



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**REDESIGN OF A HAND PALLET TRUCK FOR  
MANUFACTURING INDUSTRY USING INTEGRATION OF  
ERGONOMICS ANALYSIS AND QUALITY FUNCTION  
DEPLOYMENT (QFD)**

Thesis submitted in accordance with the requirements of Universiti Teknikal  
Malaysia Melaka for the Bachelor Degree of Manufacturing Engineering in  
Manufacturing Management

By

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**UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)**
**BORANG PENGESAHAN STATUS TESIS\***

**JUDUL:** DESIGN DEVELOPMENT OF A PALLET STACKER THROUGH INTEGRATION OF ERGONOMICS ASSESSMENT AND QUALITY FUNCTION DEPLOYMENT (QFD) AT MACHINE SHOP IN UTeM.

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This thesis submitted to the senate of UTeM and has been accepted as fulfillment of the requirement for the Degree of Bachelor of Manufacturing Engineering (Manufacturing Management) with Honours. The members of the supervisory committee are as follow:

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Mr. Isa Bin Halim  
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## **ABSTRACT**

Materials handling device such as hand pallet truck is very common for industrial application as it helps worker to handle goods. However, the negligence of the design of hand pallet truck may cause injury or discomfort to the workers. Sprains and strain are common injuries experienced by the workers associated with the misuse or poor design of hand pallet truck. In recognition the importance of hand pallet truck design, this project is conducted to redesign the existing hand pallet truck for materials handling in manufacturing industry. To achieve the objective, integration of Quality Function Deployment (QFD) and ergonomics analysis were adopted to redesign a hand pallet truck that is fulfill workers' requirements and provides safe working posture. In the design of the hand pallet truck, two criteria were analyzed i.e. working posture and pushing-pulling activities. The working posture is analyzed through RULA analysis, meanwhile the pushing-pulling activities are examined using Push and Pull analysis. Based on RULA analysis, the redesigned hand pallet truck indicated an improvement on working posture, while Push and Pull analysis has obtained the value of maximum initial and sustainable forces while using the redesigned hand pallet truck. Based on the findings, the author concluded that integration of QFD and ergonomics analysis is able to produce effective and safer design of a hand pallet truck.

## ABSTRAK

Alat pengendali barang seperti trak tangan palet biasa digunakan di dalam aplikasi industri, di mana ia membantu pekerja untuk mengendalikan barangan. Walau bagaimanapun, pengabaian terhadap reka bentuk trak tangan palet boleh menyebabkan kecederaan dan ketidak selesaan kepada pekerja. Anggota badan terseliuh dan lebam merupakan kecederaan biasa yang dialami oleh pekerja disebabkan oleh penyalahgunaan atau reka bentuk yang kurang sesuai pada trak tangan palet. Dengan memberi tumpuan kepada kepentingan reka bentuk trak tangan palet, projek ini telah dijalankan untuk mereka bentuk semula trak tangan palet yang sedia ada untuk kegunaan mengendalikan barangan di dalam industri pembuatan. Untuk mencapai objektif, integrasi antara Penempatan Fungsi Kualiti (QFD) dan analisis ergonomic telah diguna pakai untuk mereka bentuk semula trak tangan palet yang memenuhi kehendak pekerja dan menyediakan postur bekerja yang selamat. Di dalam reka bentuk trak tangan palet, dua kriteria telah dianalisis, sebagai contoh postur bekerja dan aktiviti menolak dan menarik. Postur bekerja dianalisa menggunakan RULA analisis, manakala aktiviti menolak dan menarik telah di analisa menggunakan analisis 'Push' dan 'Pull'. Berdasarkan analisis RULA, trak tangan palet yang telah di reka bentuk semula telah menunjukkan pembaikan terhadap postur bekerja, manakala analisis 'Push' dan 'Pull' telah mengenal pasti nilai daya maksimum awal dan daya maksimum yang boleh ditampung oleh pekerja semasa menggunakan trak tangan palet yang telah direka bentuk semula. Berdasarkan hasil kajian ini, penulis telah membuat kesimpulan di mana integrasi antara QFD dan analisis ergonomik mampu untuk menghasilkan reka bentuk trak tangan palet yang efektif dan selamat untuk digunakan.

## **DEDICATION**

***For my adored parents:***

**Wan Adnan Bin Wan Abas**

**Maimunah Binti Abdullah**

***And for my respected brothers and sisters:***

**Wan Faisal Bin Wan Adnan**

**Wan Mohd Farid Bin Wan Adnan**

**Wan Fadhlina Binti Wan Adnan**

**Wan Faezah Binti Wan Adnan**

**Wan Ahmad Faiq Bin Wan Adnan**

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# TABLE OF CONTENTS

Abstract.....	v
Abstrak.....	vi
Dedication.....	vii
Acknowledgements.....	viii
Table of Contents.....	ix
List of Figure.....	xiv
List of Table.....	xvii
List of Abbreviations, Symbols, Specialized Nomenclatures .....	xviii
<b>1. INTRODUCTION.....</b>	<b>1</b>
1.1 Background of study.....	1
1.2 Problem Statement.....	3
1.3 Project Objectives.....	4
1.4 Scope and Limitation of Project.....	4
1.5 Potential Benefits of Study.....	5
1.6 Report Outline.....	6
1.6.1 Report Structure.....	7
<b>2. LITERATURE REVIEW.....</b>	<b>8</b>
2.1 Introduction.....	8
2.2 Manufacturing Industry.....	8
2.3 Material Handling Device (MHD).....	9
2.3.1 Definition of MHD .....	9
2.3.2 Introduction of MHD .....	10
2.3.2.1 Automated MHD.....	10
2.3.2.2 Semi Automated MHD.....	10
2.3.2.3 Manual MHD.....	11



2.3.3 Hand Carts .....	12
2.3.3.1 Cart Handling.....	12
2.3.3.2 Factors that influence the amount of weight on cart.....	14
2.3.3.3 Force limits for horizontal pushing and pulling.....	15
2.3.4 Hand Pallet Truck (HPT).....	16
2.3.4.1 Introduction to HPT.....	16
2.3.4.2 Hazards associated when using HPT.....	17
2.4 Ergonomics.....	18
2.4.1 Introduction to Ergonomics.....	18
2.4.2 Definition of Ergonomics .....	19
2.4.3 Purpose of Ergonomics .....	19
2.4.4 Field of Ergonomics .....	20
2.4.5 Approach to assess Manual Material Handling (MMH) capabilities.....	20
2.4.5.1 Biomechanical approach.....	21
2.4.5.2 Physiological approach.....	23
2.4.5.3 Psychophysical approach.....	23
2.4.6 Analysis tools to assess MMH capabilities.....	24
2.4.6.1 Observation methods.....	24
2.4.6.2 Direct Measurement method.....	31
2.5 Quality Function Deployment (QFD).....	33
2.5.1 Introduction to QFD.....	33
2.5.2 Definition of QFD.....	33
2.5.3 History of QFD.....	34
2.5.4 Organization of information.....	34
2.5.4.1 Affinity diagram.....	34
2.5.5 House of Quality (HoQ).....	35
2.5.5.1 Six basic steps of HoQ.....	36
2.6 Computer Aided Design (CAD).....	42
2.7 Previous study related to MMH and MHD.....	44

<b>3. METHODOLOGY.....</b>	<b>52</b>
3.1 Introduction.....	52
3.2 Determine the needs of workers regarding to the design of Hand Pallet.....	52
Truck (HPT) for material handling activities	
3.3 Redesign the existing HPT to improve occupational health.....	55
3.4 Evaluate the effectiveness of the redesign HPT.....	56
3.5 Summarization of methodologies .....	63
<b>4. CASE STUDY.....</b>	<b>65</b>
4.1 Background of company.....	65
4.2 Company main product produce.....	67
4.3 Major types of MHD used.....	67
4.4 Hand Pallet Truck (HPT).....	68
4.4.1 Task that been done using HPT.....	68
4.4.2 Factors that influence to study about HPT.....	69
4.4.3 Areas covered in the study of HP.....	69
4.5 Study on the use of HPT at WINCO Precision Engineering Company.....	70
4.5.1 Design of Experiment.....	70
4.5.2 Subjects.....	70
4.5.3 Experiment task.....	71
4.5.4 Design for working posture evaluation.....	71
4.5.5 Assessment of working posture.....	74
<b>5. RESULTS.....</b>	<b>78</b>
5.1 Introduction.....	78
5.2 Determine the needs of workers regarding to the design of HPT .....	78
for material handling activities	
5.2.1 Analysis of questionnaires.....	78
5.2.2 Develop the House of Quality (HoQ).....	86
5.3 Redesign the existing HPT to improve occupational health.....	88

5.3.1 Design and evaluate the effectiveness of the current HPT.....	88
5.3.1.1 Pushing current HPT.....	89
5.3.1.2 Pulling current HPT.....	94
5.3.2 Redesign concept for new HPT design.....	99
5.4 Evaluate the effectiveness in terms of ergonomic analysis on the.....	102
redesign HPT	
5.4.1 Pushing the redesign HPT.....	102
5.4.2 Pulling redesign HPT.....	107
5.4.3 Comparison between current design and redesign HPT.....	112
<b>6. DISCUSSION.....</b>	<b>116</b>
6.1 The needs of workers regarding to the design of HPT.....	116
for material handling activities	
6.1.1 Survey by using questionnaires .....	117
6.1.2 Analysis of questionnaires by using QFD analysis.....	119
6.2 Redesign of HPT to improve occupational health .....	120
6.2.1 RULA analysis for pushing and pulling HPT.....	120
6.2.2 Push and Pull analysis for pushing and pulling HPT.....	122
6.2.3 The redesign of HPT.....	122
6.3 Evaluation on the effectiveness in terms of ergonomic analysis.....	126
on the redesigned HPT	
6.3.1 Evaluation on redesigned HPT by using RULA analysis.....	126
6.3.2 Evaluation on redesigned HPT by using Push and Pull analysis.....	130
<b>7. CONCLUSION.....</b>	<b>132</b>
7.1 Workers needs regarding to the design of HPT for .....	132
material handling activities	
7.2 Redesign current HPT to improve occupational health.....	133
7.3 Evaluate the effectiveness in terms of ergonomic analysis on the.....	133
workers for the redesigned HPT	

<b>8. RECOMMENDATIONS .....</b>	<b>135</b>
<b>8.1 Recommendation to improve the study.....</b>	<b>135</b>
<b>8.2 Further study.....</b>	<b>136</b>
 <b>REFERENCE.....</b>	 <b>138</b>

## **APPENDIX**

- A Gantt chart of study**
- B Questionnaire**
- C Orthographic view of current HPT**

# LIST OF FIGURES

1.1	Structure of report	7
2.1	Automated MHD, Forklift	11
2.2	Semi-automated MHD, Vacuum Lifter	11
2.3	Manual MHD, Hand cart	12
2.4	Hand Pallet Truck (HPT)	17
2.5	A low-back biomechanical model of static coplanar lifting	22
2.6	Group A body posture scoring for REBA	27
2.7	Group B body posture scoring chart	27
2.8	REBA posture score for performing a standard podiatry task	28
2.9	House of Quality	35
2.10	Example of CAD design	42
3.1	RULA analysis	58
3.2	Advanced mode of RULA analysis	60
3.3	Push and Pull Analysis	62
3.4	Summarization of Methodology	64
4.1	WINCO Precision Engineering (Melaka) Sdn. Bhd.	66
4.2	Forklift	67
4.3	4-wheeled cart	67
4.4	Hand Pallet Truck (HPT)	67
4.5	Cage design	68
4.6	Factors and usability of manual vehicles	69
4.7	Worker pushing HPT	70
4.8	Worker pulling HPT	70
4.9	Current HPT	72

4.10	Current Design of cage	72
4.11	Current design specification of HPT	73
4.12	Body magnitude of the workers when pushing HPT	75
4.13	Anthropometry Dimension	76
4.14	Anthropometric Data	76
4.15	3D view of worker pulling current HPT	77
4.16	3D view of worker pushing current HPT	77
5.1	Frequency of using HPT	79
5.2	Type of difficulties faced by the workers	80
5.3	Injured body parts when using HPT	81
5.4	Score of improvement for HPT	82
5.5	Improvement criteria for redesign HPT	85
5.6	House of Quality for HPT improvement	86
5.7	Body diagram for pushing current HPT	90
5.8	RULA analysis for current left sided body for pushing activities	92
5.9	RULA analysis for current right sided body for pushing activities	93
5.10	Current pushing and pulling analysis for pushing activities	94
5.11	Body diagram for pulling current HPT	95
5.12	RULA analysis for current left sided body for pulling activities	97
5.13	RULA analysis for current right sided body for pulling activities	97
5.14	Current pushing and pulling analysis for pulling activities	98
5.15	Rating for improvement	99
5.16	Specifications changes for the redesign HPT	100
5.17	Worker condition when pushing redesign HPT	103
5.18	Body diagram of pushing Redesign HPT	103
5.19	RULA analysis of left body side for pushing activities of redesign HPT	105
5.20	RULA analysis for right body side for pushing activities of redesign HPT	105

5.21	Push and Pull analysis for redesign HPT	107
5.22	Worker condition when pulling the redesign HPT	108
5.23	Body diagram of pulling Redesign HPT	109
5.24	RULA analysis for left body side for pulling activities of redesign HPT	110
5.25	RULA analysis for right body side for pulling activities of redesign HPT	111
5.26	Push and Pull analysis for pulling activities of HPT	112
6.1	Cage supporter design	123
6.2	Additional pair set of rear wheels	123
6.3	Adjustable fork with longer width and length size	124
6.4	New set of handle bar with arm supporter	125
6.5	Comparison of RULA score for left body side between current and redesign HPT for pushing activity	127
6.6	Comparison of RULA score for right body side between current and redesign HPT for pushing activity	127
6.7	Comparison of RULA score for left body side between current and redesign HPT for pulling activity	128
6.8	Comparison of RULA score for right body side between current and redesign HPT for pulling activity	129

## **LIST OF TABLES**

2.1	Recommended Limits in the Selection of Hand and Powered Trucks and Carts	13
2.2	Recommended upper force limits for horizontal pushing and pulling	15
2.3	RULA action level	25
2.4	REBA score and associated action levels	26
3.1	Fields to be selected	57
3.2	RULA analysis	59
3.3	Options setting	60
3.4	Intermediate scores of RULA analysis	61
3.5	Parts of Push and Pull Analysis	62
4.1	Working posture magnitude of the workers using HPT	74
5.1	Improvement parts of the current HPT	83
5.2	Comparison between RULA score for current and new design of HPT	113
5.3	Final score of RULA before and after improvement of design	114
6.1	Results of Push and Pull analysis based on Snook and Ciriello methods, 1991	130



# **LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE**

<b>CAD</b>	<b>Computer Aided Design</b>
<b>CATIA</b>	<b>Computer Aided Three dimensional Interactive Application</b>
<b>CNC</b>	<b>Computer Numerical Control</b>
<b>EMG</b>	<b>Electromyography</b>
<b>HoQ</b>	<b>House of Quality</b>
<b>HPT</b>	<b>Hand Pallet Truck</b>
<b>IAP</b>	<b>Intra-Abdominal Pressure</b>
<b>LBD</b>	<b>Low Back Disorders</b>
<b>LLM</b>	<b>Lumbar Motion Monitor</b>
<b>MHD</b>	<b>Material Handling Device</b>
<b>MMH</b>	<b>Manual Material Handling</b>
<b>MSDs</b>	<b>Musculoskeletal Disorders</b>
<b>NIOSH</b>	<b>National Institute for Occupational Safety and Health</b>
<b>OWAS</b>	<b>Ovako Working Posture Analysis</b>
<b>QFD</b>	<b>Quality Function Deployment</b>
<b>REBA</b>	<b>Rapid Entire Body Assessment</b>
<b>RULA</b>	<b>Rapid Upper Limb Assessment</b>
<b>UteM</b>	<b>- Universiti Teknikal Malaysia Melaka</b>
<b>VOC</b>	<b>Voice of Customers</b>
<b>VOE</b>	<b>Voice of Engineers</b>
<b>WMSDs</b>	<b>Work Musculoskeletal Disorders</b>

# **CHAPTER 1**

## **INTRODUCTION**

This chapter provides information regarding to the background of study, problem statement, and objectives of the study. This chapter is also explains the scope and limitation of study, potential benefits from the study that may considerable to the personal, authorities, or related organizations. The outline on how the study will be conducted also presented in this chapter.

### **1.1 Background of Study**

The manufacturing industry includes businesses engaged in the mechanical or chemical transformation of materials or substances into new products. The manufacturing industry includes sectors which involve the manufacturing, processing, beverages, plastics, clothing, furniture, household products, metal products, machinery, equipment, concrete products, petroleum, etc. These businesses are usually described as plants, factories, or mills and normally use power driven machines and material handling equipment to done the product movement process.

One of the sectors in manufacturing industry is the precision manufacturing. Precision manufacturing is regarded as really important nowadays. Products that been produced by

a company currently, had some parts of the products been produced by other company, also called vendor. This business transaction occur because the company that produced the main products didn't had the equipments and expertise to produced the parts, and also because they had done the business strategy in order to maximize the profit and had a subordinate to produces several products parts for them. Hence, precision is really needed to the parts that been produced from a vendor in order to produced a main products of the main manufacturer.

The used of materials handling device in order to transfer parts and machined equipments to the production places are really important, not only in precision manufacturing, but also others manufacturing products. Material handling devices such as carts and trucks are widely used in manufacturing industries. The common material handling devices used in manufacturing industry is hand pallet truck (HPT). HPT been used usually to transfer or moved products with pallet from a location to another. As increased of production in order to compete with other competitor, the needs to transferring products had to be faster and smooth. Besides that, the load for each pallet had been increased in order to maximize the production of products. This had increased the workers jobs and had cause injuries and problems known as musculoskeletal disorders (MSDs). Therefore, ergonomics solutions had been taken and used in order to prevent this problem by designing the material handling device that will effectively reduced the muscular work from the workers.

By using the integration of ergonomics assessment analysis and Quality Function Deployment (QFD), workers expectations and requirement for the handling device that suits to them can be designed. This based on voice of customer that been used as one of the parts of house of quality of QFD. The voice of customer are then been transmit into technical specifications and the essential requirements of customer can be determined. Hence, it can be useful to improve their works and reduce accidents and muscular

problems towards them. This chapter provides an overview of the research project titled Redesign of Hand Pallet Truck for Manufacturing Industry using Integration of Ergonomics Analysis and Quality Function Deployment (QFD).

## **1.2 Problem Statement**

Many risks factors related to the increase of MSDs are commonplace in manufacturing industry tasks. Mass production and service in industry have placed a burden of manual material handling on workers (Myung, C.J. et al., 2005). In order to reduce the problem, organization has provided manual material handling devices, such as carts, trucks, wheelbarrows, and others. The use of such vehicles was shown to be efficient as an operator needs to expend only about 12 cal/min extra energy per kilogram of load (Haisman et al., 1972; Datta et al., 1978, 1983). However, several problems related to material handling devices were identified as follow:

(a) Recent studies reported that material handling devices (carts, trucks, wheelbarrows, and others) have caused suffering and injuries to workers in various industries because the misuse of such vehicles or use of poorly designed vehicles increased the risk of musculoskeletal problems (Myung, C.J. et al., 2005).

(b) Strains, sprains, and bruises were identified as major injuries associated with pushing and pulling trolleys and carts (Health and Safety Executive, 2002).

(c) The Liberty Mutual Research Center for Safety revealed that overexertion, comprising of injuries due to lifting, pulling, holding, carrying or throwing of an object, was the number one cause of workplace injuries in 2002 and ranked among the top five during the proceeding years (Fredericks, T.K., et al, 2007).

Therefore, to provide solutions for the above problems, it is essential to integrate ergonomics analysis and QFD at the design stage so that the device will be accommodated the requirement and satisfaction of users as well as providing safety to them.

### **1.3 Project Objectives**

In recognition the importance of above mentioned problems, this project tries to achieve the following objectives:

(a) To determine the needs of workers regarding to the design of hand pallet truck for materials handling activities.

A survey was conducted among the workers in their usual workplace which requiring them to use hand pallet truck to transfer materials or products in the production plant.

(b) To redesign the existing hand pallet truck to improve working posture.

By considering the input from the workers, the existing hand pallet truck was redesigned and solutions are proposed to improved occupational health of workers.

(c) To evaluate the effectiveness of the redesigned hand pallet truck

The redesigned hand pallet truck was evaluated to determine its effectiveness. This is essential to ensure the proposed design able to offer safe and comfort to the workers so that in the long run, the occupational

health and productivity of manufacturing industry could be increased and more competitive in the new industrialization world.

#### **1.4 Scope and Limitation of Project**

The study is focus on material handling activities in manufacturing industries activities. The precision manufacturing industry was selected to be observed on manual material handling activities and the use of material handling device for particular activities. A device, HPT had been selected for the study and it was redesigned to improve the workers requirement and comfort. The study of HPT is focused only at the production area of the case study which involved the manipulated tasks such as pushing and pulling activities. One type of precision manufacturing product load with pallet or cage that contains the load is studied in order to determine the effectiveness and capability. The proposed design may found to be an effective solution to enhance materials handling activities. Nevertheless, the implementation of proposed design is depended on company's willingness to deploy the solution. In addition, the company is free to make decision whether to accept the proposed design.

#### **1.5 Potential Benefits of Study**

The conducted study offers potential benefits to the following parties:

- (a) Industry
  - (i) The findings or design in the study can be used by the industry to improve their material handling activities.

- (ii) The design may reduce musculoskeletal disorders against the workers who use HPT as device for their material handling activities.
  - (iii) Improves the occupational safety and health for material handling activities in industry.
- (b) University
- (i) The study can be used as a reference for academic studies related to material handling device especially in ergonomic design approach.
  - (ii) The study would give an idea for the future researcher to improve the proposed designed that been produced from this study.
- (c) Student / Country / Society
- (i) The study may enhance student's skills in handling a project and improve their attitudes and soft skills when developed this study.
  - (ii) May provide suitable alternatives for the society that want to used material handling device that gives a concern on ergonomics factors.

## **1.6 Report Outline**

This study is divided into six chapters. Chapter 1 is generally about the introduction which consists of problem statements, objectives, scope and limitations of study, potential benefits of study and the study outlines. Chapter 2 is the literature review. Based on the reference gathered, this chapter discusses the definition and the introduction to the key words which are the ergonomic design, material handling device,

quality function deployment and manufacturing industries. Chapter 3 describes the methodology adopted in the study about the methodology. In this chapter, it discussed the project methodologies that were used to collect the relevant data to support the development and analysis of the study. Chapter 4 discusses about the case study, where the study was conducted and what the device or item that was studied. In chapter 5 and 6, which discussed about results and discussion, results will go through the development of the study on material handling device and the evaluation of the effectiveness of the proposed design compared to existing design. In chapter 7, it will give conclusion of the whole project with the recommendations to improve the manual materials handling activities and finally in chapter 8, the recommendation to improve the study in the future is describe and determine.

### **1.6.1 Report Structure**

The structured of this report is shown in Figure 1.1