UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN, ANALYSIS AND DEVELOPMENT OIL PALM LOOSE FRUITS COLLECTOR DEVICE

This report is submitted in accordance with the requirement of Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

by

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

Herdy Rusnandi

(Project Supervisor)

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ABSTRAK

Malaysia adalah penghasil and pengeksport minyak sawit terbesar di dunia. Malaysia merupakan pengeksport minyak sawit utama dunia sebanyak 60% bahagian pasaran. Dalam usaha demi meningkatkan produksi industri minyak sawit, proses penuaian adalah merupakan satu proses yang perlu dititikberatkan. Mengenai dengan proses penuaian, teknologi baru telah diguna pakai dan mesin mekanikal di perkenalkan untuk tujuan meningkatkan produktiviti pekerja. Teknologi dan mesin mekanikal ini akan menggantikan kaedah konvensional di kalangan pekerja dalam proses penuaian terutamanya untuk mengutip buah sawit lerai. Ini kerana, kaedah konvensional sama ada mengutip menggunakan tangan atau alat pengaut adalah tidak berkesan, membuang masa, menjurus kepada masalah sakit belakang dan tidak selamat. Objektif projek ini, adalah untuk mereka bentuk satu alat pengutip buah sawit lerai yang berkesan dan ergnomik, dengan itu produk ini dapat menyelesaikan semua masalah yang berlaku semasa menggunakan kaedah konvensional. Dalam mencapai objektif projek ini, beberapa proses telah dilaksanakan mengikut urutan bermula daripada definisi masalah, konsep reka bentuk, pemilihan reka bentuk, reka bentuk terperinci, fabrikasi, ujian dan penilaian. Melalui reka bentuk "CAD", dua bahagian telah dipilih sebagai bahagian yang kritikal telah dianalisis tekanan Von Mises yang maksimum dan jarak perubahan yang maksimum menggunakan analisis generatif struktur untuk mengetahui kekuatan bahagian tersebut. Ujian kaedah telah dijalankan antara tiga kaedah mengutip buah sawit lerai. Keputusan Ujian telah ditakrifkan dan dianalisis dengan membezakan pencapaian produktiviti yang maksimum dan kutipan serpihan yang minimum diantara tiga kaedah yang telah digunakan. Kesimpulannya, alat pengutip buah sawit lerai telah dibina sebagai prototaip yang berfungsi.

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ABSTRACT

Malaysia is the world's largest producer and exporter of oil palm. Malaysia is now the world's leading exporter of palm oil with 60% market share. In order to increase the production of oil palm industry, harvesting is one of the important processes that need to be considered. Regarding to the harvesting process, new technology is adopted and mechanical machinery is introduced purposely to increase the worker productivity. This technology and mechanical machinery will replace the conventional method among the workers in harvesting process especially for collecting oil palm loose fruits. This is because the conventional method either hand picking and raking are inefficient, time consuming, lead to back pain problem and unsafe. The objective of this project is to design a device for picking the oil palm loose fruits efficiently and ergonomics. Thus, this product can solve the problems occur while using conventional method. In order to achieve the objective of this project, a few process were carried out by following sequences starting from the problem definition, conceptual design, design selection, detail design, fabrication, test and evaluation. From the CAD design, two parts has been chosen as critical part in which it has been analysed their maximum Von Mises stress and maximum displacement of deformation by using generative structural analysis to know the strength of the parts. Method testing had been carried out among the three methods of collecting oil palm loose fruits. The results had been interpreted and analysed by comparing the maximum productivity achieved and minimum debris collected among three methods used. In conclusion, the oil palm loose fruits collector device was developed as a functional prototype.

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DEDICATION

To my beloved parents

Nazari Bin Ahmad
Rozila Binti Mohd Noh

Thank you for all supports, sacrifices, patient and willing to spend your time for me.

To my honoured supervisor,

Herdy Rusnandi and all UTeM lecturers

Thank you for always show me the guidance and persistence in helping to complete this project thesis.

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CHAPTER 1
INTRODUCTION

1.1 Project Background

Over the years, Malaysia is currently the world's largest producer and exporter of oil palm. In agriculture industry, oil palm well known as major source of vegetable oil (edible oil). According to Wahid et al., (2005) who stated that in 2001, Malaysia and Indonesia was the major centre of production in South East Asia (SEA) accounting for around 83% of world palm oil production and Malaysia is now the world's leading exporter of palm oil with 60% market share. Palm oil also is exported to West Asia, Pakistan, Japan, Singapore, European Union and Chinese.

Harvesting is an important process that directly increases the production of oil palm industry. Harvesting uses high percentage of the work force which is 60% compare to production cost which is 50% (Jelani et al., 2008). That means a huge amount of labour is needed in harvesting process in order to increase the production of oil palm. There are some problems in harvesting process, one of the problems is collecting the loose fruits on palm base. The conventional method is widely practiced in plantation. It is normally done manually by hand picking, raking, scrapper and net (Awaludin, Salim, & Ali, 2016). The labours need to sit, squat and bow their body in order to collect loose fruits on ground and need to move from one tree to another tree.

In order to increase the labour productivity, the new technology has been adopted and mechanical machinery has been introduced. The main purpose of using machine in oil palm plantations is to perform tasks while reduce the burden of labours at the same time speed up the harvesting operation. According to Wahid et al., (2009) machine created in order to reduce the time for harvesting, FFB evacuation, loose fruits collection, fertilizer application, and field up keep and pesticide application. Recently,

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many types of harvesting technology are invented such as hand-held mechanical cutter, telescopic and elbow type arm harvester, CANTAS, automatic cutting system, manipulator automation for mechanical harvester, pruner and harvester machinery (Nawi, Deros, & Nordin, 2014).

Palm oil loose fruits collector device is created and experimented to achieve objective of this project. Palm oil loose fruits collector device is a product that to collect loose fruits at the palm base in mechanical method. It is light, portable and easy to be brought anywhere. The design of the device is targeted as easy to be used, easy to repair with less maintenance cost. In order to achieve the lower cost of manufacturing and fabrication, the design of product must be simple but can be function well and by using the existing material or product to create a new function of product.

1.2 Problem Statement

Basically, during the process of harvesting the matured oil palm fruits, there are a lot of loose fruits dropped. Those loose fruits contain high oil amount, therefore the loose fruits need to be collected to increase the profit of the oil palm industry. The current method for collecting oil palm lose fruits are usually by hand picking or raking.

The conventional method is highly used among the labours in palm oil plantation. Hand picking and raking was inefficient way in order to collect oil palm loose fruits. This is because the body movement of the labours will creating an injurious to labours' body parts especially back pain. The back pain problem happened because they need to sit, squat, and bow in long period of time.

In addition, the conventional method is also time consuming because the labours need to collect the loose fruits one by one. Other than that, time has been

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wasted in order to move from one tree to another tree. Therefore, extra labours is needed to reduce the time consuming.

1.3 Objectives

i. To design a device for picking an oil palm loose fruits efficiently.

ii. To analyse the mechanism and the strength of the critical part of the device.

iii. To develop the functional prototype of the device.

iv. To conduct a real test of the product in the field.

1.4 Scopes

i. Designing the device by using CATIA Software.

ii. Analysing the strength of critical parts of the device by using CATIA V5 software.

iii. Fabricating the functional prototype of the device.

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iv. Testing the prototype of the device in some oil palm plantation's field.

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CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter review about the existing oil palm loose fruits in harvesting process and the method used for collecting oil palm loose fruits process. The method is including the conventional method and also the current technology used.

2.2 Palm Fruits

Oil palm fruits can be categorized into several types. There are three oil palm categories of palm fruits that are mainly selected for economic production which are Dura, Pisifera and Tenera (Verheye, 2010).

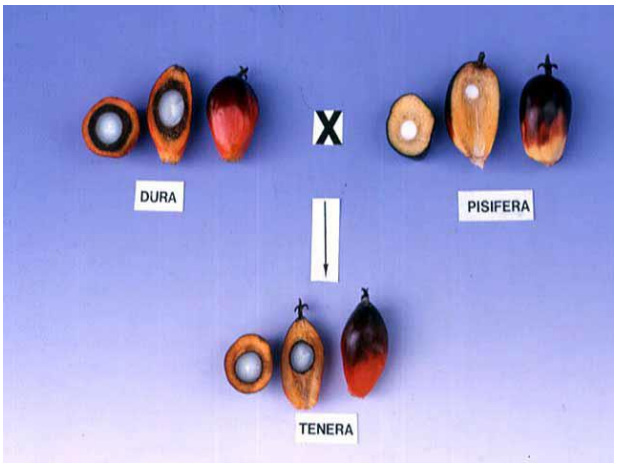

Figure 2.1: Types of oil palm fruits (WWF, 2002)

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2.3 Loose Fruits

Oil palm loose fruits are the fruits scatted around the palm based because of an impact and Fresh Fruits bunch ripeness due to harvesting process of Fresh Fruits Bunch. Figure 2.2 shows Fresh Fruit Bunch falls to ground and causing the oil palm loose fruits scatted around the palm base within distance about 1.5 to 2.5m.

Oil palm loose fruits (Figure 2.3) are normally left in the fields uncollected during the harvesting process. Losses are estimated to be more than 80,000 tons of crude palm oil even 1% of the loose fruits are not being collect ("Design and Development of an Oil Palm Loose Fruits Machine," 2000). Therefore, if the oil palm loose fruits is not collected, for sure it will reduce the profit opportunity to the palm oil industries.

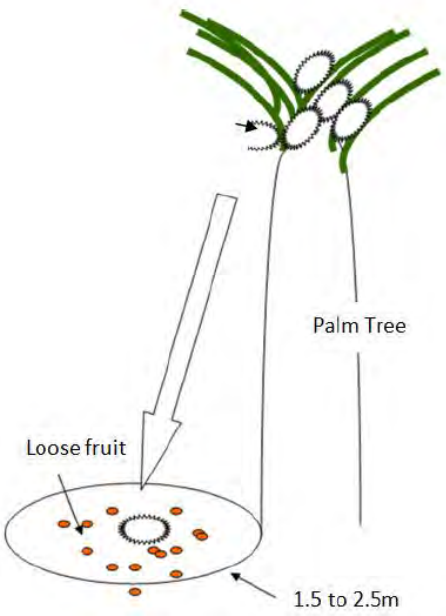

Figure 2.2: Fresh Fruit Bunch Falling to Ground (Awaludin et al., 2016)

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Figure 2.3: Oil Palm Loose Fruits

(Retrieve From: Http://Www.Unitedplantations.Com/Public/Giving_Back.Asp)

2.4 Harvesting

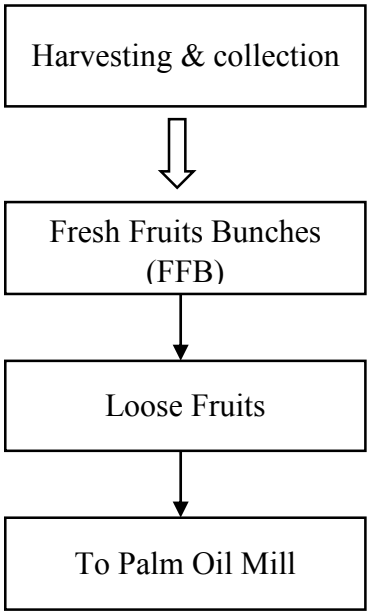

Figure 2.4: Processes in Harvesting and Collecting Oil Palm Fruits

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Figure 2.4 shows that processes in Harvesting and collecting oil palm fruits starts from harvest the Fresh Fruits Bunches (FFB), then collecting the Loose fruits (LF) and transferred to Palm Oil Mill. The time from flowering to harvesting of ripe fruits is about 5-6 months. A bunch of a mature palm contains 1000 to 4000 fruits, depending on the tree's age and vigor (Verheye, 2010). Harvesting process begins about 24 to 30 months after field planting and each palm can produce between 8 to 15 fresh fruit bunches (FFB) per year weighing about 15 to 25 kg each (WWF, 2002).

The harvesting of fresh fruits bunches is done manually by using chisel for short palms and a sickle mounted on a bamboo or aluminium pole for the taller palms. Harvesting of short palm as in Figure 2.5 requires the worker to throw the tool with great force and high speed towards the target. However, the important role that ensures the efficiency of cutting is the angle of cutting plays. For the harvesting of tall palms as in Figure 2.6, it requires a different technique which are lifting and cutting. These two techniques require high skill and energy ("Design and Development of an Oil Palm Fresh Fruit Bunch Cutting Device Abdul Razak Jelani," 1997).

Figure 2.5: Harvesting Short Palm Tree

(Retrieve from: <http://dopr.gov.in/digital%20library/harvest.htm>20/5/17)

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Figure 2.6: Harvesting Tall Palm Tree

(<Retrieve from: http://dopr.gov.in/digital%20library/harvest.htm>20/5/17)

About 30% of the harvest time is used up for the oil palm loose fruits collection. Currently, most of the oil palm loose fruits are collected manually by conventional method such as hand picking or raking. It has been estimated that the capacity for manual collecting of loose fruits is about 1.2 kg/min ("Design and Development of an Oil Palm Loose Fruits Machine," 2000). After the collecting process, the loose fruits are transferred to the road side by wheelbarrow. Then the collected oil palm loose fruits will be transported to oil palm processing mill by lorry.

The conventional method of the loose fruits is found to be time consuming and lead to the back pain problem of the workers as in Figure 2.7. In addition, conventional method by using raking will contain high trash such as stone, debris, soil and other matter which absolutely reduce the quality of crude palm oil (Awaludin et al., 2016). Figure 2.8 shows the trash contain in loose fruits collected.

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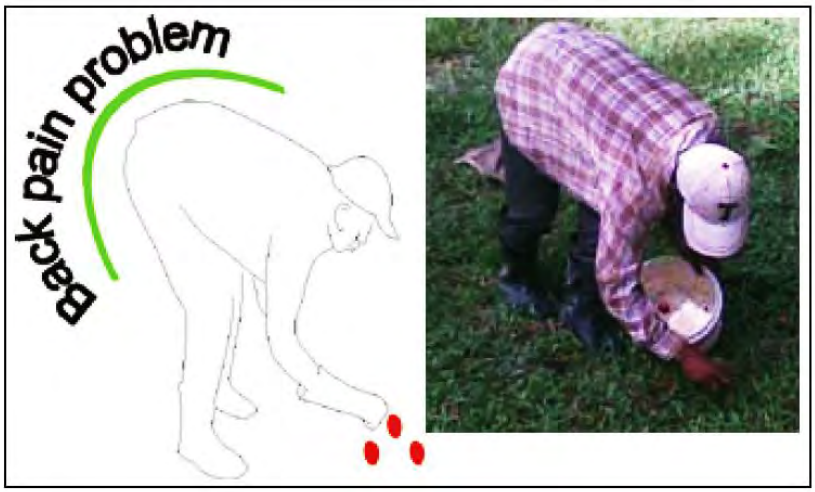

Figure 2.7: Conventional Method Of Collecting Loose Fruits In An Oil Palm Estate By Hand (Mohd Solah & Rahim, 2009)

Figure 2.8: Trash Contain In Loose Fruits Collected (Awaludin et al., 2016)

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