



DEVELOPMENT OF A NEW ENVIRONMENTAL FRAMEWORK
FOR MANUAL WHEELCHAIR USING ANALYTICAL HIERARCHY
PROCESS (AHP) IN PRODUCT DEVELOPMENT PROCESS

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MASTER OF MANUFACTURING ENGINEERING
(INDUSTRIAL ENGINEERING)

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Faculty of Manufacturing Engineering

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PRODUCT DEVELOPMENT**

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**In fulfillment of the requirements for the degree of Master of Manufacturing
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DECLARATION

I declare that this thesis entitled “Development of a new environmental framework for manual wheelchair using analytical hierarchy process (AHP) in product development process” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name :

Date :

APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion this dissertation/report is sufficient in terms of scope and quality as a partial fulfillment of Master of Manufacturing Engineering (Industrial Engineering).

Signature :

Supervisor Name :

Date :

DEDICATION

I dedicate my dissertation work to my beloved family. A special feeling of gratitude to my loving parents, Nurah Yusuf Ali Hoosh and Abshir Ibrahim Dirie, and my siblings, for their continuously support and endless loves that give me strength to complete this work.

ABSTRACT

Development of a new environmental framework for manual wheelchair in the product growth process is an important decision due to the increasing awareness of the need for environmental protection, industries today focus to minimize the environmental impact of their products. The aim of the project is to minimize the environmental impact of wheelchair and to develop a new environmental framework using AHP at the selected designs. To evaluate and develop a new framework it should be considered at the existing product design phase which contains several judgement making tasks. This project presents the use of analytical hierarchy process (AHP) through using expert choice software to determine the most suitable design for the environment. A three (3) manual wheelchair designs was chosen as a case study. The results show that design 1 (D1) is the most appropriate design because it has the highest percentage of priority value of 45.9% compared to the other designs. The final judgement of the designs is gained by performing two (2) scenarios of the sensitivity analysis and the analysis showed that it is proven that design 1 (D1) is the most optimum design.

ABSTRAK

Penghasilan satu rangka kerja alam sekitar yang baru untuk kerusi roda dalam proses perkembangan produk adalah satu keputusan yang penting berikutan peningkatan tahap kesedaran tentang keperluan perlindungan alam sekitar, hari ini kebanyakan industri memberi tumpuan terhadap produk mereka dalam meminimumkan kesan kepada alam sekitar. Tujuan projek ini adalah untuk mengurangkan kesan alam sekitar daripada kerusi roda dan untuk menghasilkan satu rangka kerja alam sekitar yang baru dengan menggunakan Proses Hierarki Analitikal (AHP) pada reka bentuk yang dipilih. Untuk mengkaji dan mewujudkan satu kerangka yang baru ianya perlu dipertimbangkan pada fasa produk rekabentuk sedia ada yang mengandungi beberapa tugas penilaian yang perlu dilaksanakan. Projek ini menjelaskan tentang penggunaan AHP dengan menggunakan perisian expert choice untuk menentukan rekabentuk yang paling sesuai untuk alam sekitar. Tiga rekabentuk kerusi roda manual telah dipilih sebagai kes kajian. Dapatan kajian telah mendapati rekabentuk 1 (D1) adalah yang paling sesuai kerana mempunyai peratusan nilai keutamaan tertinggi dengan 45.9% berbanding rekabentuk yang lain. Penilaian terakhir rekabentuk diperolehi melalui pelaksanaan dua senario daripada analisis sensitiviti dan mendapati ianya terbukti bahawa rekabentuk 1 (D1) adalah rekabentuk yang paling optimum.

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LIST OF SYMBOLS

AHP	- Analytical Hierarchy Process
D1	- Design 1
D2	- Design 2
D3	- Design 3
PV	- Priority Vector
NV	- New Vector
λ_{max}	- Eigenvalue
CI	- Consistency Index
CR	- Consistency Ratio
RI	- Random Index
ANC	- Average of Normalized Columns
n	- Number of Elements in the row

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CHAPTER 1

INTRODUCTION

The chapter clarifies about the overall view of the Project development of a new environmental framework for manual wheelchair using Analytical Hierarchy Process (AHP) method in product improvement process. The outcome of this project will minimize the environmental impact of manual wheelchair and develop a new environmental framework using AHP at the conceptual design phase.

This project is about choosing a best design from a three (3) manual wheelchair designs to improve the product to be more efficient, accurate, substantive and environmental friendly. It is a study that will be a reference for upcoming environmental framework structure. Contain in this chapter, it also covers introduction of the study, problem statement, objectives, scope and what are the paybacks from this study.

1.1 Background

Development of a new environmental framework for wheelchair in the product growth process is an important decision due to the increasing awareness of the need for environmental protection, industries today focus to reduce the environmental effect of their goods. To evaluate

and develop a new environmental framework for manual wheelchair should be consider at the conceptual design phase which contains several judgement making tasks.

Conceptual design it is the process to improve ideas that will let a new product will work and meet its performance requirements, and it's one of the most significant levels in product growth specifically Pugh method, 1990 (Ariff et al., 2008). There are four (4) key events in conceptual design phase which are idea explanation, idea generation, concept selection and concept improvement (Hambali et al., 2009). Conceptual design takes a very important portion in the general accomplishment of the product, overall the main objective of conceptual phase stage is to choose the most appropriate idea from a number of potential choices in the early product design stage (Hambali et al., 2011). One of the important system that can be utilized for the conceptual design stage is Analytical hierarchy process (AHP) (Hambali et al., 2009).

The Analytical hierarchy process (AHP) strategy was present by Saaty in 1980, is an operational technique for dealing with difficult choice taking, and may help the decision makers to make precedence and take the finest decision (Saaty, 1988). By diminishing complex decisions to an arrangement of pairwise judgments, and after that orchestrating the results, the AHP helps to seizure both subjective and target sides of a judgment. Including that, the AHP incorporates an important strategy for testing the reliability of the judgment creator's evaluations, along these lines diminishing the predisposition in the decision making process (Saaty, 2008). The AHP thoroughly consider various evaluation criterion, and various option decisions among which the best decision is to be made. The AHP is an extremely adaptable and effective instrument on the grounds in light of the fact that the scores, and consequently the keep going positioning are gotten on the reason of the pairwise relative evaluations of both the criteria and decisions gave by the user (Battistoni et al., 2013).The AHP can be implemented in three

(3) basic strides which are calculating the vector of criteria weights, figuring the lattice of choice scores and positioning the alternatives (Saaty, 1990).

This project deals with the usage of AHP method to develop a new environmental framework for wheelchair in product development process, three manual wheelchair designs are selected as main criterion for the new environmental framework and the sub criterion were selected considering the environmental factors.

1.2 Problem Statement

The Analytical Hierarchy Process (AHP) technique is being utilized widely in decision taking nowadays specifically in terms of AHP implementation in product development process but there is very limited study on the environmental framework in product development process.

The case study for this research is all about developing an environmental framework for manual wheelchair. After employing several stages in product growth process and selecting three (3) manual wheelchair design it's time to pick the most reasonable design idea by utilizing AHP.

1.3 Objectives

The primary objective of the study is: -

- i. To create a new environmental framework using AHP at an existing design.

And to solve the problem mentioned above, two specific objectives are found: -

- ii. To conduct a manual wheelchair design as a case study with a specific end goal to verify the proposed framework.
- iii. To perform sensitivity analysis to verify the results.

1.4 Scope of the Project

The extent of this study is mostly concentrating on the developing a new environmental framework for a wheelchair using AHP. Developing this new environmental framework is an important decision due to the increasing awareness of the need for environmental protection.

This project divided into six (6) phases; the first phase will focus and involve on researching and literature review thoroughly about development of a new environmental framework using AHP in product development process.

The second and third phase involve on the selecting a manual wheelchair from the existing manual wheelchairs design and development of framework system using AHP.

The fourth and fifth phase tests the framework using expert choice software and sensitivity analysis. And lastly selection of final environmental framework.

CHAPTER 2

LITERATURE REVIEW

This section clarifies on the past and the simple theoretical part of development of a new environmental framework for manual wheelchair using AHP in product improvement process which may help in escaping the errors for the period of the analysis. It also covers the dissimilar types of or the previews studies that have been done in this field. Finally, this chapter were comprised a brief choice from previous studies.

2.1 Product Development Process

For the current years, improvements in the design method and the supervision of manufacture have been vital to diminish the time required and the advantages utilized as a part of the design, manufacture, and conveyance of products having continuously lifted and additional separated execution needs. Methodological techniques have changed to help designers met with the developing intricacy of design troubles and of the structure of components affecting design challenges in a few ways. The new design trials have need of a customary, joined, and synchronous association on an item and its connected procedures, according (Ulrich, 2003) to the new methodologies identified as Concurrent Engineering and