UNIVERSITI TEKNIKAL MALAYSIA MELAKA

TO STUDY THE END OF LIFE COASTAL BOAT USING DESIGN SUSTAINABILITY METHOD

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

By

AFFENDY BIN MOHD SALEH

B051010168

870730085595

FACULTY OF MANUFACTURING ENGINEERING

2014

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **TO STUDY THE END OF LIFE COASTAL BOAT USING DESIGN SUSTAINABILITY METHOD**

SESI PENGAJIAN: **2013/14-Semester 2**

Saya **AFFENDY BIN MOHD SALEH**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	TIDAK TERHAD	

Disahkan oleh:

_____ _____

Alamat Tetap:

No.1, Jalan 4,

Lorong Sri Kinta 17,

31650, Ipoh, Perak.

Cop Rasmi:

Tarikh: _____ Tarikh: _____

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled "To Study the End of Life Coastal Boat using Design Sustainability Method" is the results of my own research except as cited in references.

Signature : ……

Author's Name : AFFENDY BIN MOHD SALEH

Date : 29 JUNE 2014

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Design) (Hons.). The members of the supervisory committee are as follow:

……

(Project Supervisor)

ABSTRAK

Topik untuk laporan ini adalah rekabentuk eko menjurus kepada kajian dan analisis badan bot pantai. Kajian ini adalah untuk mengenal pasti masalah yang dihadapi oleh sektor pembuatan rekabentuk eko badan bot pantai di mana jangka hayat produk yang bergantung kepada kaedah pembuatan dan bahan yang digunakan. Laporan ini juga menerangkan beberapa kaedah yang digunakan untuk mencapai matlamat menjadikan rekabentuk eko yang mampu dibangunkan adalah berbeza-beza metodologi seperti FMEA, Analisis Kemapanan, Bahan Aliran Analisis, Analisis Kesan Alam Sekitar (EEA). Berdasarkan kepada kajian kes, kelestarian SolidWork digunakan sebagai yang dapat dilihat sebagai kaedah yang boleh memanjangkan kitaran hidup produk Hasil dapatan sukatan yang melalui kajian kelestarian yang dijalankan melalui modul kemampanan daripada perisian SolidWork.

ABSTRACT

The topic for this report is the Eco Design bared on the research and analysis of the body of a coastal boat. This purpose of this research is to identify the problems faced by the manufacturing sector of Coastal Boat body Eco Design where the lifespan of a product is dependent on the methods of manufacture and materials used. The report also describes some of the methods used to achieve the goal of making Eco Design which is able to be developed are varying methodologies such as FMEA, Sustainability Analysis, Material Flow Analysis, Environmental Effect Analysis (EEA). Based to the case studies, SolidWork Sustainability is used which able to seen as method that will extend the Life Cycle of the product. The result obtain is the measure through the sustainability study carried out of the sustainability module on SolidWork software.

DEDICATION

I dedicate this report to my beloved parents that always support me all the time to further study in UTeM, my beloved family members that help me from far away from Ipoh to manage my important document, my supervisor, En. Baharudin bin Abu Bakar, who responsible to help me in managing my study, give the idea in writing the report and my beloved friends that give me inspired to write up this report, and anyone that help me whether direct or indirect help.

ACKNOWLEDGEMENT

In the name of Allah, Most Gracious, Most Compassionate. Praise be to Allah. With His kindness, here I present final year project report.

Firstly, I would like to express my infinite thanks to my final year project supervisor, Mr. Baharudin bin Abu Bakar, for all the guidance, encouragement, ideas and useful advice in order to finish my final year project report. I also would like to present my thankfulness to my lecturer Engr. Dr. Hambali bin Arep @ Ariff for the help and useful guidance.

My highly gratitude to my beloved parents, Mr. Mohd Saleh bin Lajis and Mdm. Wan Salmah binti Wan Chik,, my siblings for all the moral support for me to finish my final year project. Thank you very much for your prayers for me. Last but not least, for those who contributed in my journey of education either directly or indirectly, thank you very much.

Only Allah can repay all the kindness and generosity and may Allah bless all of you. Insha'Allah. Thank you once again.

CHAPTER 1

INTRODUCTION

1.0 Background

Eco Design is known as ecology or environmental based design method to emphasize the importance of green sustainability. It is also known by other names as Design for Environment (DFE), Green Design, Sustainable Design, Environment Concious Design, Life Cycle Design, Life Cycle Engineering and Clean Design have same goals and objective. It can be defined as approach that consider all the environmental impacts of a product right from the earliest stage of its design and throughout product development process by systematic way and encountered with other traditional approach such as function, safety, ergonomic, endurance, quality, and cost. This is stated in ISO 14062, that integrating environmental aspects into product development is able to minimize the total environmental impact in a life cycle perspective from raw material extraction, production, packaging, distribution, use, recovery and recycling

This chapter describes the general terms that will be implemented in this project. It covers the background of the problem, objectives, scope, and significant and research methodology that influence the sustainability.

Eco Design is a tool of product design aiming to minimize the adverse environmental impacts during the whole life cycle of a product while maintaining or increasing its functionality or value. In a Life Cycle Assessment the life cycle of a product is usually divided into disposal, manufacture and use.

Nowadays, it is growing responsibility and understanding of our ecological footprint on the planet. Besides that, Green awareness, over population, industrialization and an increased environmental population has led to the questioning of consumer values. It is imperative to search for new manufacturing solutions that are environmentally friendly and lead to a reduction in the consumption of materials and energy.

1.1 Statement of the problem

Today's challenge is to develop the Coastal Boat Body that balancing of the impact of the Eco Design Sustainability concept. There are several methods in making the Coastal Boat body that suitable in Eco Design concept which are using different type of analysis. The boat designer's challenge is determine the Eco Design concept that will affect the Environment Impact and Transportation Impact. Usually, the problem comes when choosing the wrong material to sustain the End of Life Cycle.

This analysis must reflect the tight economic situation that is present to the material selection that involved:

1. Increased operational costs, fuel, and etc.
2. Reduced financial resources for updating or rebuilding coastal boats.

1.2 Objective of the study

The objectives of this project are:

1. To choose the right material in making Coastal Boat body that focus on Environment Impact and Transportation Impact.
2. To compare of the End Life Cycle between two selected material using SolidWork Sustainability. .

1.2 Scope of the study

This research project will focuses on tools, methods and strategy that employed in Eco Design that consider all the environmental impacts of a product right from the earliest stage of its design and throughout product development process until end of life of product by systematic way.

In this study, there are important thing to focus on:

- To choose right material to build Coastal Boat Body.
- Focusing on the right method of sustainability in Eco Design.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter will discuss briefly about the available ideas and implementation of suitable methods used in order to complete this project. Literature review is the phase where all the processes happen such as searching, collecting, and analyzing that has been done or published by another researcher. All of the process can be completed through relevant sources such as book, journal, and technical report, proceeding conferences, web pages and others. Research findings from readings, observing and gather all the information related to the previous project will be include to gain the knowledge about the tools used. Literature review could be main references guidance in the process of making this project. To have a brief understanding of the researches related to the project.

2.1 The History of Eco Design

Eco Design may be found in the late 1980's when it became evident that end of pipe technologies would not resolve the two causes of environmental problems: scarcity and pollution of resources. Policy, research and technology were challenged to find concepts and solutions that would prevent pollution and save resources. Two fields of action are identified which are production processes and products. Two business-oriented concepts were born such as Cleaner Production and Eco Design. Cleaner production led to

production technologies working much more efficiently and very soon helped to reduce the consumption of resources, thus lowering production cost. Manufacturers therefore directly felt the benefits of greening their processes. In contrast, the Eco Design of products turned out to be a more complex challenge. It is potential ecological and economic impacts or advantages go beyond the reach of the manufacturer (Boks, 2006).

Table 2.1 : Facts of Eco Design (Boks, 2006).

12 Facts of Eco Design
1. Use product design to educate on the environment.
2. Make it durable.
3. Make it easy to repair.
4. Design it so it can be remanufactured.
5. Design it so it can be refused.
6. Use recycled materials.
7. Use commonly recyclable materials.
8. Make it simple to seperate the recyclable components of a product from the non-recyclable components.
9. Eliminate the toxic component of a product or make them easy to replace or remove before disposal.
10. Make products more energy or resource efficient.
11. Work toward designing source reduction-inducing products which are the products that eliminate the need for subsequent waste.
12. Adjust product design to reduce packaging.

2.2 Eco Design Current Statuses

The concept of Eco Design is now popular which is implemented in everyday work. Dedicated methods and tools were first developed but an engineering platform is now needed to professionalize Eco Design activities. It also define that the integrated Eco Design methodology developed for company product development in a project team and integrating both environmental assessment and improvement advice techniques. The impacts of products and materials during their whole life cycle are just not only during the production stage, but also during extraction of raw materials, distribution, use and

end-of life. In details, Eco Design, that aims at integrating environmental aspects during the product's design process as any other criterion has been strongly developing and maturing. Today, although it is quite a well-known concept in the manufacturing industry, it is not widely and routinely implemented and it should be further elaborated to reach its full potential. (Maud Dufrene, Peggy Zwolinski and Daniel Brissaud, 2013)

2.3 A Life Cycle Approach

Just like living organisms, products have a Life Cycle as well. Where living organisms originate, reproduce, and eventually die, products are produced from raw materials, used by consumers, and eventually disposed of. A product's life cycle is generally broken down into stages.

The number of stages can vary. Six stages are often distinguished in figure 2.1:

1) Product design,
2) Raw material extraction and processing,
3) Manufacturing of the product,
4) Packaging and distribution to the consumer,
5) Product use and maintenance,
6) End-of-life management: reuse, recycling and disposal.

In every stage of its life cycle, products interact with other systems when life cycles are therefore called open cycles. In order to make a product; substances, energy, labour, technology and money are required, while other substances are emitted to the environment. Products can interact with the environmental (extraction or addition of substances, land use), economic (the cost to produce a product, implement technology, the profit to sell) and social domain (employment, workers' rights). The relations between the environmental, economic and social domains are quite dynamic. The implementation of cleaner technology will decrease the pollution of the environment, but might increase the cost to make that product, at least in short term (Edith et.al, 2012).

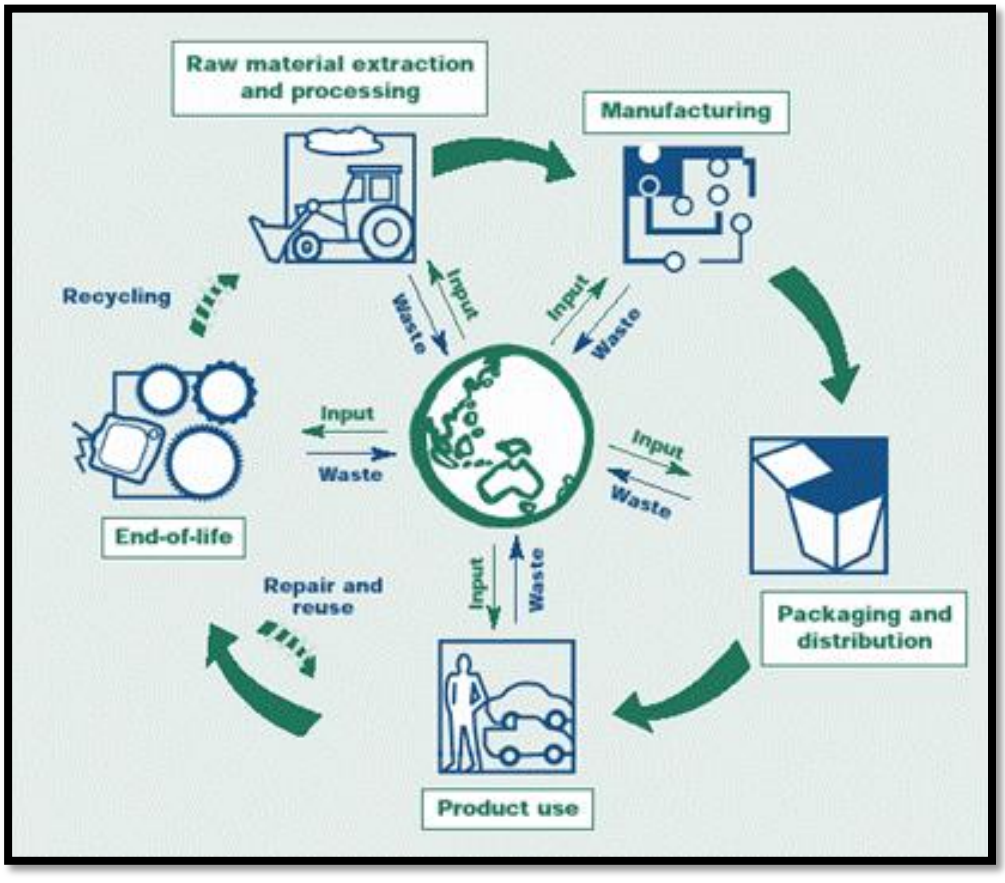

Figure 2.1: Stages of a Products Life Cycle (Edith et.al, 2012).

2.4 Cradles-to-Cradle Development

Cradle-to-Cradle also known as Eco-Efficient of design and development, or eco-effectiveness can be described as the next step on from Eco-Efficiency because it moves beyond simply reducing environmental impact (less bad) to the creation of products, buildings or systems with beneficial environmental or social outcomes (McDonough and Braungart, 2002). It takes a systems approach to designing buildings or industrial systems that perform highly without any negative environmental or social consequences to keep balance in both side of situation.

Cradle-to-cradle design has also been described as a business strategy and it is approach to design aims to restore the health of water, soil and the atmosphere. It eliminates the idea of waste by proposing that waste can equal food. This moves from a paradigm of cradle-to-grave, which is a linear use of resource resulting in waste, to one with a cyclic use of resource eliminated waste. The cradle-to-cradle future of industry is seen to be a 'world of abundance' rather than one of limits (William McDonough, EXPO 2000)

2.5 Eco Efficiency Approach

The term Eco Efficiency was based on the concept of creating more goods and services while using fewer resources and producing less waste and pollution. Eco Efficiency is achieved through the delivery of 'competitively priced goods and services that satisfy human needs and bring quality of life while progressively reducing environmental impacts of goods and resource intensity throughout the entire life cycle to a level at least in line with the Earth's estimated carrying capacity' (DeSimone et al, 2000).

The starting point for Eco Efficiency is minimizing the waste, pollution and natural resource depletion. Their approach is a carrying capacity approach where it is focused on reducing the footprint of activities and, in particular, delivery of goods and services, while still satisfying human needs. Ultimately Eco Efficiency looks to neutralise the effects of development by achieving a steady state between the resources used and the resources remaining. It does not seek to achieve positive environmental outcomes (Birkelan, 2002).

2.6 Life Cycle Design Principles

According to the Life Cycle Design Guidance Manual (F.Giudice, G. La Rosa and A. Ristino, 2002), there are three main principles for guiding environmental improvement of product systems in life cycle design:

1) Systems Analysis of the product life cycle.

2) Multicriteria Analysis for identifying and evaluating environmental, performance, cost, cultural, and legal requirements
3) Multistakeholder Participation and cross-functional teamwork throughout design.

2.7 Life Cycle Design Process

After building an interdisciplinary multistakeholder life cycle team, understanding and integration of life cycle thinking, and development of life cycle design goals and principles, life cycle design process should be elaborated (Koeleian and Menerey ,1993), have elaborated and offered a useful plan to build Life Cycle Design Process (Figure 2.2) that consists of six main steps:

1) Developing of Life Cycle Framework and Goals.
2) Building Life Cycle Team and Elaborating Strategies and Policies.
3) Analyzing needs of Stakeholders (Stakeholders Management).
4) Setting Life Cycle Design Requirements.
5) Developing Product Design.
6) Implementing Product Design.

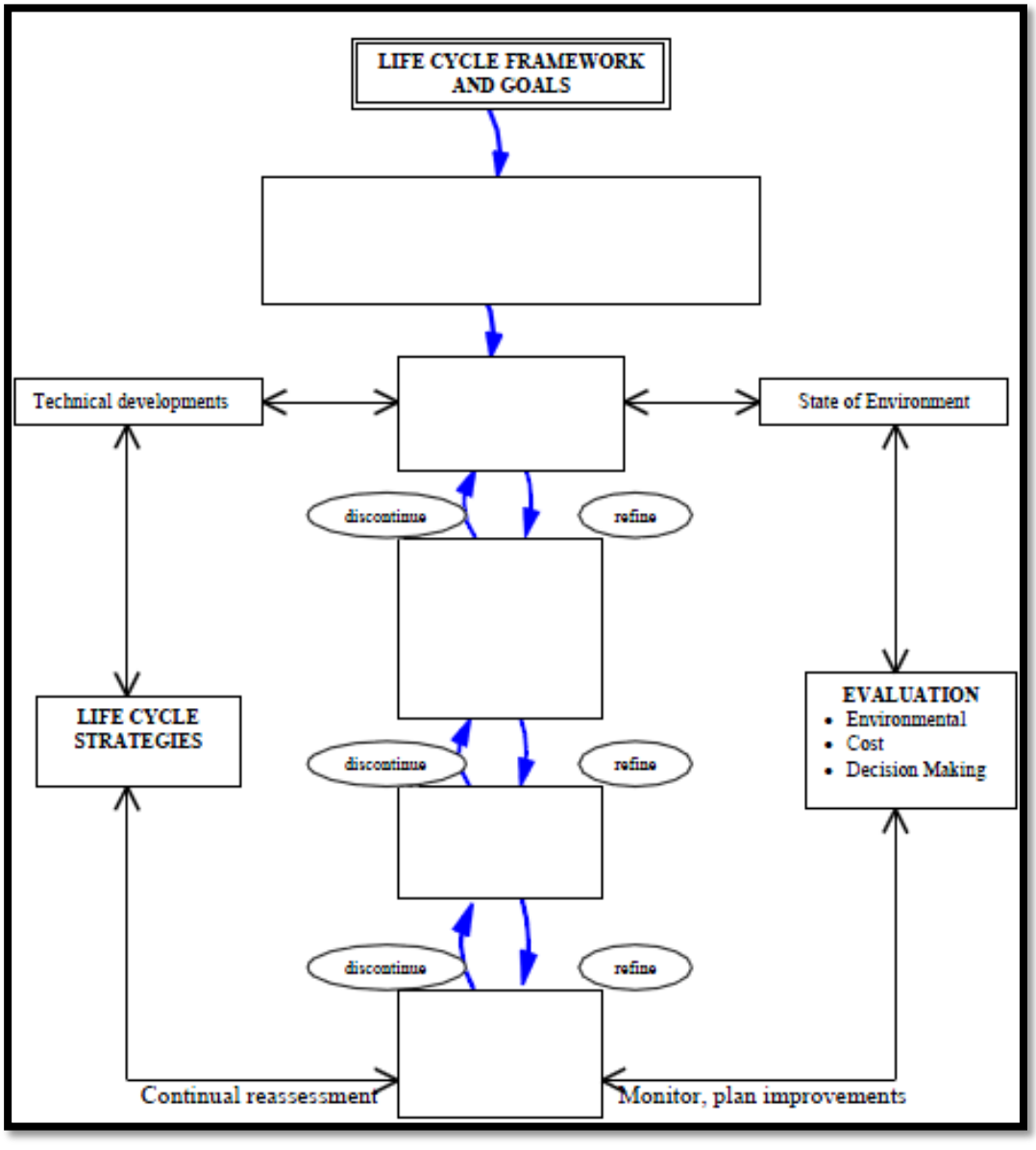

Figure 2.2 : Flow Chart: Life Cycle Design Process (Keoleian and Menerey, 1993)

In the diagram of life cycle goals are very important. Therefore, they are located at the top. Management influences all the stages of life cycle design process. Concurrent design and life cycle quality provide models for life cycle design. Moreover, measures of success, life cycle team coordination, and policy, strategy are needed in order to support all life cycle design process with design projects.

2.8 Goals of Eco Design

Eco Design aims at reducing the harmful environmental impacts of a product during its whole life cycle. This objective can be divided into five main goals (Kärnä, 2002):

1) Efficient use of materials
2) Minimising energy consumption
3) Minimising the use of substances harmful to health or the environment
4) Optimizing the product lifetime
5) Improving recyclability

2.8.1 Design Approaches

Each organisation should consider the suitability of the different design approaches for their environmental objectives. Examples of design approaches are:

- **Materials**: environmental impacts of using less materials, low impact materials, renewable materials or recycled materials.
- **Durability:** life span, reparation and maintenance, improvements of new technologies
- **Functionality**: multiple functions, modularity and automation
- **Re-use**: easy disassembly, reduced material complexity, use of recycled materials
- **Hazardous substances**: minimising the negative effects to health, safety and environment including transports.

2.9 Tools of Eco Design

There are many tools that can be used in related with eco design concept. The tools can help decision-making, development of measurement methods, analysis of environmental impacts, generation of ideas and precise of design.

Table 2.2 : Typical Stages of Product Design and Development Process (ISO, 2002, Enroth 2001)

Stage	Output	Action related to Eco design
Planning	Design ideas	Collecting Data, setting priorities, alligning with strategy, analysing environment aspects, setting requirements.
Conceptual Design	Design concept	Analysing life cycle, setting targets, making basic specificcation.
Detailed design	Design solution	Applying design approaches, finalising product specifications.
Testing/Prototype	Prototype	Verifyng specifications, reviewing life cycle considerations.
Production, market launch	Product	Publishing communication of environmental aspects, considering environmental product declaration.
Product review	(feedback)	Evaluating experiences, environmetal aspects and impacts.

Examples of these tools include the following (ISO, 2002, Enroth 2001):

- Decision-making tools such as matrices, checklists, Pareto diagrams, SWOT analyses, spider web diagrams
- Benchmarking tools based on physical quantities or environmental factors
- Product development tools that often used in quality management such as QFD (Quality Function Deployment) and FMEA (Failure Mode and Effects Analysis)
- Tools based on life cycle approach, like LCA (Life Cycle Analysis), LCC (Life Cycle Costing), SolidWork Sustainability, MFA (Material Flow Analysis) and CERA (Cumulative Energy Requirements Analysis).
- Other tools like hazard and risk assessment and stakeholder benefits and feasibility analysis. Many of the tools listed above are included in a presentation which classifies the tools in terms of complexity and purpose of application. (Tischner et al , 2003).

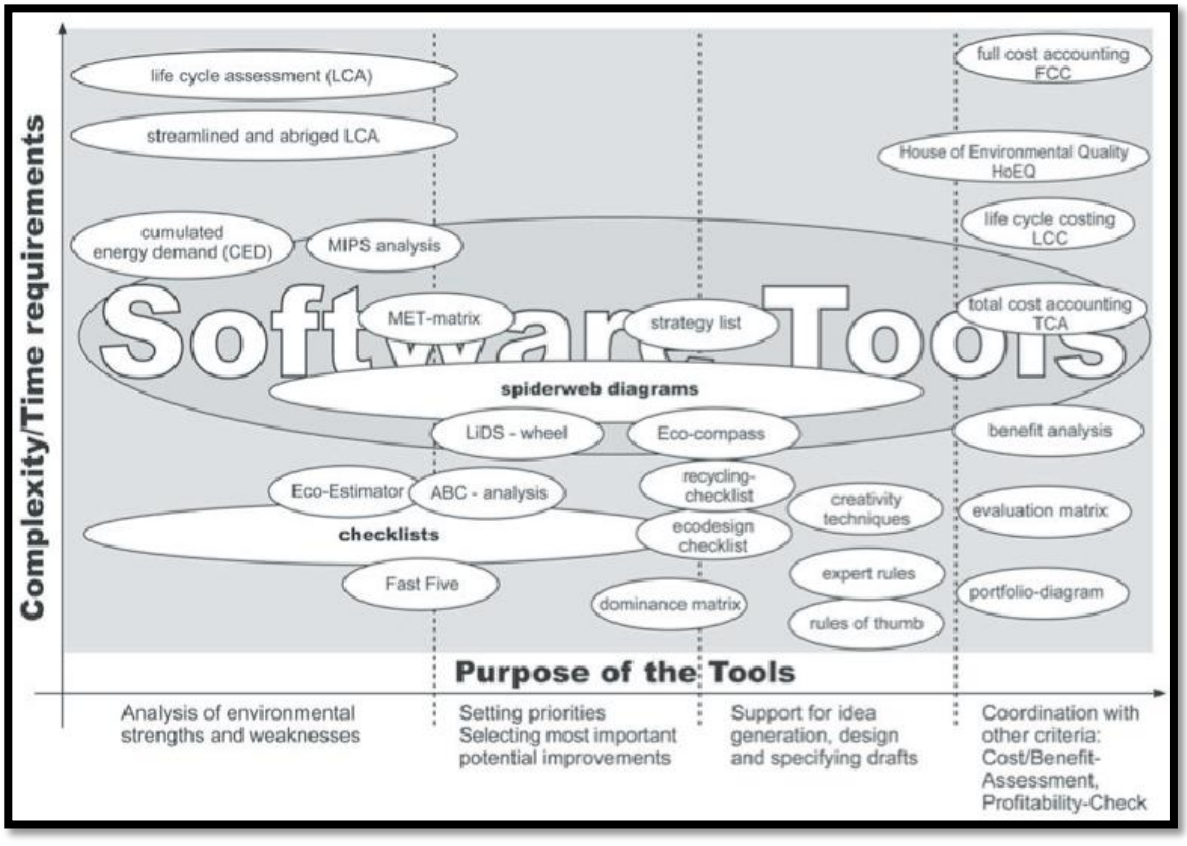

Figure 2.3: Tools of Eco Design (Tischner et al, 2003).

Table 2.3 : The Product Development Process and Related Eco Design Activities

Stage	Eco Design activities
1) Planning	• Clarify: what is the product idea? • What are the priorities (economical, technological, ecological) for this product? • Is it totally new product or a improvement • What is the overall and environmental company strategies? • Status quo: what Eco Design activities can you already base on? • Consider business environment: Customer/market needs, market niches, competitor's product.
2) Conceptual	• Intergrate Eco design aspects when drafting the specification (hard or soft criteria) • Check feasibility (technologival, financial) • Apply guidelines and checklist to refine the specification. • Communicate with your supply chain.
3) Detailed design	• Apply Eco Design tools and related with data based. • Find alternatives for problematic materials. • Develope life cycle scenarios for a better product understanding. • Design for assembly/diassembly.
4) Testing/Prototype	• Benchmark with former product generation. • Target achieved?
5) Market launch	• Communicate environmental excellence of your product • Communicate related features such as quality and life cycle cost. • Raise awareness among consumers.
6) Product Review	• Which are the competitors dong? • Evaluate success of the product. • Identify further improvement.

2.10 Environmental Effect Analysis (EEA)

Environmental Effect Analysis (EEA) is a systematic study of a product's environmental effects from "cradle-to-grave". The analysis aims to identify the largest expected environmental impact, so-called "hot spots", and generate an action plan for how to decrease the total environmental impact of the product. EEA is performed in cross-

functional teams and provides a qualitative result. The method is carried out in five stages; Preparation, Inventory, Analysis, Implementation, and Follow-up. The EEA is less time consuming and complex than an LCA which was the motive for the development of the method. (Lindahl & Tingström, 2001). EEA was developed based on Failure Mode and Effect Analysis (FMEA), which is a method used for identifying possible ways in which a design could fail, the causes, and their resulting effects. Because of the familiarities with the FMEA, EEA is believed to be easier implemented at a company if the FMEA method is already established. EEA is in literature sometimes referred to as Environmental- FMEA or E-FMEA, but the name was changed to EEA due to legal problems since FMEA was a protected name. (Lindahl and Tingström, 2001)

2.11 Material Flow Analysis

"Material flow analysis (MFA) is a systematic assessment of the flows and stocks of materials within a system defined in space and time." (Brunner and Rechberger, 2004). The applications of MFA:

2.11.1 Industrial Ecology

1) IE design principles related to MFA:
   - Controlling pathways for materials use and industrial processes
   - Creating loop-closing industrial practices
   - Dematerializing industrial output
   - Systematizing patterns of energy use
   - Balancing industrial input and output to natural ecosystem capacity
2) Environmental Management and Engineering
   - Environmental impact statements
   - Remediation of hazardous waste sites
   - Design of air pollution control strategies
   - Nutrient management in watersheds

- Planning of soil-monitoring systems
- Sewage sludge management

2.12 Life Cycle Assessment

Life Cycle Assessment is the only method that assesses the environmental impacts of a product or activity (a system of products) over its entire life cycle. It is therefore a holistic approach that takes into account:

- Extraction and treatment of raw materials
- Educational tools
- Product manufacturing
- Transport and distribution
- Product use
- End of life

The main goal of the method is to lessen the environmental impacts of products and services by guiding the decision-making process. For companies, designers, and governments, life cycle assessment represents a decision-making aid tool for implementing sustainable development (Abdul Ghafur, 2007).

2.13 Eco Design in Malaysian Industries

Malaysian is well known as the manufacturers that have a strong global market presence but that is now threatened with growing pressures from tighter environmental regulations, stronger green consumerism demand and decreasing natural resources due to the lack of implementation of sustainable manufacturing practices. The soft approach of the local legislation does not contribute much towards seeing a major change in attitude. There is different level to describe about eco design in Malaysia (Abdul Ghafur, 2007).