

REDESIGN OF A CRADLE FOR AIRCRAFT MAINTENANCE
USING ERGONOMICS ANALYSIS AND QUALITY
FUNCTION DEPLOYMENT (QFD)

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By

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ABSTRACT

This report is prepared to explain the result of study on Redesign of a Cradle for Aircraft Maintenance using Ergonomics Analysis and Quality Function Deployment (QFD). The focused company for this study is CTRM Aviation Sdn Bhd, Melaka. This is a study of a cradle that been used to help the workers do the job under valley side on aircraft. It focused on assessing the working posture of workers while they performing composite repair. The objective of the study is to improve working posture by using a cradle while performing the aircraft maintenance. To achieve the objective, the integration of Quality Function Deployment (QFD) and Ergonomic Analysis were adopted to ensure the improved design of cradle able to meet worker's requirement and provides safe working posture. The working posture was analyzed by using RULA analysis. Based on the analysis of the working posture, the existing cradle provides 4 score for left worker's body while 5 score for right worker's body. Beside that, from the improvement done on the cradle the results are 3 score for left and right worker's body. The collected data are analyzed and been compared to the current design in order to get the best proposing design to reduce the awkward working posture. For the conclusion, is recommended to use the proposed design of cradle than existing cradle because it is prepared the worker's for safe working posture while performing aircraft maintenance.

ABSTRAK

Laporan ini disediakan bagi menerangkan hasil keputusan daripada kajian tentang merekabentuk semula 'penyokong badan' untuk penyelenggaraan pesawat ringan dengan menggunakan analisa ergonomik dan Penempatan Fungsi Kualiti (QFD). Syarikat yang telah dipilih adalah di CTRM Aviation Sdn Bhd, Melaka. Projek ini adalah kajian tentang penggunaan 'penyokong badan' yang beroperasi membantu untuk melakukan kerja di bawah rangka pesawat ringan ini. Lebih khusus lagi, ianya fokus kepada penilaian tentang postur badan pekerja semasa melakukan tugas penyelenggaraan. Tujuan kajian ini dilakukan untuk memperbaiki postur pekerja dengan menggunakan 'penyokong badan' semasa aktiviti penyelenggaraan pesawat ringan. Untuk mencapai objektif kajian ini, gabungan antara Fungsi Mengatur Kualiti (QFD) dan Analisis Ergonomik telah diadaptasikan untuk memastikan rekabentuk 'penyokong badan' memenuhi keperluan pekerja dan seterusnya menyediakan postur bekerja yang selamat. Postur pekerja dianalisis menggunakan RULA analisis. Berdasarkan analisis yang dilakukan, 'penyokong badan' yang sedia ada menunjukkan skor 4 bagi bahagian kiri badan pekerja manakala bagi bahagian kanan badan pekerja ialah skor 5. Selain itu, dari pembaikan daripada 'penyokong badan' menunjukkan skor 3 pada bahagian kiri dan kanan badan pekerja. Data terkumpul kemudiannya dianalisis dan dibandingkan dengan rekabentuk asal dengan tujuan untuk mendapatkan rekabentuk terbaik untuk mengurangkan ketidakselesaan postur badan pekerja. Kesimpulannya, rekebetuk yang dicadang digunakan kerana ia menyediakan postur bekerja yang lebih selamat semasa melakukan aktiviti penyelenggaraan pesawat ringan berbanding rekabentuk sebelumnya.

DEDICATION

Firstly, thank to Allah S.W.T for the opportunity to finish this project. I owe this project and my true happiness to my beloved parent. Since the day I started joining this University until today, they are very caring and supporting for me.

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Siti Aminah Bt Mat Yaakub

And for my respected brother and sisters:

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Mohd Zakri Bin Md Tahir

Zakiah Bt Md Tahir

Mohd Fakhruddin Bt Md Tahir

Siti Aisyah Bt Md Tahir

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

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

CHAPTER 1

INTRODUCTION

This chapter describes the information about background of study, problem statements, project objectives, scope and limitation, potential benefit of study, report outline and project structure.

1.1 Background of Study

The manufacturing industry is one of the sectors which give most profit for the country. The manufacturing industry includes sector that involve the all side of manufacturing product such as services, household product, metal product, machinery, equipment, aerospace, and etc. One of the sectors under manufacturing industry in Malaysia is aircraft manufacturing and services. The aircraft industry tries to fulfill the requirement of Malaysians with learn the technology on aircraft to improve the Malaysian aircraft industry. Normally, aircraft company manufacture and produce aircraft and provides services on aircraft that the company produce. In aircraft industry, the whole of aircraft body parts are critical and need a special instruction from the engineers during the maintenance.

Actually, most of manufacturing industry have material handling device in order to transfer part and machined equipments to the maintenance places. One of examples material handling device that is widely used in manufacturing industry is cradle. The cradle mostly used as a material handling device for aircraft maintenance when the service under valley side of aircraft is needed. Appropriate design of cradle is useful to improve the work quality and reduce injury risks to technicians. All the parts on the aircraft are critical and need attention during the maintenance session. To increase the work quality and achieve the maintenance schedule, the technicians should try to complete the work as per schedule, and at the same time, meet the terms of instructions from the engineers.

The used of materials handling device in order to transfer parts and machined equipments to the production and maintenance places. The used of material handling device also in order to help the workers and reduce the injured risks. Material handling device such as cradles and truck widely used in maintenances industries. Cradle been used usually to help the workers do the job at under valley side on aircraft. Beside that, during the job on aircraft the workers wide open with that task for a long time. That situation will be had cause the awkward posture and stress on workers. This had increased the workers jobs and had cause injuries and problems known as musculoskeletal disorders (MSDs). Considering the ergonomic analysis on material handling device had been taking to prevent this problem which designing the material handling device that more effectively that system reduce the muscular work by the workers. Beside that, technicians should be achieving maintenance schedule and quality of work.

The workers expectations and request for new material handling device with improvement that suit with their job. The improvement considering were preventing the musculoskeletal disorders (MSDs). The proper working postures are defined to improve the existing design of cradle. The design of material handling device through ergonomic principle can help technicians to perform for their job. Considering the technicians requirement should be generate in technical support during the evaluation by using the QFD analysis. From that, the technicians need during their job are considering in house of quality once of method in QFD. For this chapters, the research project that title Design of cradle utilizing Ergonomic Analysis and QFD as material handling device for maintenance in aircraft industry.

1.2 Problem statement

Generally, the manual handling of any loads during the working process in maintenance also impose heavy physical demands and biomechanical stress. Numerous investigations have demonstrated the association between unassisted manual material handling and increased risk of musculoskeletal injury (e.g. Ayoub, 1982; Chaffin and Park, 1973; Marras et al., 1993). To reduce the problem, the management has to provide the material handling device in order to reduce and minimize the problems. The invention of several types of material handling devices such as cradle, carts and trucks had provides support for human manual material handling task. However, there are still several problems that occur coincide with the material handling device, which are:

- a) Manual material handling and awkward back posture are important risk factor for low back pain (Burdorf and Sorock, 1997; Holmstorm et al., 1992a) and manual material handling has also been associated with complaints of neck and shoulder (Hoosemans et al., 2002)
- b) Manual material handling is the most frequent and costly category of compensable loss and is associated with the largest proportion of low back disability (Murphy and Courtney, 2000)
- c) Many workers suffer musculoskeletal injuries, often of the back when moving material. Material handling is associated with the highest rate of occupation-related back pain (Andersen, Schibye, & skotte, 2001; Daynard, Yassi, Cooper, Tate, Norman, & Wells, 2001; Engkvist, Kjellberg, Wigaeus, Hagberg, Menckel, & Ekenvall, 2001).

To provide solutions for the above problems, it is essential to integrate ergonomics analysis and QFD in the design stage so that the device will be met the requirement and satisfaction of users. This project will attempt to identify the difficulties in current design of cradle. The improvement will be started from analysis the existing cradle. This includes evaluation of performance until a proper design will be produced.

1.3 Project Objectives

In order to solve above mentioned problems, this project tries to achieve the following objectives:

- i. To assess the working posture of workers while they performing composite repair at under valley side on the aircraft.
A survey was conducted among the workers in their usual workplace which they always use cradle to assist them when doing the work task.
- ii. To redesign a proper cradle to improve working posture of the workers.
By considering ergonomics principle and the input from workers, the existing cradle will be redesigned and proposed to improve working posture of workers.
- iii. To evaluate the effectiveness of the proposed design.
The redesigned cradle will be evaluated to determine its effectiveness. This is essential to ensure the proposed design will offer safe and comfort to the workers so that in the long run, the occupational health and work quality could be increased.

1.4 Scope and Limitation of Project

This study is focus to describe the used of cradle for maintenance activities in aircraft industries. A manual material handling device, a cradle was studied for this current study and it was redesigned to improve the workers requirement and comfort. This study will assess during the composite repair focused at under valley side on the aircraft. The proposed design of cradle may lead to enhance the effective of material handling activities. This study may try to solve the problem of cradle about the working posture of human. This study evaluation try to prove the implementation of proposed design through ergonomic analysis may reduce MSDs on industrial workers. This study was not covered for material usage to manufacture the cradle. Nonetheless, the implementation of the new design will depend on company, to accept the solution.

1.5 Potential Benefits of Study

Throughout this study, more benefit can be obtained as an achievement from the study. The potential benefits of study can be offered to industry and university and they are described as follow:

Potential benefit to industry:

- i. To reduce the occurrence of musculoskeletal complaints and subsequent sickness absence against the workers that using cradle once of part their working activities.
- ii. To ensure the employee work out of stressed and that will improve the work quality and achieve work time schedule.
- iii. Improves the occupational safety and health during using material handling device for activities in included in an aircraft industry.

Potential benefit to university:

- i. This study can be referred by academician who interest to study that material handling device through ergonomics principles in aircraft industry.