

QUALITY FUNCTION DEPLOYMENT FOR BIO PLASTICS ADOPTION IN MALAYSIA INDUSTRY

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Abstract

Plastic have transformed our everyday life and their usage is increasing with about 50 percent of plastics is used for single-use disposable applications. However, carbon-based plastics have brought a lot of environmental issues, such as global warming, greenhouse effect and air pollution. Hence, bio plastics are introduced and they are manufactured from renewing raw materials which may help lower the dependency on mineral fuels and plastics waste. Quality Function Development (QFD) model is the technique that is based on the analysis of the clients' requirements which normally are expressed in qualitative terms. QFD is divided into four phases: product development, product design. Process preparation and process control. Customers are looking for substitute of petrochemical plastics due to the concern of the nature that petrochemical plastic when disposed of and burned can release toxic pollutants. Besides, think of the raw materials used, European also consider about the sustainable food chain from bio plastic. After getting the customer requirements, QFD led to study on the characteristics of bio plastic. This step is to understand how the need can be satisfied and ask 'why; until they truly understand what the root need. Further on, the degree of correlation between the selected characteristics was shown in the correlation matrix. The characteristics that taking account refer to the commodity and comfort in use, the shape of the package, temperature at distribution, trade mark, labeling and the possibility to correlate the ration price/ quantity. Awareness in using bio plastics can be witnessed in many developed countries where a wide range of favorable initiatives is put into action, including government policies, research and development and the industrial promotion.

Keywords: Bio plastics, Environmental issues, Quality Function Development (QFD), Sustainable

1.0 Introduction

Due to major concerns of global warming, our nation's dependence on mineral fuels, and increasing solid waste, there is interest in replacing petroleum based products with sustainable alternatives. Plastic, one of the plastic based products have transformed people, daily life and their usage is increasing and about 50 percent of plastic is used for single-use disposable applications (Hopewell *et al.*,2009). The exploits of carbon-based sources of energy for use in plastics manufacturing adds greenhouse gases to the atmosphere, impeding the world's attempts to cut CO₂ emissions. In addition, it is energy intensive to manufacture of mineral fuel based plastics and results in the emission of gasses such as carbon dioxide in large quantities that contribute to global warming (Pilla, 2011). In an attempt to move to a more sustainable position, several companies are doing research, manufacturing, processing and disposing of plastics made from renewable resources.

Bio plastics, which are plastic term for state-of-the-art plastics manufacturing from organic sources, such as sugar cane, potato starch or the cellulose from trees, straw and cotton

(Chang, 2013). However, bio plastic that available in the market is made from polymers such as starch-based, polyhydroxyalkoates (PHAs), polylactic acid (PLA) and other polymers derived from the renewable sources. According to Helmut Keisler Consultancy (2008), the manufacture of the bio plastics is less carbon dioxide will be formed, which not much contribute to global warming. In addition, bio plastics degrade in the open air, others is made so that they able to compost in manufacturing composting plant, aided by fungi, bacteria and enzymes. Hence, bio plastics, can be treated as ecofriendly plastic which could be originated from plant-based materials or other renewable resources through fermentation process.

2.0 Literature Review

2.1 Quality Function Deployment (QFD)

The Malaysian Government has recognized the biotechnology division as one of the crucial strategic sectors that will back the growth of the Malaysian economy. In year 2005, the Malaysia government enacted the Malaysian Biotechnology Policy and one of the focus areas is to sustenance the growth of the industrial biotechnology segment (Frost and Sullivan, 2009). Malaysia with its rich agro-biomass resources as well as booming agriculture industry, it is widely recognized that Malaysia has what it takes to develop its biomass industry. Consequently, the Malaysian Government identified biotechnology as one of the core technologies to accelerate the transformation of Malaysia into a knowledge-based economy and an industrialized nation by the year 2020. For this purpose, the National Biotechnology Policy (NBP) was launched in 2005 to provide a development framework for the industry.

The Quality Function Deployment (QFD) facilitates translation of a prioritized set of subjective customer requirements into a set of system- level requirements during system conceptual design. It provides a set of metrics that work as a structure and as a graphic of the deployment process. The QFD model is broken down into two main actions: product quality deployment and deployment of the quality function. Product quality deployment transforms the “voice of the customer” into product control features and the analysis normally are expressed in qualitative term such as: easy to use, safe, comfortable and luxurious. Then, the fuzzy requirement only translates into quantitative service design requirements. The process followed by identifying the process characteristics and lastly only enter into the market. Based on the explanation of Dornberger (2009), the system must keep the meaning of the clients, required during the development process to merge with the fundamental concept of QFD. House of Quality (HOQ) is one of the metrics that used to identify the customer requirements and prioritize the design requirements to meet customer requirements. Akao (2004) had divided HOQ into four phases: product development, product design, process preparation and process control .

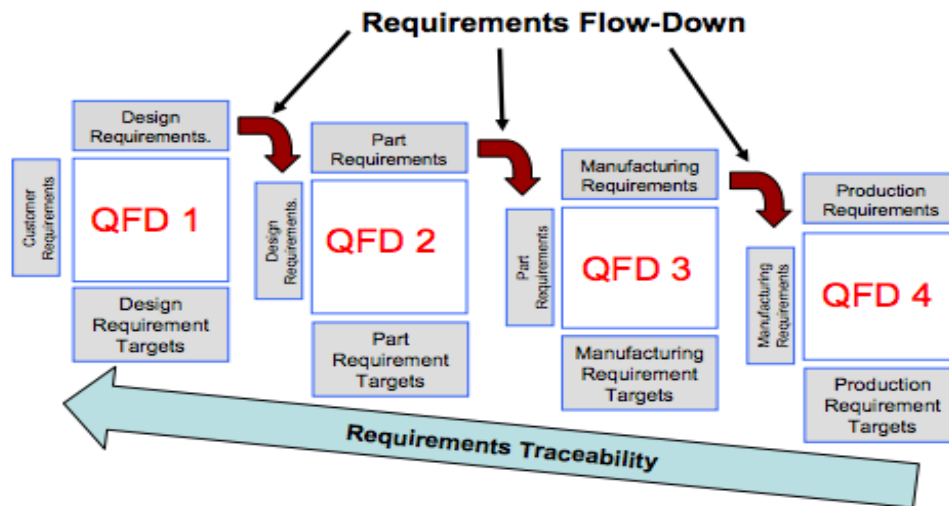


Figure 1: Requirement Traceability of Quality Function Deployment

Source: A Functional Approach to Quality Function Deployment (Dr Stuart Burge, 2007)

- i. Phase 1: Product Development
Document customer needs, warranty data, competitive prospects, product dimensions, competing product measures, and the technical capability of the organization to meet each customer requirement.
- ii. Phase 2: Product Design
Involves creativity and innovative team ideas. Product concepts are crafted during this phase and part descriptions are documented. Parts that are determined to be most important to meeting customer requirements are then implemented in process preparation.
- iii. Phase 3: Process Preparation
The manufacturing process is flow charted and process limitation is documented.
- iv. Phase 4: Process Control
The conclusion is made. Manufacture planning, performance markers are created to monitor the production process, maintenance programs, and skills training for operators.

2.2 Bio Plastics

Approximately 4% of the world's oil production is transformed into plastics for use in products as varied as shopping bags and the exterior panels of cars. The additional few percent is used in processing industries, as oil-based plastics require substantial amounts of energy to manufacture. Particular bio plastics degrade in the open air, others are created so that they compost in a manufacturing composting plant, aided by fungi, bacteria and enzymes. Others imitate the toughness and stability of conventional plastics such as polyethylene or PET. Bio plastics can commonly be directly replaced for their oil-based equivalent. Undeniably, they can generally be created to be chemically identical to the standard industrial plastics. Bio plastics, as the ecofriendly plastics, are plastics, which could be originated from plant-based materials or other renewable resources through fermentation process. This process demands low energy input and makes the plastics with the ability to degrade when being composted, yielding carbon dioxide and water as end products. In fact, bio plastics have become one of the most state-of-the-art materials, which respond to the ever-rising demand for more environmentally friendly solutions.

The national interest in biotechnology started as early as the 5th Malaysian Plan (1986-1990) but was given due recognition and emphasis starting from the 8th Malaysian Plan (2001-2005). Consequently, the Malaysian Government identified biotechnology as one of the core technologies to accelerate the transformation of Malaysia into a knowledge-based economy and an industrialized nation by the year 2020. The NBP is to be implemented over three phases, namely Phase I – Capacity Building (2006-2010), Phase II – Science to Business¹ (2011-2015), and Phase III – Global Business (2016-2020). Malaysian Biotechnology Corporation Sdn. Bhd. (Biotech Corp) is the lead agency responsible for the coordinated implementation of the NBP. Since the launch of the NBP in 2005, the Malaysian biotechnology industry has recorded a total investment of USD 1.3 billion (RM 4.5 billion) by 2009. Out of this investment, the Government funded 57.8%, while the remainder was funded by the private sector. The contribution of the biotechnology industry towards the Gross Domestic Product (GDP) in 2009 was estimated at 2%. In terms of total employment, it is estimated that 54,000 people were employed in the life science and biotechnology-related industry in 2009. In tandem with the anticipated increase in private investment in 2010, total employment is also expected to increase in both directly and indirectly support the biotechnology industry.

Table 1: National Biotechnology Policy–The Development Goals (2006 – 2020)

Development Goals	Phase I (2006 – 2010) Capacity Building	Phase II (2011 – 2015) Science to Business	Phase III (2016 – 2020) Global Business	Progress To- date 2009 *
Investment by Government and private sectors				
USD billion	1.7	2.6	4.3	1.3
RM billion	6.0	9.0	15.0	4.5
Total Employment	40,000	80,000	160,000	54,000**
Contribution to GDP (%)	2.5	4.0	5.0	2.0***

Source: Biotech Corp, 2011

3.0 Methodology

Kothari (2004) defined that the study is a unique involvement with the existing collection of knowledge creation in its development. The organized approach pertaining generalizations and formulation of a theory is also studied. The research methodology is a technique to find out the cause of a given predicament on a precise research issue or problem. It is the approach of searching or solving the research problem (Industrial Research Institute, 2010). The main aim of the study is to find out the fact which is hidden and which has not been revealed as yet. While the research methodology is a technique to scientifically solve the research problem. Therefore a study is the discovery of answers related to the questions. Moreover, research design is a proposal that provides the element of essential method in obtaining the information desired in order to structure or solve the research problem. Parahoo (2006) describes a research design as “a plan that describes how, when and where data are to be collected and analyzed”.

Data can be gathered in a variety of ways, both from primary or secondary resources. Main research generally indicates to that research which comprises the collection of unique data using an accepted research methodology. Interviews are normally a face-to-face discussion between the contributor and the research (Gubrium and Holstein, 2002). Data can be collected from primary or secondary sources. Based on the finding of Veal (2005), primary data are new data specifically collected in a current research project and there are survey, observation and experiment data collected to solve a particular problem under investigation. On the other hand,

Veal (2005) also mentioned that secondary data are the data that already exist and which were collected for some other (primary) purpose but which can be used a second time in the current project. According to Uma Sekaran (2002), secondary data refer to evidence collected from foundations already existing for examples journal, articles, government publication, web pages and book.

According to Remenyi *et al.* (2003), research strategy provides the overall direction of the research, including the process by which the research is conducted. There are numerous strategies that can be adopted for a research study. Some of the strategies are experiment, survey, action research, case study, grounded theory, ethnography and archival research (Saunders *et al.*, 2012). Time horizon, according to Saunders *et al.* (2012), is an important factor while planning the research. Time horizon for a research is determined by the length of time taken to gather the required data. In 2010, Pira International says that Europe is the largest regional market for bio plastics packaging with over half of world tonnage (Elliot, 2010) The aims of Germany which approved the budget for bio economy help to tap into research and innovation to facilitate a structural shift from an oil-based to a bio-based chemical industry. Malaysia may want to develop similar blueprint for our bio economy targets.

In this research, the units of analysis depend upon the exact type of the research question. This exploration focused on how the Malaysian plastic industry could adopt the Quality function deployment for bio plastics development and what are the innovative suggestions could be made to resolve weakness found during development of Quality function deployment in the Malaysian plastic industry for bio plastics. The researcher decided to use a qualitative method as the tools of collecting data. This will provide the prospect to confer, with the numerous stakeholders, entrepreneurial issues in depth. In order to set up a structure around the consultations, and with emphasis on particular issues with different interviewees, the interviews will be coordinated with questions assembled beforehand. In this research, data were obtained from secondary sources such as international journals, online books and articles, relevant textbooks and references, web sites, and the Internet. The database and library of Universiti Teknikal Malaysia Melaka (UTeM) has been a central spot for collecting secondary data and yet other online journal databases also have been visited. These secondary data are applied and used mostly in literature review for compiling recent and past research studies. The data were collected from Top Management of food, plastic packaging, working in 15 different companies in the Malaysian food packaged industry, between October and December 2013 to study the current level of bio plastics adoption and development in Malaysia and the customer acquisition of bio plastics. This is a one-shot or cross-sectional study to assess the likely demand for the bio plastics in food packaging.

4.0 Results and Discussions

Description of the Respondents

A total of 30 respondents were surveyed, from the packaged food industry in Malaysia. Respondents were dominantly Directors or Senior Managers from two respondents per company, in 15 leading Malaysian packaged food companies. The respondents were chosen from among those considered professionally active in the development and decision making of food plastic packaging. An overall total of 80% of respondents owned more than seven years of experience in the field.

House of Quality for Bio Plastics

The House of Quality (HOQ) for bio plastics starts with a “What-How” Matrix that identifies the wants, desires and needs of the customer. These customer requirements are shown on the left part of the HOQ in the box labelled as bio plastics requirements of the company. The

ceiling of the House, i.e., the horizontal axis below the roof, shows the design or technical requirements labeled as bio plastic characteristic, while the body of the House visually displays the relationships between the customer requirements and design requirements. This way the HOQ quickly reveal patterns and identifies weak points in the design requirements.

QFD for Bio Plastics Development in European Plastics Industry

1) Bio Plastics Requirements of the Company (Customers' Need)

Reducing plastic usage is critical to a sustainable future, but plastics are undoubtedly an integral part of our daily life. A key solution to cutting plastic use can be found in bio plastics, which are not only made from renewable resources but also biodegrade significantly quicker than conventional plastics. Customers are looking for substitute of petrochemical plastics due to the concern of the nature that petrochemical plastic when disposed of and burned can release toxic pollutants. Bio plastics originally come from biomass and are thus potentially carbon neutral in its lifecycle. It's may help towards the goal of a cleaner and greener environment for the reason that they are made using renewable materials such as starch/ sugars, vegetable oil and wood pulp.

Packaging fulfills numerous function; however, customers not only looking for preservation of food quality during the whole life cycle from manufacturing to storage, but also towards cleaner and greener environment due to sustainable food chain from bio plastics. One of the key strengths and drivers in Europe is the existence of a strong chemical industry, which is in itself a vital driver for the development of bio-based products on top of a strong biotechnological and chemistry R&D based on chemical and industrial. Consequent to the definition and measurement of the consumers need, the QFD establishes that the respondents grant a major importance to the three packaging R's: reducing, reusing or recycling the materials needed for packaging.

That fact proves the necessity to sustain and develop further the product of bio plastics, otherwise, the product the best positioned on the market. The study also demonstrated the necessity to pay a greater attention of promoting the use of bio plastics. This aligns with its vision/ mission of supporting and promoting technological innovation of bio plastics to improve the balance between environmental benefits and environmental impact. Furthermore, it supports the call for additional investment in research and development to increase the sustainability of bio plastics.

2) Bio Plastic Characteristic

The next step of the QFD is to identify what the customer wants and what must be achieved to satisfy these wants. In addition, regulatory standards and requirements dictated by management must be identified. In general, bio plastics refer to two categories of plastics. The first category consists of plastics derived from renewable biomass sources of carbon (as opposed to mineral fuels) and the second category consists of biodegradable plastic made of biomass or mineral fuels. Bio plastics may be used for packaging purpose and catering items like bowls, pots, straws, cutlery, and bottles for soft drink, bags and trays.

Unlike conventional plastics, which are made using petroleum and other fossil fuels, bio plastics support the earth by offering a reduced carbon footprint, and a reduced use of fossil resources. The sources of bio plastics are diverse but the benefits are similar. It requires less energy to produce than conventional plastics, and there are made with renewable biomass. This result in less landfill usage, less pollution and less waste accumulation in vulnerable ecosystems as well as a greatly reduced carbon footprint.

Plastics applications are only ever likely to be a small portion of total demand for this source of biological starch. Companies are finding themselves increasingly obliged to consider the production of bio plastics for the reasons of both higher demand for environmentally friendly products by customers and, at the same time, stricter environmental regulations covering a large range of products. This approach consists in an often-adopted strategy of upgrading already existing products, for example by improving their performances rather than rethinking the concept of a new product from scratch. With new innovations anticipated in the near future, there would be growingly applications in bio plastics, for example the automobile industry and electronics industry, where plastics play a significant role. The area of bio plastics is expected to offer growing opportunities due to the escalating world price of oil and the increasing policy support in order to combat climate change. Furthermore, this will go together with significant technological progress in order to produce more sustainable advanced bio plastics at competitive price.

3) Relationship Matrix

Further on, the degree of correlation between the selected characteristics was evidenced in the correlation matrix. The degree of correlation between the selected characteristics demonstrated by the QFD team that the majority of characteristics is sustained each other, but it is necessary to improve the characteristics referring to the commodity and comfort in use, respectively the shape of the package, temperature at distribution, trade mark, labeling and the possibility to correlate the ratio price/quantity. Taking into account the result after the consumer's investigation, the QFD team proposed the realization of a new package with improved characteristics that consequently assured a significant growth of sales of the analyzed products.

The purpose of this matrix is to show if the final technical needs cover the customer needs. This kind of evaluation is usually based on the experts' experience, customer's reaction or controlled experiments. The lack of a solid link between the customer needs and the technical ones show both that the needs are not covered and that the final product will hardly accomplish them. The following shows how the bio plastics related to the bio plastics.

The characteristic design of bio plastics

Bio plastics can be processed into a vast number of products using conventional plastics processing technologies. Packaging made from bio plastics can be processed with all customary plastic processing technologies. The graft is a series of disposable tableware made of bio plastic PLA revealing its source materials - the plants. Texture and form in nature autonomously exist with a function that can be utilized for another purpose. The advantages of bio plastics include the uses of plant sources as renewable resources and the product could be further recycled as new biomass sources, for thermal, organic or chemical recycling.

Production and use of bio plastic

The development of bio plastics and their applications can be seen in term of three generations. The first generation was characterized by a single focus of on biodegradable and/or compostable plastics, primarily intended for simple packaging applications. Second generation bio plastics have reached industrial scale production but are still at a price disadvantage relative to petrol plastics. This generation material was specifically developed to be biodegradable and compostable for the packaging, agricultural or gardening sectors. Third generation bio plastics are far more durable, a move from degradability towards resilience. They can be categorized as bio plastics as their carbon content comes from renewable resources, and they therefore have a potential contribution to make to greenhouse gas (GHG) emissions savings. It has been predicted that the global

trend in bio plastics production will shift significantly to be dominated by durable bio-based thermoplastics.

Labeling

Each labeling system has its own testing systems following ISO standards in biodegradability and constituents. However, current labeling systems allow bio plastics to use inorganic materials, including petroleum-based polymers, which create the concern that a part of bio plastics would remain in the soil without decomposing. There have been some studies showing how it affects an ecosystem in the long term. Marketers to increase consumer awareness of the product and brand attributes use labels. It is important to gain more consumer understanding of what bio plastics are and how they benefit consumers and the ecosystem. The standard or requirements for bio plastics have been promoted through bio plastic labeling systems created by industry associations and governments. Improved technical properties and innovations open new markets and applications with higher profit potentials in automotive, medicine and electronics. Bio plastics production companies are relatively small plants and are still in the infant stages of the development and surely, with new developments in the future, the production will be more and more effective and will open new applications, and new opportunities.

Price

Price is the exchange value of a good or service. Customer seek for the best value for their money in exchange for the product. Price setting must consider the kind of competition in the target market. For sustainable products, pricing has often been an issue limiting the product mass acceptance and market growth. Price is the main reason consumers are not going for bio plastics. Consumers are deterred from purchasing bio plastics because they are perceived to be too expensive. According to most individuals surveyed, they held the view that it is important to inform the public and the end consumer on the benefits of bio plastics through public and/or private information campaigns. The advertising of the green products as safe for the environment influences the consumer's attitude to purchase the products. Bio plastics are one of the most innovative materials being developed in the plastics industry.

Land requirements for the raw materials used in the manufacturing of bio plastics

Land use is a feature of standard life cycle assessments and is a staple of sustainability and biodiversity debates. The impact of biofuels on land use patterns has focused discussion on the competition for land use between biomass earmarked for the production of biofuels and plants grown only as food crops. However, biofuels have a quite limited impact on land use patterns as 92% of all global arable land is used for food and animal feed production, 6% of industrial materials and only 2% of biofuels. Estimates have shown that the impact of bio plastics on food markets, agricultural prices and land competition in 2008 was about 250 times less than that estimated for biofuels. The topic requires further investigation, but certainly the land requirements for bio-based energy production is much more than for the production of bio plastics.

The Ways Malaysian Plastics Industry could adopt the Quality Function Deployment (QFD) for Bio Plastics Development.

When looking for the most established QFD success in Europe for bio plastics factors, the following shows the ways which Malaysian Plastic Industry could adopt the QFD for bio plastics development:

✚ Subsidies and Taxes

In 2005, the Malaysian Government recognized biotechnology as one of the key strategic drivers that will propel the nation's social and economic development to greater heights. To propel this new domain, the Government created the National Biotechnology Policy (NBP) and Biotech Corp, a dedicated biotechnology agency. Based on the NBP's objectives and guidelines, Biotech Corp acts as the chief driver for biotechnology development by providing strategic direction, operational assistance for businesses and developing specialized infrastructure. For many companies with conventional production is their main business and there may be a conflict so it may take a while to develop new products. The other challenge is that this does not belong to just one policy area, but covers environment, transport and energy, and all of these have separate ministries. It is difficult to bring them together in a coordinated approach to incentives. By referring to the facts, Quality Function Deployment studies on European plastic industry issues, Malaysia government should coordinate the approach not only by giving tax incentives for bio plastics production, but also Malaysian government need to work together between the ministries involved in the bio-plastic policy to deal with the environment, transport and energy issues.

✚ Standards, Labels and Market Awareness

Standardization has become an important determinant in decision-making; to the public at large and at the individual level, to maintain our well-being to the industry a critical business issue and to the nation as a whole to maintain our competitiveness in the market place. Consequently, Malaysia could adopt the QFD for bio plastic development, especially in food packaging with certification labels, which gives consumers a beyond-doubt proof that the packaging conforms to specific requirements and is an undeniable advantage compared to packaging without the logo. A market consists of people in different stages of readiness to buy a product. However, Malaysian plastics industry may have limited knowledge about bio plastics as compared with European. In order for bio plastics be successful, plastic companies should adapt their marketing strategy according to the limited knowledge the Malaysian plastic industry may have. The promotion of bio plastics among Malaysian plastics industry and consumers needs to be more aggressive with the emerging trends and consumers' increasing environmental awareness. Consumers often reap ancillary financial benefits from product offerings that are designed to be environmentally friendly (Dahlstrom, 2011). Therefore, bio plastics offer great market opportunities for plastics companies to start up. Carrillat et al. (2004) suggested that a market driven approach is required for companies to develop unique internal business processes, to shape the market structure, to lead the customers and to offer them completely new value propositions.

✚ Price of Bio Plastics in Malaysia

Price is the main reason consumers are not going green. Consumers are deterred from purchasing (or acquiring) bio plastics because they are perceived to be too expensive. Therefore, importance should be given to promoting these differentiated bio plastics. According to most individuals surveyed, they held the view that it is important to inform the public and the end consumer on the benefits of bio plastics through public and/or private information campaigns. The advertising of the green products as safe for the environment influences the consumer's attitude to purchase the products (Dahlstrom, 2011). Malaysia in other way should form collaboration between suppliers, technology centers and universities that are useful for businesses as they allow for an increase in the creation of ideas, in addition to overcome the problems in the European bio plastics market. By that this move will increase the likelihood of gaining more business opportunities and reduces the price of products. Harrington (2010) reported that researchers in Malaysia have developed a bio plastics packaging from tropical fruit skins that is durable and economical to produce. It has been pioneered at Universiti Sains Malaysia (USM), known as "Fruitplast" and made from the skins of tropical fruit. Thus, the collaboration brings university researchers and plastics

companies with technical needs together in the promotion of bio plastics and in its adoption and commercialization that will result in better results with lower price.

Innovative Recommendation to Malaysia Plastic Industry for Better Development of Bio Plastic

At present, in spite of its increasing diffusion in the industrial world, bio plastics seem to be not successful from a development of successful products. The main reason of this situation can be found in the inability of most companies in Malaysia to persuade customers by appealing for understanding the higher value of their eco-products, which is a critical missing factor that has impeded the success of bio plastics in the marketplace. Several factors hold back the potential growth of bio plastics in the Malaysia plastics industry, such as lack of bio plastics knowledge, lack of infrastructure in manufacturing bio plastics, and lack of regulatory drivers to promote bio plastics. Moreover, high research and development costs have kept the price of bio plastics high and low volumes.

Although the Malaysian bio plastics market is in its infancy stage, but it holds significant promise in developing sustainable alternatives to conventional plastics, in the near future. At the moment many bio plastics are made from sugars and starches harvested from crops that otherwise might be grown for food. The research and development work is ongoing and some researchers are working to develop these bio based, and/or biodegradable or compostable plastics. An agreement that has signed by Cardia Bio plastics and RNZ Green Bio bring the establishment new Malaysian entity, Cardia Bio plastics Malaysia Manufacturing (CBMM). In addition, the Malaysia government also gave its support to Malaysia's bio economy initiative to develop bio plastics as an industry.

The future of bio plastics shows great potential and several developing countries have already begin integrating bio plastics into their markets. Therefore, it is significant to drive the adoption and development of bio plastics in Malaysia. It has been suggested that the bio economy initiative by the government should be lauded. As large grains and crop producer, Malaysia is one of the promising producers of bio-based plastics under competitive costs. Malaysia's competitive advantage in raw materials, especially tropical fruits, is likely to develop an important local demand for bio plastics.

5.0 Conclusions

The bio plastics industry, while still in the emerging growth phase, has established a foothold, particularly in European countries, with a growing range of applications such as food packaging, agriculture, textile and medical. This research explored the bio plastics in Malaysia through quality function deployment, by conducting a qualitative research. Qualitative data are collected simultaneously from prominent packaged food companies in Malaysia through interviews respectively. After analyzing these data, the researcher draws some implications concerning the bio plastics in Malaysia and makes some suggestions to further develop bio plastics industry in Malaysia. The Malaysian plastics industry should make use of opportunities to engage with food firms and industry suppliers in gaining useful insights into bio plastics market trends and the value-added offerings. The researcher emphasizes that the food companies may consider redesigning the bio based food packaging with eco-labels to promote the use of bio plastics. Accordingly, the research suggested that a green alliance can be formed among plastics manufacturers, universities, food firms and suppliers to get together experts for the collaboration for the development and promotion of bio plastics in Malaysia. Future work may be conducted to compare the predictive validity of the model across different applications or industries. Future

research may be beneficial if more items and better measures are developed in relation to this outcome variable.

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