Engineering	Strongly Disagree			Moderate			Strongly Agree
CE 1	Much of process design is done concurrently with product design.	1	2	3	4	5	6	7
CE 2	Product development activities are concurrent.	1	2	3	4	5	6	7
CE 3	Product development group members share information.	1	2	3	4	5	6	7
CE 4	Product development group members trust each other.	1	2	3	4	5	6	7
CE 5	Product development employees work as a team.	1	2	3	4	5	6	7
CE 6	Product development group members seek integrative solutions.	1	2	3	4	5	6	7
CE 7	Purchasing managers are involved from the early stages of product development.	1	2	3	4	5	6	7
CE 8	Process engineers are involved from the early stages of product development.	1	2	3	4	5	6	7
CE 9	Manufacturing personnel is involved from the early stages of product development.	1	2	3	4	5	6	7
CE 10	Various disciplines are involved in product development from the early stages.	1	2	3	4	5	6	7

	Customer Involvement	Strongly Disagree	Moderate	Strongly Agree
CI 1	We typically rely on the user to help us define and clarify that user's needs in developing our new products.		1 2 3 4 5 6 7	
CI 2	We visit our customers to discuss product development issues		1 2 3 4 5 6 7	
CI 3	During the development of our products, we often have the users try out whatever we have developed up to that point.		1 2 3 4 5 6 7	
CI 4	We typically try to put working prototypes in the user's hands as early as possible in our development efforts.		1 2 3 4 5 6 7	
CI 5	We proficiently review customer reactions to early product designs.		1 2 3 4 5 6 7	
CI 6	We study how our customers use our products.		1 2 3 4 5 6 7	
CI 7	Our product development people meet with customers		1 2 3 4 5 6 7	

	Supplier Involvement	Strongly Disagree	Moderate	Strongly Agree
SI 1	Our component suppliers often place some of their personnel on our development teams.		1 2 3 4 5 6 7	
SI 2	Our suppliers do the product engineering of component parts for us		1 2 3 4 5 6 7	
SI 3	Our suppliers develop component parts for us.		1 2 3 4 5 6 7	
SI 4	Our suppliers develop whole subassemblies for us.		1 2 3 4 5 6 7	
SI 5	Our suppliers are involved in the early stages of product development.		1 2 3 4 5 6 7	
SI 6	We ask our suppliers for their input on the design component parts.		1 2 3 4 5 6 7	
SI 7	We make use of supplier expertise in the development of our products.		1 2 3 4 5 6 7	

SECTION IV: OVERALL INTEGRATION

In this section, we are trying to measure the degree of integration between NPD teams and various organizations/ constituents associated with an NPD process. Please indicate your level of agreement or disagreement to which you believe your company has the feature described by the statement. Circle the number between 1 and 7 to show how strong your belief is.

	Overall Integration	Strongly Disagree			Moderate			Strongly Agree
OI 1	NPD team and other organizations attempted to avoid creating problems for each other during the NPD process	1	2	3	4	5	6	7
OI 2	NPD team and other organizations were perceived to have mutual new product goals	1	2	3	4	5	6	7
OI 3	NPD team and other organizations appeared to work smoothly together to develop a new product	1	2	3	4	5	6	7
OI 4	NPD team and other organizations acted as a unified group during the development of a new product	1	2	3	4	5	6	7

SECTION V: VIRTUALITY

In this section, we are trying to measure the degree of virtuality involved in the NPD process in your company. Kindly rate how often or intense is the following statement.

	Virtuality	Not at all	Moderate	Very High
VT 1	Work at home during normal business days	1 2 3 4 5 6 7		
VT 2	Work while travelling, for example, at airports or hotel	1 2 3 4 5 6 7		
VT 3	Collaborate with people in different sites or geographies	1 2 3 4 5 6 7		
VT 4	Collaborate with people you have never met face-to-face	1 2 3 4 5 6 7		
VT 5	Work extended days in order to communicate with remote team members	1 2 3 4 5 6 7		
VT 6	Collaborate with people in different time zones	1 2 3 4 5 6 7		
VT 7	Collaborate with people who speak different native languages or dialects than your own	1 2 3 4 5 6 7		
VT 8	Collaborate with people from different cultural backgrounds	1 2 3 4 5 6 7		
VT 9	Work on projects that have changing team members	1 2 3 4 5 6 7		
VT 10	Work with teams that have different ways to track their work	1 2 3 4 5 6 7		
VT 11	Work with people that use different collaboration technologies and tools	1 2 3 4 5 6 7		

VT 12	Collaborate with people from different business groups or departments	1	2	3	4	5	6	7
VT 13	Work at different sites.	1	2	3	4	5	6	7
VT 14	Have professional interactions with people from outside the organization	1	2	3	4	5	6	7
VT 15	Participate in real-time online discussions, such as chat or instant messaging.	1	2	3	4	5	6	7
VT 16	Meet with people via video-conferencing tools	1	2	3	4	5	6	7
VT 17	Work with mobile devices	1	2	3	4	5	6	7

SECTION VI: NPD PERFORMANCE

In this last section, we are trying to gather information on the performance of one of your recent NPD activities. Both financial and non-financial measures are assessed. Please indicate your level of agreement or disagreement to which you believe your company has the feature described by the statement.

	NPD Success	Strongly Disagree			Moderate			Strongly Agree
PD 1	Overall, this project met or exceeded sales expectations	1	2	3	4	5	6	7
PD 2	This project met or exceeded profit expectations	1	2	3	4	5	6	7
PD 3	This project met or exceeded return on investment expectations	1	2	3	4	5	6	7
PD 4	This project met or exceeded overall senior management's expectations	1	2	3	4	5	6	7
PD 5	This project met or exceeded market share expectations	1	2	3	4	5	6	7
PD 6	This project met or exceeded customer expectations	1	2	3	4	5	6	7

	NPD Speed	Strongly Disagree			Moderate			Strongly Agree
PS 1	This project was developed and launched faster than the major competitor for a similar product	1	2	3	4	5	6	7

PS 2	This project was completed in less time than what was considered normal and customary for our industry	1 2 3 4 5 6 7
PS 3	This project was launched on or ahead of the original schedule developed at initial project go-ahead	1 2 3 4 5 6 7
PS 4	Top management was pleased with the time it took us from specs to full commercialization	1 2 3 4 5 6 7

Below are items to measure capabilities of the NPD team to produce a quality and innovative product. The items for capabilities compare the firm to the average in the industry with a scale from 1= much below to 7= much above.

	Product Quality	**Much Below**	**Moderate**	**Much Above**
PQ 1	Our capability of offering products that function according to customer needs over a reasonable lifetime is	1 2 3 4 5 6 7		
PQ 2	Our capability of offering a high value product to the customers is	1 2 3 4 5 6 7		
PQ 3	Our capability of offering safe-to-use products that meet customer needs is	1 2 3 4 5 6 7		
PQ 4	Our capability of offering reliable products that meet customer needs is	1 2 3 4 5 6 7		
PQ 5	Our capability of offering durable products that meet customer needs is	1 2 3 4 5 6 7		
PQ 6	Our capability of offering quality products that meet customer expectations is	1 2 3 4 5 6 7		

PQ 7	Our capability of offering high performance products that meet customer needs is	1 2 3 4 5 6 7

	Product Innovation	Much Below	Moderate	Much Above
PI 1	Our capability of developing unique feature is	1 2 3 4 5 6 7		
PI 2	Our capability of developing new product and feature is	1 2 3 4 5 6 7		
PI 3	Our capability of developing a number of new features is	1 2 3 4 5 6 7		
PI 4	Our capability of developing a number of new products is	1 2 3 4 5 6 7		

THANK YOU FOR YOUR TIME IN COMPLETING THIS QUESTIONNAIRE.
YOUR COOPERATION AND SUPPORT IS HIGHLY APPRECIATED.