

## **Factors and Priorities Considered in the Product Design Process: *A Case Study of SMIs***

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### **1.0 INTRODUCTION**

This main aim of this paper is to identify and prioritise the factors considered by the Malaysian SMIs (small and medium industries) in their product design process, particularly in the manufacturing sector. As we know that, the manufacturing sector is the most players in the country's continued economic development by producing products and services for the local market as well as for foreign markets. Thus, SMIs (known more generically in other countries as SMEs, small and medium sized enterprises) played an important role in the supply chain management of most industries and often end producers in their own right.

The Malaysian SMIs need to work hard and smartly in order to have competitive advantage and to produce successful products. This company's competitive advantage could be achieved by creating differentiation of products in order to distinguish them from the offerings of other companies, particularly in Malaysia and overseas. Nowadays, the Malaysian SMIs have been struggling very hard to survive and to design and develop products that meet customer requirements and needs in the competitive global environment. The Malaysian SMIs need to compete in different aspects of products in one or more areas. Therefore, the quality of management of the product design

process is an important characteristic and should be efficient enough to cater for the whole product design processes.

Overall, Malaysian SMIs need be able to make adequate efforts in their product design process in order to compete more effectively in enhancing their product marketability in the open market. The most effective product design process is a major variable when SMIs want to increase their product's quality to enable them to be successfully marketed their quality's products to both local and foreign customers.

Even though the products already existed in the current open market, but then, SMIs need to continue thinking about how to make further product's improvements and development in order for them to sustain their competitiveness or increase their product's value in the eyes of customers. However, product "redesign" also relies upon quality management programmes and management. In addition, SMIs also heavily rely on how they utilized the available guidance and resources in term of the labour and capital markets.

Hence, the main aim of this study is to identify the factors, priorities of product attributes been considered by Malaysian Small and Medium Industries (SMIs) when designing and

redesigning their products. This study also focuses on who are involved in the company's product design process and their level of involvement in managing their product design process. It is believe that well designed products that match customers' needs, requirements and tastes will win the customer's heart and could improve orders (demand) in world open markets.

## 2.0 LITERATURE REVIEW

### 2.1 The Roles of Malaysian SMIs

Malaysia has recognised the importance of SMI development since the early 1960s, although SMIs (somewhat disparagingly known as "petty traders" before independence in 1957) have been in existence since the fourteenth century. However, in the late 1990s and early 2000s, there was a global a trend of emphasizing the quality of products and services produced by the manufacturers, from which Malaysia could not be excluded.

The structure of the Malaysian economy changed from a reliance on resource-based industries to an industrial base, with the emergence of the electronic and electrical, the textile and clothing, and the machine and equipment sectors.

Amongst the roles that could be played by Malaysian SMIs are the creation of job and employment opportunities for local people, the generation of income and a better way of life, the smooth process of technology transfer and know-how, the training and development of employees, and the promotion of the Malaysian SMIs through cooperation and collaboration with the MNCs as suppliers or complementary services.

### 2.2 Product Design Processes

The product design process "contains a conception of the market or customer requirements, a translation of these requirements to specification for drawing, for production and for the preparation of the manufacturing process" (Sharifi and Pawar, 1996). However, Barton (2000) defined the process of design as "generating a complete description of the product that satisfies a set of requirements and constraints" which involved most important stages, that is the movement from abstract to concrete ideas and specifications. Therefore, in general, the product design process involves conceptual design, product design, and the production of the products.

The designing and redesigning is a process of continual improvement and development. Feedback and ideas from the end-users (e.g. customers), external sources (e.g. design consultants, researchers) and within the company (e.g. employees) are necessary during the product's designing/redesigning process and also throughout the product life cycle. During the product design process, SMIs need also aware of the market and customers' needs. Therefore, all these factors must be well integrated and incorporated during the product design process by the company's design function and/or via cross-functional teams.

Many Malaysian manufacturing companies are currently unable to compete effectively and sell their products in the world markets. This is despite their best efforts to respond to market needs and changes, and enhance their competitiveness by introducing new products and conducting innovative redesigns on their existing products. With all their best intents, and the fact that some companies are keen to update their products, many Malaysian companies have failed to effectively operationalise their conceptual ideas at the initial stage of the new product design process, have had product design projects cancelled during the design and development process, or

have launched what they believed to have been attractive products only to have them fail in the marketplace. The failure of Malaysian manufacturing companies in this respect seems to be either due to product costs being too high, or the quality and design of Malaysian products not equating to international standards, and therefore not being competitive enough to penetrate overseas markets. They appear to be, in Porter's (1980, 1990 and 2004) terms, "stuck-in-the-middle – neither lowest cost or perceived as differentiated.

Malaysian companies need to face up to these challenges by changing their product designs, learning how to innovate more effectively, and better managing the product design and development process so that customer needs and requirements are more accurately reflected. Malaysian companies should ensure they offer products that are very competitive in terms of design, technical performance, marketing, after-sales service, aesthetics, ergonomics, ease of use and reliability - not to forget the quality of the materials, manufacturing and finishing processes. For a newly designed product to penetrate a market or market segment, the company must simultaneously match customer needs such as features offered, superior quality and attractive pricing (Schilling and Hill, 1998).

Malaysian companies need to compete on differentiation factors because of the competition from the developed world and they must at the same time compete with the emergence of newly industrialising countries that have relatively low labour cost and produce similar products such as China (including Hong Kong), Mexico, Indonesia, Vietnam and India. Hence, Malaysian companies have to mix these factors correctly so that they can compete effectively in both domestic and export markets.

Schilling and Hill (1998) suggested that, for companies to succeed in marketing their products, they have to maximise customer features and minimise the time taken to

introduce products in the market. Thus, the companies should formulate their strategic intent in the product design process, conduct market research on customer needs, and determine the extent to which current resources (people, equipment and tools) are capable of carrying out the product design process.

### 2.3 Designs in Manufacturing

There needs to be a close relationship and integration between the engineering function dealing with technical design and the production function of the company. Hence, attention to the manufacturability of emergent design will reduce the eventual cost of production, and increase product quality by designing a product that is easy to manufacture, and within the required resources of the company. The designing for manufacturing enables companies to produce products that are competitive in terms of costs and of high quality.

The use of design for manufacturing helps SMIs to fulfil their customer needs for high quality, enable a very attractive price to be set in relation to the product's features, reduce the number of unwanted parts in the assembly operation, reduce the time needed to adjust product designs during the manufacturing process, and eliminate unwanted, non-value adding, processes.

In addition, the stage-gate process involves different stages of development such as idea generation, preliminary investment, business case preparation, product development/design, product testing, and production introduction into the market. This it is a method and process of how one manages the product development process for launching a new product to ensure success and acceptability in the market. As a result, it will reduce development time, increase the ratio of internally developed products, and help to identify which projects should be continued or otherwise.

## 2.4 How do customers “value” a product?

In order to satisfy domestic and international customer needs and expectations, companies need to formulate product strategies that enable them to differentiate their products from their competitors in the global market (Burpitt & Rondinelli, 2000). Today, customers demand more customised and personalised products and are very discerning about certain products. They expect the producer to recognise their specific needs and meet these on times, when they need it, and at the right price (Clemmet, 1998).

This means that many Malaysian SMIs need to make improvements in their customer service on a continual basis, and especially in their product offerings. Most companies nowadays claim to be customer oriented, but few really know how their product is valued or assessed by customers: “How does the consumer view our company’s product in terms of value as compared with a competitor’s product?” Companies nowadays need to be more concerned with their customers and determine what they really want from the company and, specifically, its products and services (Toombs and Bailey, 1995).

The concept of value provides a means for determining customer needs. Coyle (2004) suggested that most customer “value” their product based on the right quoted price, the right quantity/unit of product received, the right place when that particular products are needed (time), and the right condition of product (as specified). Hence, designing for value is conducted to make customers more satisfied with the products as a final user. Here, the value is any benefit (or attribute) that might be perceived by customers, whether tangible or intangible. Value is also determined in terms of price and non-price benefits offered by the company (Walters and Lancaster, 1999).

In addition, the survival of the company also depends on the customers’ satisfaction (what the customer might need in the future) with a

company’s product. Customer satisfaction means the company should try to meet the customers’ needs by providing products at the right time, in the right quantity, at the right price, and of the level of performance they want (Prasad, 1998). This means the company must have the ability as well the capability to meet the customers’ needs or priorities at the right time; in the right place and with the right product even though the customers’ desires will change as over time.

## 2.5 Product Attributes

A major assertion underpinning this research is that “product attributes” play an important (and, perhaps, an even more important) role in the marketing of products than the conventional strategies of categorizing and segmenting products. Product attributes help to communicate messages about the product and provide information to customers, as well as marketers. Companies use product attributes to market their products while consumers use product attributes in evaluating and comparing a particular product in order to discover what benefits they receive when purchases have been made. Thus, in the end, the consumer benefits by being able to buying a product in terms of the values they desire (Puth *et al*, 1999). Customers purchase products for a range of uses and reasons such as taste, emotion and fashion, service and financing, security, performance, aesthetics, convenience, economy and reliability (Walters and Lancaster, 1999); functions, and features (Prasad, 1998); price, quality, and delivery (Howard, 1998); and the classic retail options of product range, display and store location, and a loyalty card (Clemmet, 1998).

Product attributes can be categorised into product development, brand extension, and product positioning (Viswanathan and Childer, 1999); speed, efficiency, and quality (Goldense, 1994); colour (Puth, *et al*, 1999); time compression, concurrent engineering, quality function (during designing and development) and agility (Prasad, 1998), and price and

delivery (Howard, 1998), features, convenience and value, service after sale, product design, etc.

Even though so many product attributes have been identified and mentioned above, however, this paper will discuss a few such as ergonomics, economic effects, aesthetics, and technical aspects. Product attributes are considered as “value” for customers when they are in the process of choosing an intended particular product.

### 2.5.1 Ergonomics

In order for customers to buy a certain product they should have some idea of that particular product in terms of quality (Karapetrovic, 1999), and an image such as “luxurious, gorgeous, and strong” (Nagamachi, 1995). A person experiences products in varying ways, through their eyes, ears, skin and tongue and the surrounding environment (Rooney, 1994) in relation to familiarisation, the suitability of its functionality, ability comfort, anthropometrics fit, ease of using and maintenance with adjustability (Butter and Dixon, 1998).

This is normally in response to demands made by customers concerning their feelings about product design and functionality (Nagamachi, 1995), innovation and responsiveness of product development based on human-centred design of products (Hsu, 2001), appearance, comfort of users, safety factors, and economic factors (Fernandez, 1995).

### 2.5.2 Environmental impacts

The environmental impact on the ecological system is becoming increasingly important to most companies and many companies have developed new products or redesigned their products with environmental sustainability in mind. Thus, companies need to improve their product design in a more recycling-friendly manner by taking into consideration the

temporal impact globally or locally, the precaution of pollution prevention, and the multiple attributes or use of the products. The designers or any other person that becomes involved in the process of designing a product should also look into the criteria regarding individual components, criteria regarding subassemblies, criteria regarding disassembly operations, criteria regarding the product as a whole, and criteria relevant to the logistics (Kriwet *et al*, 1995).

Manufacturing, packaging, storing, transporting, and using a product all have an impact on the environment (Hollins and Pugh, 1990). The temperature range, safety aspects, labelling, operating instructions, pressure range (altitude), humidity, noise levels, insects, vibration, corrosion from fluids, and any unforeseen hazards are aspects that will be considered in the design process (Ulrich and Eppinger, 2000; Hollins and Pugh, 1990).

### 2.5.3 Economic effects

The companies will also look into the costs and benefits, focusing on the cost invested and the “value” of a particular product. Is it economical to produce a specific product? Will a specific product satisfy the needs and desires of the customers? Does the designing work process enable the product to be produced at the lowest cost and can it be sold at a price that finally generates reasonable profits? What are the required maintenance costs? (Oakley, 1984). Therefore, the value as seen by the customer – is the product at the right price or “valuable” to purchase in the first place?

### 2.5.4 Aesthetics

Hollins and Pugh (1990) suggested that aesthetic features played an important role in a ‘highly visible’ product (e.g., appearance of computer) rather than an ‘invisible’ one (e.g. network card for a computer). Consumer appeal will be achieved through appearance, feel/touching, sound/hearing, and smell.

Packaging design or redesign, packaging graphics, functional design, application of corporate identity, product styling, logos, and corporate identity are aesthetic features that could create consumer appeal through the appearance of the product. Colour, weight, shape, form, surface, and texture of the finish products should always be considered from the outset (Hollins and Pugh, 1990). Hence, the artistic or aesthetic features of a specific product need to be taken into careful consideration throughout the design process.

### 2.5.5 Technical aspects

The designers should access current knowledge/information in order to practice the most recent appropriate technology available to comply with the compliance of the customer needs and desires. Most products will involve technical design work in some measure to achieve specified performance, rigidity, durability, and safety (Oakley, 1984; and Bennett *et al*, 1988). Technical value can often be a major factor in the purchase decisions made by customers.

## 3.0 RESEARCH METHODOLOGY

The main instrument used in the data collection for this study was a set of questionnaire. The data and information were gathered through a survey (mailed questionnaires). This study utilized secondary sources of data, but initially focused on a self-administered survey using a structured questionnaire, supplemented by personal observations, and in-company documentary searches. In addition, the fieldwork was done to discover how Malaysian SMIs practise the activities of product design in their daily operational activities, and therefore how they generate product attributes.

A set of questionnaires was mailed to companies' top level management of 989 organizations in West Malaysia (i.e.: all states except Sarawak and Sabah: "East Malaysia", non-manufacturing, and duplicated companies)

listed in the SMIDEC's directory for the year 2001. The shortened list was then divided into four discrete and identifiable sectors of company involvement, namely: primary resources processing companies, transportation or vehicles production companies, electrical or electronic companies, and machine tool and production equipment companies.

The researcher received 150 completed questionnaires. However, only 137 questionnaire returns (13.85%) were used for the data analysis due to misinformation, incorrect data, and identifiable errors contained in the returned questionnaires. The total response rate was 15.17% (150 from 989) that can be considered relatively high in the posted survey questionnaires at the industrial population in the South East Asian countries (Harzing, 2000 and Jobber, 1990).

The most widely used computer software, Statistical Package for the Social Sciences (SPSS) for Windows Version 10.0.05, was used to analyse and manage quantitative data for this study (Coakes and Steed, 2001).

## 4.0 ASSUMPTIONS AND LIMITATIONS

The information and data obtained from the sample of the survey are assumed to be adequate and to represent the population of Malaysian SMIs. The instrument used in this study is assumed to be the most effective measurement tool for gathering the information and data that are needed. The answers (completed questionnaires) given by the respective respondents were assumed to be the most reliable and a true reflection of their best knowledge about the priorities considered and product attributes in their respective companies, and Malaysia in particular.

The different top company managers projected different perceptions about the priority concepts and product attributes that had been used in designing and redesigning products of their

company. This study is limited to the Malaysian SMIs who responded to the questionnaires were particularly from the heavily populated area on the West Coast of Malaysia. Therefore, the results of this study may not be generalised to other states, particularly the East Coast of Malaysia and East Malaysia (Borneo Island) which is less densely populated. It is thought that some of the designated receivers of questionnaires might have forwarded the questionnaires to their subordinates to complete and return the questionnaires, even though they were instructed not to do so.

## 5.0 THE FINDINGS

The Malaysian SMIs were relatively young companies, founded after 1991 (52.55% of the sample). Most participating SMIs employed fewer than 150 employees with a total current turnover of less than RM 5 millions and a paid-up capital of less than RM2 millions. The neighbouring ASEAN countries are the most important trading countries for Malaysian SMIs.

The results show that 65.7% of the companies had introduced less than 10 new products in the last five year. It is clear that most companies whose export, exported (40.3%) less than ten products in the last five years. Overall, 48.9% companies would consider their companies' products have a potential for growth and can contribute for company expansion. Then, we can conclude that 50.4% have active product design activities within the company even though just 78.9% of the companies utilise less than ten people to design or redesign their products.

Malaysian SMIs must not forget the company's product design activities. The design department contributed 28.9%, senior executives (26.5%), and manufacturing/operations department (14.9%) toward the company's design process. Meanwhile, designers (36.1%), senior executives (26.1%), and manufacturing/operations (23.5%) are those that led and managed the company's product design projects.

The important factors considered by the Malaysian SMIs during their product design process for local customers were purchase price for customers, technical performance of products, and customisation to direct customer need. On the other hand, the technical performance of product, the purchase price for customer, and the build quality of product are the factors considered for foreign customers in their company product design process.

Overall, the respondent company choice is cost of manufacture (22.7%), followed by technical performance of product (17.7%) and customisation to direct customer needs (16.8%) are their company's priorities in designing or redesigning products and variations of choices of Malaysian SMIs..

## 6.0 DISCUSSION

It is important for the SMIs to venture into an industry where products can provide a better income and that can also be expanded in the future through continuous improvement. For example, the resource-based SMIs can venture into the international market by collaborating with a foreign SMIs partner, probably in the same sector, in order to share any relevant experiences and information regarding the products.

The emergence and rapid growth of companies in this industry from the early 1970s till the 1990s has contributed tremendously to Malaysia's economy, particularly in "balancing" the balance of payments amongst the trading countries. However, this industry was affected when a few manufacturers shifted their operations to other countries which provide better initiatives and lower production costs. It is important to the Malaysian SMIs to remain competitive through putting more emphasis on the product design process and they should aggressively take part as a component supplier to leading Malaysian companies such as PROTON, INOKOM, and MODENAS.

Most Malaysian SMIs are young or at the infant stage in their business life cycles or experience. It is hoped that the present top management will continue to enhance their knowledge and skills in relation to their job in the near future, and eventually gain more experience to further develop their company's performance.

The study also indicates that not all exporters had succeeded in their exporting activities. These indicators suggest that the Malaysian SMIs still lagged behind in terms of exporting their products and need some guidance on how to enhance their performance in this area. They need to be up-date with current events and world trends in exporting, such as the quality demanded by customers and suppliers; procedures, rules, policies of import/export; and current laws regarding exporting to foreign countries. The Malaysian SMIs should take proactive action in designing or redesigning their products based on the forecasting of product attributes that might be needed by customers or for a specified market niche.

There is no doubt that product design activities are an important aspect of producing a company's products but the management of it should be given priority as well. The company's product design activities will be more effective and efficient if the company's management, specifically the personnel directly involved, are well informed about current trends in the global market and products availability. Even though designers are presumed to be experts in designing products as indicated in the study, the final decision about the design of products and production is determine by the senior executives or the owner of the company. In addition, it is vital for a company to have its own research and development department to help its management in terms of designing or redesigning products, and also to facilitate other areas of interest, such as advice on marketing strategies, export opportunities, financial aspects, and methods and techniques in production.

The study suggests that Malaysian SMIs have used different priorities when designing or redesigning products for their customers. In the researcher's

opinion, it is time for Malaysian SMIs to give high priority consideration to the "value" of the product which includes the technical performance of the product, ergonomic value or ease of use of the product, environmental factors, and aesthetic and product styling. In addition, most customers are more sophisticated and demanding about what they want nowadays. And they assume that producers will understand this and fulfil their needs and requirements.

It is also suggested that Malaysian SMIs could have the same priorities for foreign customers when they produce products for the local customers. It is believed that local consumers would like to consume an "imitated products" from overseas which can be copied by local producers very quickly through the mass media or electronic media. Finally, the researcher believes that "quality" should be given as much emphasis as aesthetic "value" when designing or redesigning products.

Factors for local customers and foreign customers

No	Factors	Local (%)	Foreign (%)
1	Purchase price for customer	47.6	27.4
2	Technical performance of product	29.0	43.2
3	Customisation to direct customer need	8.1	4.2
4	Fashion trend	4.9	6.3
5	Economy of use for customer	4.0	2.1
6	Build quality	3.2	13.7
7	Aesthetic & product styling	1.6	3.1
8	Ergonomic value or ease of use of product	0.8	0.0
9	Environmental or "green" factors	0.8	0.0

The study indicates that Malaysian SMIs gave lowest priority to fashion trends, timeliness of product launch, legal consideration, and environmental "green" factors when designing or redesigning their products. These suggest



that most SMIs considered costs (fixed costs and variable costs) as their main priority when designing or redesigning their products rather than thinking of the “product” itself or anything to do with the product. The researcher considers that, it is time for the Malaysian SMIs to place more emphasis on the “products” themselves. As we know, different countries have their own standards and requirements relating to imported products.

Thus, the main task of Malaysian SMIs is to search for the information regarding these specific requirements and at the same time, determine the most suitable tools and techniques available that might help them in producing the desired products. In addition, Malaysian SMIs can respond quickly to local customers who required goods produced overseas which are too expensive, may ask a local company to produce quality similar product.

## **7.0 THE CONTRIBUTIONS OF THE STUDY**

The product design process has been discussed, practised, and applied widely in the western or developed countries. The findings of this study have extended this concept, the product design process, to other developing countries such as Malaysia. This phenomenal is supported by indicating that Malaysian SMIs have adapted and adopted the concept of product design process in this study.

This study has identified the product attributes as a platform to enhance a company’s performance. This contribution could help and assist future researchers to expand the boundary of knowledge by conducting studies that could help to further verify as well identify others product attributes.

Initially, this instrument was developed and applied within the Malaysian SMIs, however, this instrument should be valuable to future researchers who might be interested in exploring the product design process in other countries, in other sectors of businesses, or in different environments.

The findings of this study revealed that the top priorities or factors in designing products for local customers and foreign customers are different in terms of technical performance of the product, purchase price for customers, build quality of the product, customisation to direct customer need, aesthetics and product styling, and economy of use, to name a few. The managers could make use of these indicators in their future production as a guide to identifying priorities for product design purposes.

The concept of product attributes and its important could be introduced at the early stage in the education system, in Malaysia in particular, at the secondary school level. The policy makers could utilise the findings when designing the curriculum for subjects like design and technology for various levels of education. This objective could be achieved through encouraging inventions and competitions for new designs amongst the school children in different categories of product attributes (e.g. safety precautions or ease of product use).

## **8.0 RECOMMENDATIONS AND SUGGESTIONS**

As a result of this study, the longitudinal studies should be conducted on how SMIs beliefs over time about priorities given to product attributes used in manufacturing their products locally or internationally have changed. These studies could also look at how the customers, other interested parties, and policy makers or implementers view the priorities used in designing the products. These studies could provide valuable insight into the

appropriateness of priorities used in designing the products and would aid them in designing strategies to promote a company's growth and thus, enable it to stay competitive in the open market.

This study has examined perceptions, beliefs, and practices of SMIs and their priorities. The survey method was unable to provide details of the actual practices of SMIs used to determine the priorities in the product design process. Thus, other qualitative methods such as product observation and imitation, and interviews with regular customers could be used as they may provide a better explanation of the underlying priorities that influence their decision in consuming those products. The customer's perceptions and beliefs about the products were not explored at all. Thus, the researcher recommends a study which explores the customers' views of the appropriate priorities should be conducted.

In addition, the researcher suggests the establishment of a library under the proposed new ministry that contains all research, proceedings, and other related information on SMIs. It would also allow Malaysian SMIs to benefit from the ideas and research of the educators and researchers in the related fields, and also allow the researchers to benefit from the materials available in the library.

## 9.0 CONCLUSION

This study suggests some new findings and results about the factors and priorities (product attributes) in relation to the Malaysian SMIs product design process. The progressive development of Malaysian SMIs will enable them to develop world leading companies. This aim will be achieved through their strong will and effort, and the government's commitment toward the helping them. The progressive development of SMIs will eventually boost the Malaysian economy through increasing the capability of exporting products that will fulfil

customer needs and requirements. Close cooperation between the policy makers and the practitioners is necessary to formulate strategies or draft procedures, policies, laws, or instructions to enhance the Malaysian SMIs. On the other hand, the Malaysian SMIs should give inputs or any necessary information to the government to formulate strategies or assistance for the benefits of SMIs. These will be needed to help the Malaysian government to enhance its assistance package to the Malaysian SMIs.

The researcher believes that the findings of this study will contribute to the policy makers, the governments (include government agencies), the Malaysian SMIs or any interested parties regarding the development of the SMIs, particularly in prioritising factors and product attributes in the product design process, then, finally venture into the export market (for those companies that have not yet ventured internationally). Finally, all the involved parties will benefit and keep on progressing.

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