UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF A DATABASE TO SUPPORT SUSTAINABLE PACKAGING DESIGN

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering

(Manufacturing Design) (Hons.)

by

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ABSTRAK

Pembungkusan berfungsi untuk melindungi produk dan memastikan penghantarannya selamat sampai di tangan pelanggan. Walau bagaimanapun, pengeluar memberi tumpuan kepada penciptaan produk dan pembungkusan sering diabaikan. Pembungkusan juga dijalankan di peringkat terakhir penciptaan produk dan pembangunan. Dengan itu, pereka pembungkusan tidak dapat mengetahui kepentingan pembungkusan terhadap kesan alam sekitar dan pengeluar tidak akan mengambil risiko untuk meneroka pembangunan berlanjutan kerana ia akan meningkatkan kerumitan kepada proses reka bentuk pembungkusan dan memakan masa. Objektif projek ini adalah untuk mengkaji semula pada reka bentuk pembungkusan yang berlanjutan, penyelidikan mengenai kepentingan dan membimbing ke arah kelestarian bagi produk electronik. Dari kajian, didapati penciptaan pangkalan data bagi reka bentuk pembungkusan yang mampan berguna untuk meneroka cara-cara untuk mengurangkan kesan alam sekitar. Pangkalan data akan dibuat menggunakan MySQL untuk menyimpan data dan Java sebagai bahasa pengaturcaraan. Pangkalan data ini memerlukan pengguna untuk memberikan spesifikasi input berdasarkan produk dan ia akan memberikan pilihan bahan yang sesuai. Kaji selidik atas 50 responden telah dilaksanakan untuk menguji kebolehgunaan dan fungsi pangkalan data. Keputusan menunjukkan pangkalan data berkesan dalam mencapai keperluan fungsian dengan memilih bahan yang sesuai tanpa kesan alam sekitar yang banyak. Ia juga berkesan dalam mereka bentuk bahan dan penggunaan tenaga ke tahap minimum untuk meningkatkan kecekapan system pembungkusan. Pangkalan data ini boleh diperbaiki dengan menjalankan analisis yang lebih teliti berdasarkan lima fasa kitaran hidup untuk mengurangkan kesan alam sekitar. Bahan dalam pangkalan data harus diperluaskan serta pangkalan data harus dibawa ke “online” untuk maklum balas bagi peningkatan.

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ABSTRACT

Packaging mainly serves to protect the product and ensure safe delivery to the customer‟s hand. However, manufacturer focuses on the product creation and therefore the packaging is often neglected. Packaging is developed at the last stage of the product creation and development thus cost and time are limited. With the limitations, packaging designers are unable to fully explore the importance of the packaging towards environmental impact and manufacturers will not take their risk to move to sustainability development as it will increase intricacy to the process of packaging design with time consuming. The objective of this project is to review on the sustainable packaging design by researching on the importance and guidance towards sustainability in electronic products. From the study, it was found the creation of a database for sustainable packaging design is useful for designers and engineers to explore ways to reduce environmental impact and ecological foot print. A database was be created using MySQL for information storing and Java as a programming language. The database will require user to provide input specifications based on their product and the database will deliver suitable material choice with its sustainability. Survey will be taken with 50 respondents to test the usability and functionality. The result shows the database is effective in achieving its functional requirement, to select proper material with minimal environment impact. The database is also efficient in designing material and energy usage to its minimum level to increase efficiency of the packaging system. The database can be improved by forwarding the output with additional analysis based on the five life cycle phase to reduce environmental impact. The material database need to be broaden for variety of material and the database can be brought online for global user to use and provide feedbacks as well as improvement from time to time.

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DEDICATION

Dedicated to my mother and father

Cherished siblings

Honorable lecturers

Faithful friends

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LIST ABBREVIATIONS, SYMBOLS AND NOMENCLATURES

SQL	- Structured Query Language
SPA	- Sustainable Packaging Alliance
BPA	- Bisphenol A
MSW	- Municipal Solid Waste
DLSR	- Digital Single-Lens Reflex
GDP	- Gross Domestic Product
EU	- European Union
TBL	- Triple Bottom Line
LCA	- Life Cycle Assessment
EPR	- Extended Producer Responsibility
NPD	- New Product Development
PET	- Polyethylene Terephthalate
CO2	- Carbon Dioxide

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CHAPTER 1
INTRODUCTION

This chapter introduces the project title, problem statements, aims, objectives and project scopes.

1.1 Introduction

Sustainable packaging design is a product development link between packaging and the environment. Packaging is a containment, handling, protection and distribution of goods. It can also be referring to design process, evaluation and packaging production. There are many contexts for the definitions of sustainability or sustainable development. Sustainable can be considered in the context of limited resources and the needs of future generations. Sustainable development is a path with a plan to achieve sustainability in activities that uses environmental resources and immediate replacement is needed.

Sustainability in packaging design explores ways to reduce environmental impact and ecological foot print. Most business implemented sustainability in their packaging design led by the packaging experts. Sustainability in packaging design needs new information regarding environmental product life cycle and its packaging, packaging role to create sustainable development objectives, environmental rules and regulations and systems ready for retrieval, use with removal of the packaging at the end of the life.

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In this project, information will be gathered regarding packaging materials and components, levels of packaging and packaging design principles. The data are gathered, assembled, categorized and arranged in respective areas. The database will be able to show sustainable packaging guidelines and checklists to inform packaging design. This will help packaging designer in manufacturing field to design packaging for their products in a sustainable and economic way.

1.2 Problem Statement

Most of the packaging designer design products packaging using concepts generated from ideas to solve their problem. Their design concepts are based on appearances, cost competiveness, and less on environmental aspects. Designing a packaging is an intricate process which requires major marketing area, function and cost as well. Designing for sustainability will increase intricacy to the process of packaging design with time consuming. Designing electronic product packaging is a challenge where the packaging needs to protect the electronic product from static loads, impacts, vibrations and climate changes. Thus, manufacturer will tend to over protect their product which causes waste of production material and consumer often discard the packaging after purchase leads to excessive waste. Thus it gives packaging a negative environmental image (TCGF, 2011).

1.3 Aims

The aim of this project is to develop a database to aid packaging designer to create sustainable packaging design for their product mainly in consumer electronic devices. Developed database will be ensured to be user friendly, easy to access and correct design selection output. This series of database example will be able to help

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designer choose their sustainable packaging design efficiently and effectively which aims to reduce environmental impact and ecological footprint from the packaging.

1.4 Objectives

The objectives of the project are:

a) To review on sustainable packaging design.
b) To develop a database program for sustainable packaging design specifically for consumer electronic products.
c) To test and run the database for effectiveness and efficiency.

1.5 Scope

The scope for this project covers the sustainable packaging design in consumer electronic devices. Information and data regarding sustainable packaging designs will be gathered and categorized in each respective area. The information and data will be stored into a database system by using MySQL and will be displayed in webpage using Java. The material in the database will only be limited to polymer and paperboard. To ensure the functionality of the database, testing will be carried out for functionality and survey for feedbacks as well as recommendations for improvements.

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CHAPTER 2
LITERATURE REVIEW

This chapter, it will provide information on sustainable packaging design, development strategy, laws and regulations, environment, packaging design and materials, tools used, and its implementation.

2.1 Definition of Sustainable Packaging

Sustainable packaging is a product development link between packaging and environment to achieve sustainability. The word sustain is derived from old French *soustenir* and Latin *sustinere*, from *sub* „from below" + *tenere* „hold" (Oxford Dictionaries). It means to hold, maintain and uphold. Packaging serves to contain, handle, protect and distribute goods/products made from any material of any nature, from raw material to finished goods, from manufacturer to the end user (EC Directive 94/62). Environment is the surrounding of the organization"s operations which are water, air, earth, natural resources, flora & fauna, humans and their interrelation (ISO 14001 clause 3.5). Thus, implementing sustainability into packaging design serves to design and manufacture packaging that concurrently provides social, economic and environmental value.

Sustainable Packaging Alliance (SPA) defines sustainable packaging by considering packaging roles in social and economic system to meet environmental goals. From

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Figure 2.1, they aim to differentiate between macro levels of society of society related to success, functional performance level of the packaging system, environmental performance level to the micro level of human and eco toxicological soundness of the packaging components (James, 2005).

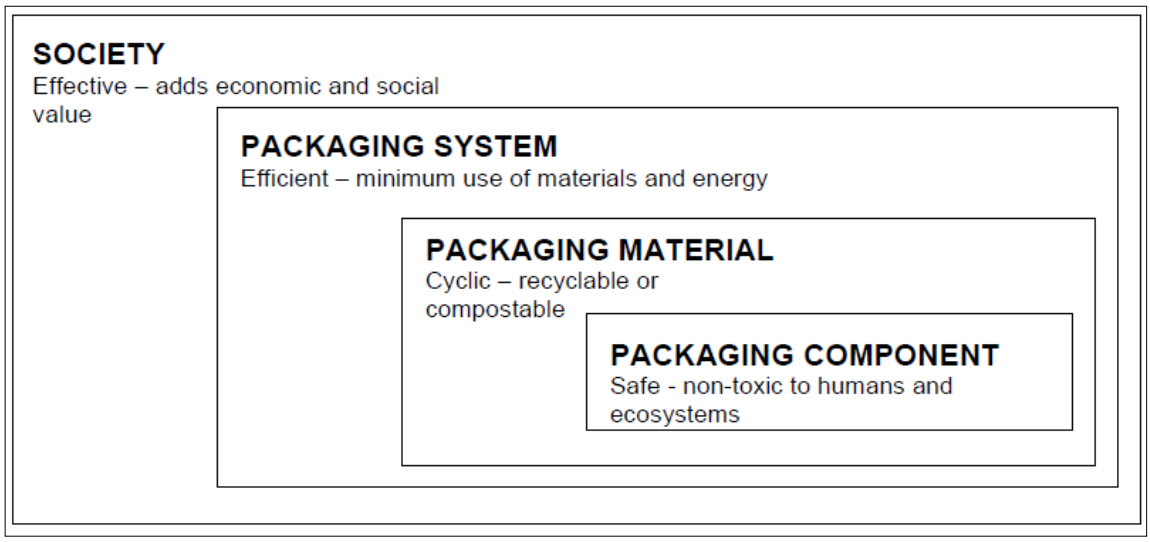

Figure 2.1: Four levels and principles of SPA‟s sustainable packaging (James, 2005).

2.2 Introduction to Sustainable Packaging Design

For the last 50 years, world‟s population doubled to seven billion today. Therefore, with increasing population growth, production of goods also increases significantly. This growth affects our environment from harmful gasses and particles emission to the depletion of natural resources. This includes packaging, as almost all goods required to be packaged. EU data shows despite 40% growth in GDP from 1998 to 2008, the packaging volume increased by 10% only, while waste disposed drop to 43%. EU exceeded minimum target of 55% packaging recycling (EUROPEN, 2011). It shows that packaging is a vital impact towards sustainable production and consumption process through product waste reduction and resources protection.

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Packaging undeniable consumes resources and requires energy for manufacturing but technology now is constantly aiming for reducing packaging waste as low as possible. Sustainability in packaging design requires new information such as product and its packaging environmental life cycle, packaging role in attaining sustainable development goals, packaging environment regulatory requirements and systems in place for recovery, use and disposal of packaging at end-of-life (Helen, 2012).

2.3 Sustainable Development Strategy

The concept of sustainable development is rather abstract and theoretical for new business as it an entirely new idea and knowledge (IISD, 2001). Organization or company will have to consider profitability, market share and revenue growth including regulatory requirements in order to accept sustainable development. For businesses to successfully practiced sustainable development for entire operations, they have to make major changes in their strategy, new skills and knowledge development.

2.3.1 Sustainable Development

Sustainable development has been defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). From business perspective, sustainable means adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future (IISD, 2001).

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2.3.1.1 Triple Bottom Line

Triple Bottom Line or known as three pillars of sustainability is an approach to consider sustainable development for business. It was introduced by John Elkington in the year of 1997. John Elkington said, health signifies the ultimate bottom line with economy depends on it while society depends on economy (Elkington, 1997). This framework overcomes the traditional method of profits gaining, investment return and shareholder value by including environmental and social dimensions. Therefore, focusing on comprehensive investment results, with respect of interrelated magnitudes of profits, people and the planet, triple bottom line can be an important tool to hold sustainability goals and vision. The three elements can open up huge opportunities and challenges for the business. The TBL and its core value of sustainability attracted in the business due to long term profitability (Timothy, 2011). An example would be waste reduction leads to cost reduction. Cascade Engineering stated that big firms already implemented TBL such as General Electric, Unilever, Protor & Gamble, 3M and Cascade Engineering themselves (Douglas, 2009). For nonprofit organizations, they also adopted the TBL to address wide sustainability issues and cooperate with private companies in hope to achieve wide sustainability issues shown in Table 2.1. These alignments will make good business sense while nonprofit will achieve their economic boost and environmental safety. Elkington summarized the traditional sustainability measures, measures assessed through academic discourse (Elkington, 1997);

Table 2.1: Issues for business by triple bottom line (Elkington, 1997).

Bottom Line	Issues for Business
Social issue	Community relationships Rights of human Working environments Negligent marketing Effects on local people Hire of minority

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Economic issue	Cost effectiveness Request for products and services Level of improvement Capital of human and intellectual Margin profit
Environmental issue	Environmental agreement Use and protection of natural capital Environmental managing costs Material, energy and water consumption Solid waste and pollution Life cycle impacts of products and services Performance against best practice standards

2.3.2 Sustainability for Corporate

It is important that businesses are urged to address worldwide challenges in sustainable development. According to Dow Jones, corporation sustainability is a way to getting a business that forms long-term shareholder value through chances embracement including risk management derived from social, economic and environmental developments. The focus on corporate sustainability is based on two principles, creation of long-term shareholder value in resource-constrained world and opportunities and risks that companies must be aware (Knoepfel, 2010).

2.3.3 Role of Packaging in Sustainable Development

In business community, life cycle thinking is not widespread or uniformly applied yet. Regulations only focusing on waste reduction and recycling but with a better understanding on the role of packaging in sustainable development, government

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policies and industry initiatives can be more focused of LCA and sustainability metrics.

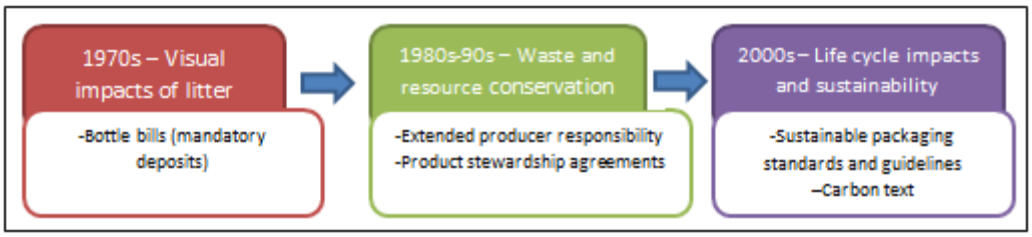

Figure 2.2: The evolution of packaging concerns and regulations (Fitzpatrick, 2011).

For many years, public has voiced out that packaging is bad for the environment due to litter, waste and even endangers marine life. The regulatory and political action responded to them when the pressure on the land for disposal availability and waste increasing management cost. Then the term sustainable packaging came as a new approach and becoming more evident globally in government policy and industry regulation. Now these developments provoked the The Consumer Goods Forum which representing 650 retailers, manufactures, service providers and other stakeholders across 70 countries in 2008 (TCGF, 2008).

2.3.4 Business Case

In recent years, sustainability agenda has rose significantly making business strategy to change it course and relevant to the consumers. Companies realized the right approach will helps to handle risks, cost reductions, innovative and efficient and increase in customer loyalty. In business there will be always be risks if it is not sufficiently coordinated, the response will be weak and less efficient. Consumers see packaging as a concern on how it affects the environment after disposal but manufacturers or retailers, judge environmental sustainability from different

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perspective. An example would be companies may be focusing on weight reduction thus lower material input, reduced transport, lower carbon emissions but the weight reduction will have consequences too. It can be a greater waste if the packaging becomes too fragile and not recyclable as shown in Figure 2.3.

Figure 2.3: Excessive supermarket food packaging is undermining householders‟ effort to recycle

(Source: <http://myzerowaste.com/2009/02/excessive-supermarket-food-packaging-is-undermining-householders-efforts-to-recycle/>, 22/10/2014).

Others use life cycle assessment to evaluate and measure sustainability as it is more comprehensive approach but can be costly in resources and time if not handled properly. Thus, to get responses industries, there will be a need for common metrics and definitions on how companies measure sustainability in their packaging system (TCGF, 2011).

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2.4 Packaging Sustainability Framework

A sustainability framework is useful as a decision support tool to integrate new approaches required for addressing sustainability efficiently and effectively. The framework was introduced by Sustainable Packaging Alliance in 2002 and improved in 2010. The framework in Figure 2.4 consists of four principles to guide decisions making about design, manufacturing, transport, use and recovery of packaging (SPA 2010).

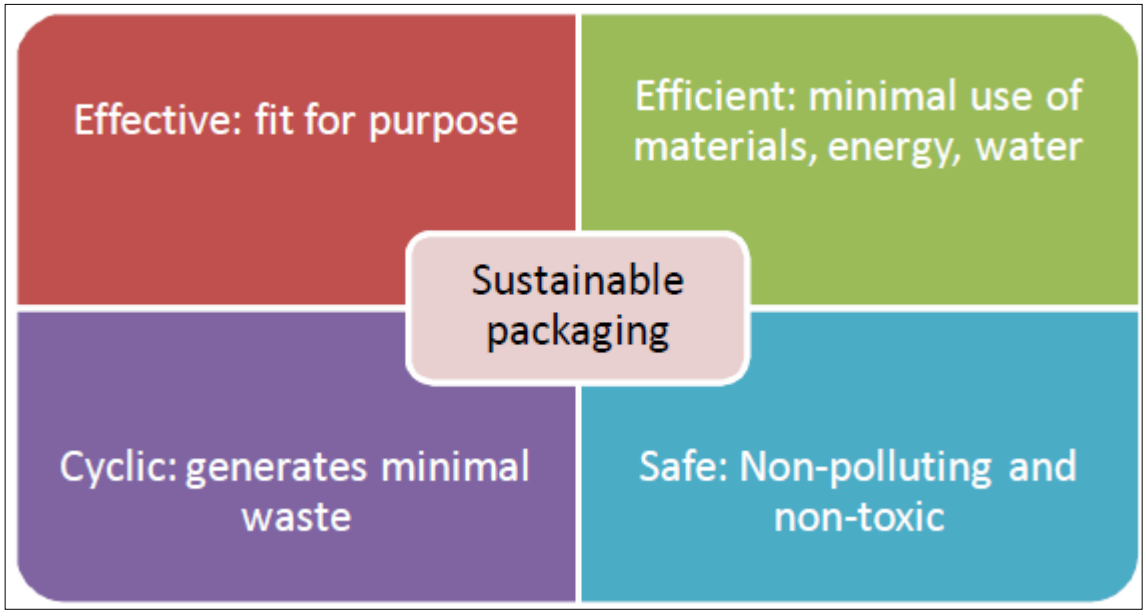

Figure 2.4: Four sustainable packaging principles (SPA, 2010).

For contribution and moving towards sustainable development, packaging needs to be effective in achieving its functional requirements with minimal environmental and social impact, efficient in designing material usage and energy efficiency throughout the product life cycle, cyclic in reducing reliance on non-renewable resources and to recover them for reuse or recycling, lastly safe to be used in the system, including materials, finishes, inks, pigments and other addictive that may pose harm to the humans and ecosystem.

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