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MATERIAL SELECTION OF CAR'S TIRE BASED ON DESIGN FOR SUSTAINABILITY APPROACH

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

by

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This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirement for the degree of Bachelor of Manufacturing Engineering (Manufacturing Design) with Honours. The member of the supervisory committee is as follow:

.....

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ABSTRACT

Tire is one of the important parts in car which is it plays an important role in automotive industry. In recent years, much progress has been made whether in the physical or chemical understanding as to measure the endurance value of the tires. The objectives of this project is to study and do a research about the tire making process and also analyze the car's tire by using Design for Sustainability approach and techniques. The analyzing of the tire in this project was included the factor of weather and road surface. From the result, it can be seen that tire's endurance increases when the properties of tensile strength and elongation is increase. In a short meaning of Design for Sustainability (DFS), it is the process of designing goods and services that takes into account all the dimensions of sustainable development and particularly environment, economic and social factors. DFS also includes in concept of Ecodesign, Design for Environment (DFE), and Industrial Ecosystem. For this project, the analysis or method that was used to achieve all of the objectives are Sima-Pro software (Life-Cycle Assessment), CES Edupack software (material selection), questionnaire and also gathering information from many resource of literature review. In the end, the collected data from all of the analysis will be concluded what is the better material but in many condition such as about hot weather, cold weather, cost and also road surface.

ABSTRAK

Tayar adalah salah satu bahagian kereta yang sangat penting dimana ia mempunyai fungsi yang begitu penting dalam industry kenderaan. Dalam tahun-tahun lepas, telah banyak penyelidikan telah dilakukan samada dalam bentuk pemahaman fizikal atau pun kimia dalam mengukur tahap keupayaan ketahanan tayar. Objektif projek ini adalah untuk memahami dan menyelidik bagaimana proses membuat tayar dan juga melakukan analisis pada tayar tersebut dengan menggunakan kaedah dan teknik-teknik Design for Sustainability (DFS). Analisis tayar dalam projek ini telah merangkumi dari segi faktor cuaca dan juga permukaan jalan. Daripada keputusan yang dikeluarkan, ia dapat dilihat bahawa keupayaan tayar meningkat jika sifat tegangan dan pemanjangan meningkat. Dalam maksud yang singkat, DFS adalah servis dan proses membuat barangan yang mengambil kira semua keadaan peningkatan dalam keupayaan bertahan terutamanya dari segi faktor persekitaran, ekonomi dan social. DFS juga terlibat dan berkait dengan konsep Eco-design, Design for Environment, Industri Ekosistem. Dalam projek ini, analisis yang digunakan untuk mencapai semua objektif adalah perisian Sima-Pro (penilaian kitaran hidup), perisian CES Edupack (pemilihan bahan), bancian soalan dan juga pengumpulan hasil-hasil bacaan dari banyak sumber. Yang terakhir, data-data yang dikumpul dari analisis akan di konklusikan bahan manakah yang terbaik mengikut keadaan yang tertentu seperti cuaca panas, cuaca sejuk, kos dan juga permukaan jalan.

DEDICATION

To my beloved mother, father and friends, thank you for the support and encouragement.

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DFE	-	Design for Environment
DFS	-	Design for Sustainability
EIA	-	Environment Impact Assessment
SEA	-	Strategic Environment Assessment
LCA	-	Life Cycle Assessment
LCC	-	Life Cycle Costing
IE	-	Industrial Engineering
VE	-	Value Engineering
MAUT	-	Multi Attribute Utility Theory
EPD	-	Environment Product Declarations
CES	-	Cambridge Educational Selecter
TBM	-	Tire Building Machine
PSM	-	Projek Sarjana Muda
IR	-	Polyisoprene Rubber
SBR	-	Styrene-Butadiene Rubber
EPR	-	Etylene Propylene Rubber
EPM	-	Etylene Propylene Monomer
EPDM	-	Etylene Propylene Diene Monomer
PUR	-	Polyurethane Rubber

CHAPTER 1
INTRODUCTION

This first chapter discussed about the introduction of design for sustainability (DFS) principles and approaches for new improvement on the car tires. In this part, the briefing of the background, problem statement, objectives, scope, and the expected of the study are discussed.

1.1 Introduction

Design for Sustainability (DFS) is the process of designing goods and services that takes into account all the dimensions of sustainable development and particularly environment, economic and social factors. Design for Sustainable is also much related to Design for Environment (DFE) which means the systematic consideration during design, of issues associated with environment safety and health over the product life cycle. Both of these design takes many product development aspects:

(a) Material selection
(b) Energy use
(c) Extended component life cycle
(d) Disassembly
(e) Reuse
(f) Recycling
(g) Reprocessing/ remanufacturing
(h) Packaging

Sustainability is commonly defined as capable of being maintained at a steady level without exhausting natural resources or causing ecological damage. When considering the sustainability of any design, it must consider all elements of the product's production, lifecycle and system in which it operates in order to properly understand the entire impact upon resources of the product. It is only when we understand the impact of the product that we can begin to even think about tackling and reducing this impact to improve the sustainability of the product.

Sustainability is also means the capacity to endure. For humans it is the potential for long-term maintenance of well being, which in turn depends on the well being of the natural world and the responsible use of natural resources. Sustainability contains three elements which are economy, society and environment. Sustainable design also known as philosophy of designing physical objects, the built environment, and services to comply with the principles of economic, social, and environment sustainability.

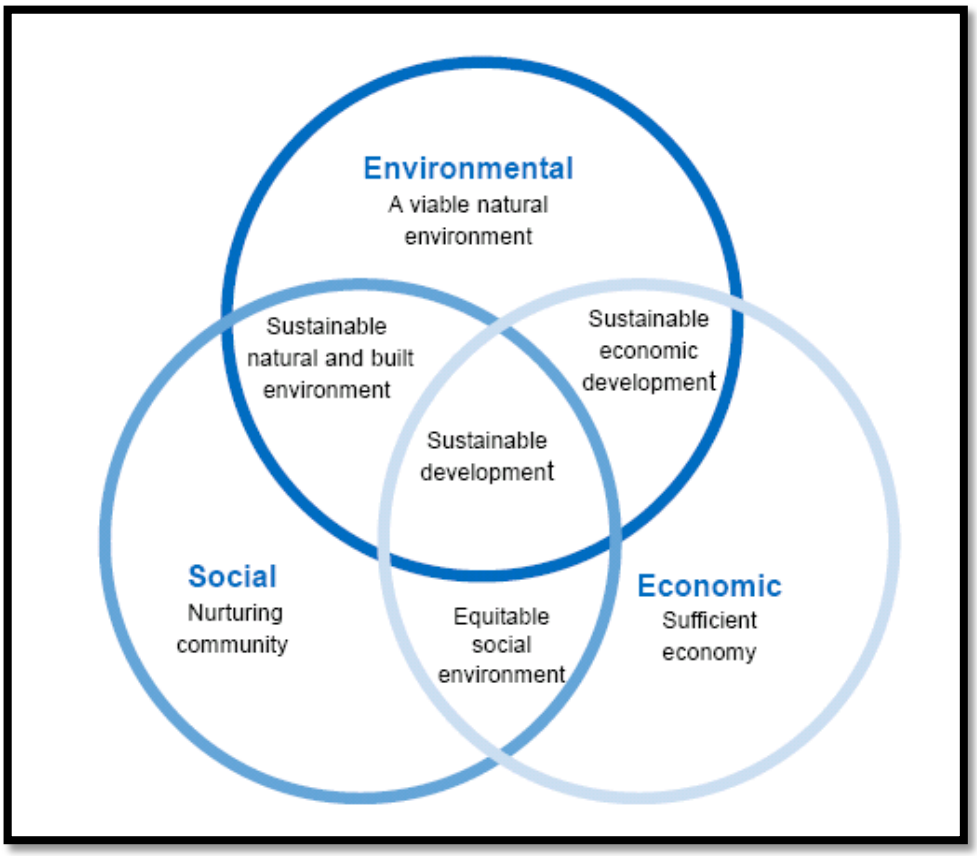

Figure 1.1: Three circle of sustainability

(Screenshot from google.com)

There are four Designs for Sustainability principles, which are;

(a) Low-impact materials: choose non-toxic, sustainably produced or recycled materials which require little energy to process.
(b) Energy efficiency: use manufacturing processes and produce products which require less energy.
(c) Quality and durability: longer-lasting and better-functioning products will have to be replaced less frequently, reducing the impacts of producing replacements.
(d) Design for reuse and recycling: Products, processes, and systems should be designed for performance in a commercial 'afterlife'.

A set of sustainability principles for engineers was then developed, based on the long term viability of the planet, intra- and inter-generational equity, and a holistic view for projects and engineering practice, integrating environmental, social, and economic issues. Practical tasks and requirements for engineers, including a checklist were then drawn up to provide further direction to practicing engineers. (Boyle and Coates, 2005)

At a minimum, sustainable development must not endanger the natural systems that support life on Earth: the atmosphere, the waters, the soils, and the living beings. New and efficient technologies will be essential to increase the capabilities to achieve sustainable development, sustain the world’s economy, protect the environment, and alleviate poverty and human suffering. Inherent in these activities is the need to address the improvement of technology currently used and its replacement, when appropriate, with more accessible and more environmentally sound technology. In short word, Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (Sotoudeh, 2005)

1.2 Problem Statement

Nowadays, the automotive industry has already known as a very competitive industry. But, automotive industry has been related to environmental issues such as air pollution, water pollution and sound pollution. Furthermore, tires and wheels are one of the most critical parts of any road vehicle. Their quality will dictate speed, road handling, fuel economy and road safety. Critically, their standard will have a significant effect on stopping distance in an emergency.

The most problem that the users always had is about tread damage before its due date. For example, tires that are under inflated or over inflated can affect tread damage and also effect tire life, driving comfort, traction and braking. Under inflation generates excessive flexing of the tire casing, which results in overheating, increase of rolling resistance and premature wear. In short word, under inflation can cause tire damage at tread. Likewise, over inflation can reduce tire life, reduce grip and create irregular wear. As we know, road hazards like potholes, glass and rocks are usually unavoidable. However, there are three most problem that we always had, incorrect inflation pressure, speeding and overloading.

Driving at high speeds has a greater chance of causing tire damage than at low speeds. If contact is made with a road hazard, it has a greater chance of causing tire damage. Driving at speed will cause the tire a greater build up of heat, which can cause tire damage. It can also contribute to a sudden tire destruction and rapid air loss if the tires are not properly maintained. If a tire experiences sudden air loss, it can lead to an accident to us.

Tire-road forces are crucial in vehicle dynamics and control because they are the only forces that a vehicle experiences from the ground. These forces significantly affect the lateral, longitudinal, yaw, and roll behaviour of the vehicle. Then, the noise emissions of studded tires are an even bigger acoustic problem than tires without spikes, and the increasing market leads to increased efforts in designing noise optimal spike arrangements on tires. The example of tire-wear-pattern and its cause is shown as Figure 1.2:

Figure 1.2: Tire-wear- pattern and its cause
(Screenshot from google.com)

1.3 Objectives

The main purpose of this project is to research and analyze the sustainability of tires that able to give an improvement on tire's quality and user safety. The objectives of this study are:

(a) Identify and study what the problem that always happened.
(b) Analyze the existing car tires and its making process.
(c) Study and do a research about the detail properties of other rubber and the existing rubber in tires.
(d) Analyze the material selection of car's tire using Design for Sustainability (DFS) approach and techniques.

1.4 Scope

Few necessary elements must be considered to guarantee the objectives of the project achieved. Besides that, the data result of this project has analyzed by using Sima-Pro software and CES edupack software. The scopes for this project are as follows:

(a) The investigation base on literature study from many sources.

(b) Analyze the conceptual new designs that fulfill the engineering of Design for Environment specification.

(c) The current tires must be analyzed to improve the sustainability based on Design for Sustainability and Green Technology.

(d) The data analysis will cover the first principle of DFS which is about the material.