ERGONOMIC INTERVENTION IN HARVESTING PROCESS IN OIL PALM PLANTATION

by

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Proses Penuaian Dengan Penerapan Ergonomik
Di Ladang Kelapa Sawit

ABSTRAK

Kebanyakan pekebun di industri kecil dan sederhana kelapa sawit menggunakan kaedah konvensional untuk melakukan kerja-kerja menuai. Oleh itu, mereka sangat terdedah kepada risiko kecederaan otot bahu yang merupakan salah satu masalah gangguan muskuloskeletal (MSDs). Merujuk kepada penilaian bahagian atas pantas (RULA), kerja-kerja penuaian konvensional sangat berisiko untuk terjadinya masalah otot bahu disebabkan postur tuaian yang ekstrem yang dilakukan dengan berulang-ulang dan menampung beban yang tinggi. Berdasarkan keputusan kaji selidik bahagian badan, terdapat 100% daripada responden terbukti mengalami masalah bahu. Oleh itu, matlamat projek ini adalah untuk mengenal pasti postur kerja yang sesuai seterusnya untuk merekabentuk alatan penuaian kelapa sawit dengan penerapan ergonomik bagi menggantikan penggunaan sabit bergalah panjang dalam kaedah penuaian konvensional. Kajian ladang yang komprehensif telah dijalankan dengan memberi tumpuan kepada postur tuaian konvensional dengan menggunakan Elektromyografi (EMG). Lima subjek lelaki menawarkan diri untuk menunjukkan postur tuaian dengan empat otot yang aktif bekerja telah dipilih dan direkodkan oleh EMG dan data isyarat kemudian diplot kepada plot taburan. Berdasarkan keputusan-keputusan tersebut, ungkapan analisis telah dibangunkan dengan asas postur penuaian yang betul dijadikan sebagai motivasi dalam merekabentuk alatan baru. Alatan penerapan ergonomik ini telah dibangunkan secara prototaip dengan sistem mekanisme. Satu penilaian ladang kepada prototaip telah dijalankan untuk memantau aktiviti otot dengan memberi tumpuan kepada otot yang dipilih dengan menggunakan EMG. Pekerja ladang yang telah menawarkan diri dipilih secara rawak untuk menunjukkan proses menuai. Keputusan kajian menunjukkan pengurangan aktiviti otot yang dipilih berbanding dengan kaedah konvensional kerana penambahbaikan postur badan semasa melakukan kerja. Analisis Aktiviti Manusia (HAA) adalah kajian untuk menyiasat postur pekerja ladang semasa melakukan kerja penuaian konvensional dan alatan penerapan ergonomik. Terdapat lima bahagian badan yang disimulasikan iaitu: L4-L5 mampatan, mampatan beban badan, paksi pusingan mampatan, lenturan / sambungan mampatan dan L4-L5 sambungan ricih. Disamping itu, RULA juga menunjukkan perincian yang lebih baik yang merupakan satu lagi bukti yang kukuh dalam menambahbaik postur badan semasa kerja penuaian dengan kaedah baru ini. Sebagai rangkuman, bantuan daripada prototaip ini dalam proses menuai kelapa sawit adalah dicadangkan memandangkan data kajian yang diberikan ianya mampu mengurangkan risiko sakit otot bahu. Kajian ini juga menggalakkan kepada penghasilan inovasi dalam merekabentuk peralatan baru untuk meningkatkan prestasi pekerja agrikultur.

Ergonomic Intervention Harvesting Process
In Oil Palm Plantation

ABSTRACT

Most farmworkers in the small and medium Oil palm industry are using conventional method for harvesting works. Therefore, they are extremely exposed to the risk of shoulder muscle injury which is one of the musculoskeletal disorders (MSDs) problems. Referring to the Rapid Upper Limb Assessment (RULA), conventional harvest works was highly risk to undergo shoulder muscle problem due to extreme harvest posture with the repetitive and high of loading. Based on the body score result, there were 100% of respondent proven suffering shoulder problem. Hence the aim of this project is to identify proper working posture with design of palm oil harvesting ergonomic intervention device in order to replace the use of long arm sickle in conventional harvest. A comprehensive field study was conducted which focusing on conventional harvest posture by using Electromyography (EMG). Five male subjects volunteered to demonstrate these harvest posture conditions with four selected muscle activity and recorded by EMG and the signal data then plotted into scatterplot. By these findings, the analytical expression developed with proper harvest posture basis as a motivation in designing the intervention. The intervention is developed into prototype with mechanism system. A prototype field evaluation has been conducted to monitor the muscles activities with focus on same selected muscle by using EMG. Volunteered farmworkers is randomly picked to demonstrate the harvesting process. The result shows reduction of selected muscle activity as compared to the conventional method due to working posture improvement. The Human Activity Analysis (HAA) was study to investigate the posture of the farmworkers during conventional and intervention harvest. There are five body conditions were simulated: L4-L5 compression, body load compression, axial twist compression, flex/ext compression and L4-L5 joint shear. Besides, the RULA's also shows better score as concrete evidence in improving body posture during harvesting work with this new method. As conclusion, optimized working posture along with the assistance of intervention prototype in oil palm harvesting process is suggested since the data provided in this research shows it could decrease the risk of shoulder muscle pain. This research also encourage of generating the innovation in designing new tools to increase the agriculture workers performance.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter describes the general background of the present study. First, it will address the research motivations behind this study, which discusses the ergonomic awareness in Malaysian agricultural industry and current issues in conventional oil palm harvesting. Then, the problem statement is discussed, which focuses on farm workers' stooped posture and biomechanical back load handling issues. Next, the research objectives are outlined, followed by the research scope that serves as the guideline in this study

1.2 Oil Palm Harvesting Process

Fresh fruit bunch (FFB) harvesting is a critical operation in oil palm production. Workers normally done of harvesting FFB by using chisel and sickle for different age of trees. Workers could be attaining a height of 1 – 3.5 meter palm trees for 3 - 4 acre in 2 – 3

weeks after planting period for harvesting and pruning. Thereafter, the fronds should be pruning every week to ensure the quality of the FFB.

Harvesting of short palm trees is normally done using a chisel fixed to a short steel pole or a sickle with a long pole for tall trees as shown in Figure 1.1. The harvester requires enough space around the trees to produce sufficient momentum to throw the tools for short trees and to slice and pull with the tools for tall trees. The sharpness, shape and profile of the tools contribute to the effectiveness of the cutting operation.

These jobs involve high levels of physical work due to the long repetitive working hours by workers. The oil palm harvesting and pruning process in Malaysia for most small and medium entrepreneur is undertaken conventionally, relying totally in physical manpower. Workers use typical tools for oil palm harvesting due to its low cost method that does not require a highly skilled workforce.

Figure 1.1: The conventional Oil Palm harvesting using sickle and chisel

1.3 Problem statement

Current Oil palm harvesting and pruning technique is not practically ergonomic due to the stooped posture of farm workers during the process and the total reliance on manpower without assistant devices. Stooped posture will expose the workers to musculoskeletal disorders (MSDs) of the back and shoulder muscles including forceful exertions such as pushing and pulling, and awkward shoulder postures and motion. These symptoms cause muscle weakness, fatigue and also stiffness among oil palm workers. Since the back muscle injury might cause low back pain (LBP) disorder, it can also be the main source of vertebrate disc damage (Kristen, 2006; Lars and Carlo, 2003; Dedering et al., 2000, and Lariviere et al., 2000). Anem, (2012) found that the conventional technique was never considered to be the proper method to handle back biomechanical load because low back muscular fatigue can occur. Furthermore, the direct contact between the limbs of the farm workers with sickle or chisel during harvesting causes maximum vibration impact to the muscular system which would then contribute to muscular fatigue as well (Schafer et al., 1984). During long durations of direct vibration exposure, along with pain on the muscular system due to poor working posture, the movement activities of farm workers would slow down, requiring frequent rest intervals as the harvesting work is done. Thus, this will contribute to decreasing productivity rate. Research to find better solutions must be pursued to overcome the biomechanical factor that is proven to impact the working posture and back load handle of workers. Evaluation of harvesting work to introduce optimum working posture instead of the conventional method may help to decrease back pain disorder risk in the oil palm industry. In order to reduce musculoskeletal disorders

(MSDs) among farm workers during oil palm harvesting, new intervention devices or tools will be designed and fabricated. Figure 1.2 shows the causes and effects diagram for existing oil palm harvesting process.

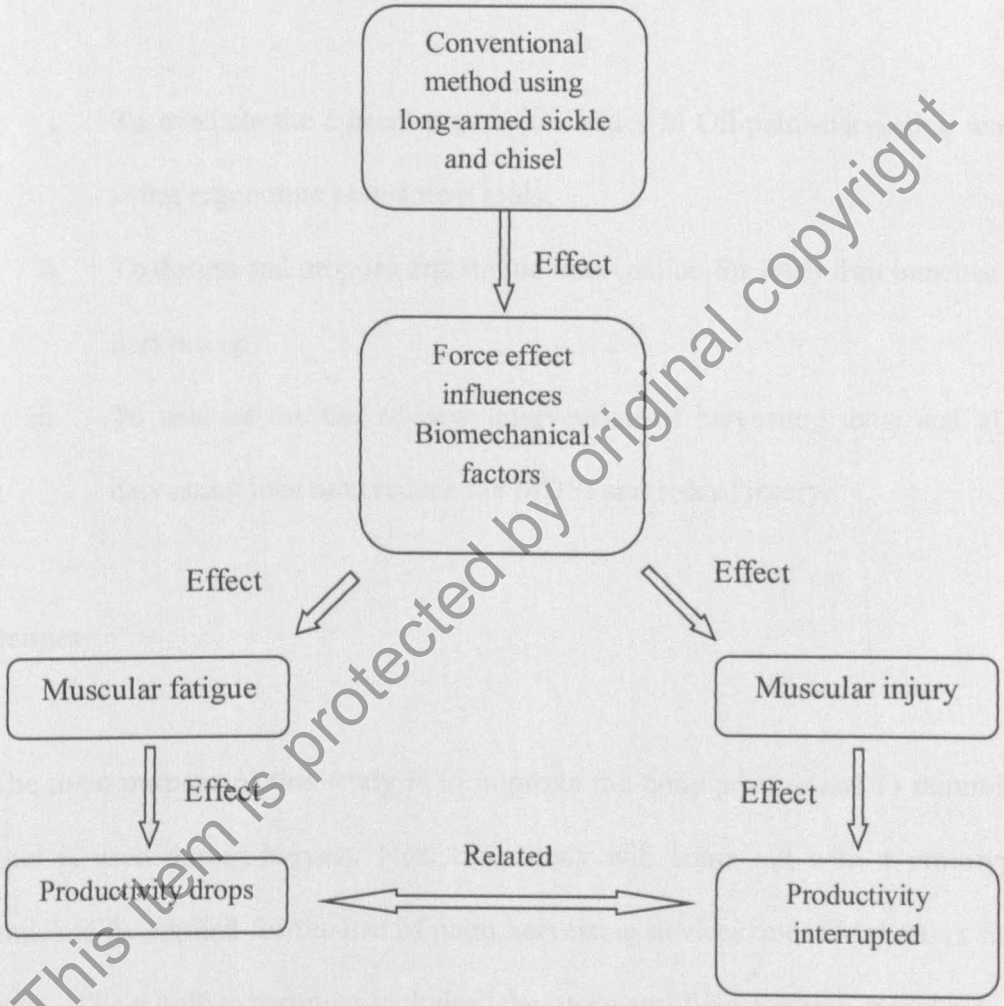

Figure 1.2: Causes and Effects Diagram for Existing Oil Palm Harvesting Process, Roejhan et al. (2015)

1.4 Objectives

This project aims to investigate the human working posture and back load handling during harvesting work. Therefore, the main objectives of this study are:

i. To evaluate the current ergonomic issues in Oil palm harvesting works by using ergonomic assessment tools.
ii. To design and propose ergonomic intervention for fresh fruit bunches (FFB) harvesting.
iii. To analyze the use of new intervention of harvesting tools and to assist harvesting jobs next reduce the MDSs and risk of injury.

1.5 Scopes

The main purpose of this study is to improve the body posture and to minimize the force that is used during harvest. Next, this study will come out with a prototype for ergonomics to be applied for the use of palm harvesting devices under Malaysia's farming conditions. The whole experiment includes laboratory and field research in order to attain comparable data. These experiments include farm workers who volunteered and focuses on palm trees with a height of 3 to 4 meters. Some considerations and scope that were applied during the implementation of this study are explained as follows:

i. Explored the influences of physical work exposure on musculoskeletal symptoms among farmworkers by using Extended Nordic Questionnaire and Rapid Upper Limp Assessment (RULA) and data analysis was conducted using Human Activity Analysis (HAA)

ii. Investigate symptoms and MSDs risk among farmworkers by using electromyography (EMG) equipment.

iii. Design new ergonomic intervention concept with Solidwork software using Anthropometry data.

iv. Finally based from the simulation, developed a prototype of the harvesting device and compare it with conventional tools.

1.6 Thesis Organization

This thesis consists of five chapters as follows:

Chapter 1: This chapter provides the brief introduction of study, deliberation of issues that are mapped during the study foundation: the research motivations; the statement of research problem; the research objectives; the research scopes; and the thesis organization.

Chapter 2: This chapter describes the literature surveys related to the theory reinforce element applied in the project. It includes reviews of comprehensive investigation on oil palm harvesting techniques, ergonomic awareness in Malaysian agriculture industries, and knowledge of musculoskeletal disorders (MSDs). The importance of Nordic

questionnaire, the study of human biomechanics on agriculture from previous researches are also covered in this chapter.

Chapter 3: This chapter provides detailed explanation regarding the methodology used in the study. There are three steps in the main phases to be completed; investigation on existing system, human posture recognition, and intervention development. Each phase is further divided by main and sub activity. The investigation on existing system is essential to identify, gather and classify the real problems to be solved comprehensively.

Chapter 4: This chapter discusses postural field experimental work including the methods employed. The experimental work is used to determine the optimum human working posture. This chapter also provides digital and graphical data as mediums to be analyzed before designing the appropriate harvesting technique and devices. In order to validate the experimental data, this chapter describes the methods and the implementation of intervention work in real condition during oil palm harvesting using new the approach. The new approach and method is generated based on previous studies. Additionally, this chapter discusses the comprehensive result and analysis of entire experimental findings exclusively. To achieve the niche area of the project, comparative analysis of methods and techniques of oil palm harvesting were performed.

Chapter 5: This chapter deliberates on the conclusion and recommendations for further research are then postulated.

1.7 Summary

This project intends to examine the human posture during oil palm harvesting. Also, it intends to design a prototype harvesting tool that emphasizes on ergonomics. In addition, it will rely on analysis to minimize problems associated with oil palm harvesting and proposes further improvement to the oil palm industry. The proposed improvements may be applicable in the industry for its future growth.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter describes relevant literature to further reinforce the theory applied in this study. It begins with a description of oil palm, followed by an explanation of the oil palm harvesting process and previous methods used for harvesting. Then, an explanation of musculoskeletal disorders (MSDs) is presented, including the specific definition and causes of contribution. Some reviews regarding the previous studies and investigations by other researchers on human biomechanical and general posture related to MSDs are also included in this chapter to address the current issues in this field. There are five human task conditions in the workplace that can potentially cause muscle fatigue: (1) heavy physical work; (2) Lifting and forceful movement; (3) bending and twisting or awkward posture; (4) body vibration; and, (5) static work posture. Next, Nordic Questionnaire is used as one of the biomechanical and ergonomic indicator tools.

2.2 Oil Palm Fruit

The oil palm is a tree with many leaves at its tops, without any branches as shown in Figure 2.1. Generally, conventional harvesting system such as the shake-catch system is used to harvest fresh fruit bunch (FFB). The period of harvesting is every 10 – 15 day or 2 – 3 weeks as FFB ripens throughout the year. The stalks of the palm fronds underlying a bunch are cut first, after that the bunch is cut and is allowed to fall freely onto the ground. FFB that are fully ripe will loosen itself from the bunch and drop on the ground with ease, according to C. Nwajiuba and Akinsami (2003).

Figure 2.1: The Oil palm Tree with Fresh Fruit Bunch