UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND ANALYSIS OF CHUTE AND LOADER SYSTEM FOR A FARMING VEHICLE

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

by

GOMER BIN RUMAI

B071310944

920216-12-5737

FACULTY OF ENGINEERING TECHNOLOGY

2016

© Universiti Teknikal Malaysia Melaka

DECLARATION

I hereby, declared this report entitled "Design and Analysis of Chute and Loader System for a Farming Vehicle" is the results of my own research except as cited in references.

Signature	:	……………………………..
Author's Name	:	Gomer Bin Rumai
Date	:	28/12/2016

© Universiti Teknikal Malaysia Melaka

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 Degree of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

………………………………

(Mr. Herdy Rusnandi)

© Universiti Teknikal Malaysia Melaka

ABSTRAK

Sejak sedekad yang lalu, permintaan global untuk minyak sayur-sayuran telah berkembang dengan kukuh disebabkan oleh peningkatan dalam penggunaan minyak dan peningkatan penduduk dunia. Negara Malaysia telah memberi tumpuan kepada industri kelapa sawit ini sejak tiga dekad yang lalu kerana ia adalah sumber utama bahan mentah yang mampan dan boleh diperbaharui bagi industri makanan, oleo-kimia, dan bahan api bio. Pada masa kini, masalah yang timbul adalah Fresh Fruit Brunches (FFB) yang rosak disebabkan kesan jatuh ke tanah semasa proses penuaian, pengumpulan dan pengangkutan. Selain itu, buah sawit yang jatuh bertaburan di atas tanah juga merupakan salah satu masalah yang perlu dikumpul dan dihantar ke stesen pengumpulan. Dengan ini, Combined Harvester Mesin yang dilengkapi dengan sistem chute dan loader, ia akan mengurangkan FFB daripada rosak kerana ia jatuh ke pelongsor dan pergi terus ke dumper mesin. Tambahan pula, buah sawit yang bertaburan di atas tanah boleh dimuatkan pada dumper mesin juga. Tujuan kerja tesis ini adalah untuk merekabentuk sistem chute dan loader untuk kenderaan pertanian. Sebuah kenderaan pertanian dikenali sebagai Combined Harvester Mesin adalah terdiri daripada lapan bahagian utama yang system chute dan loader adalah salah satu daripadanya. Berdasarkan reka bentuk konsep, reka bentuk yang sesuai untuk sistem chute dan loader akan dipilih untuk di lukis dalam perisian CATIA. Terdapat kriteria yang perlu diambil kira untuk sistem chute dan loader sebelum digunapakai dalam Combined Harvester Machine. Kesimpulannya, sistem chute dan loader daripada Combined Harvester Mesin boleh menambahbaik dan mengekalkan kualiti FFB sebelum proses selanjutnya dalam Mills of Oil Palm (MOP).

© Universiti Teknikal Malaysia Melaka

ABSTRACT

Since the last decade, the global demand for vegetables oil has been growing strongly due to increases in oil consumption and global population. Malaysia has focused on this oil palm industry since the last three decades because it is the major source of sustainable and renewable raw material for the food, oleo-chemical, and biofuel industries. Nowadays, the problem that arises is the Fresh Fruit Brunches (FFB) is bruised due to the impact to the ground during process of harvesting, collecting and transporting. Other than that, the scattered loose fruits on the ground also one of the problems which need to be collected and send it to the collection station. With this Combined Harvester Machine which is equipped with chute and loader system, it will minimize the FFBs from bruised as it fall to the chute and direct go to the dumper of the machine. Furthermore, the scattered loose fruits on the ground can be loaded on the dumper of the machine as well. This thesis work purpose is to design the chute and loader system for a farming vehicle. A farming vehicle known as Combined Harvester Machine consists of eight several main parts which chute and loader system is one of it. Based on the conceptual design, the chute and loader are decided to draw in CATIA software. There are some criteria need to be taken consideration for the chute and loader system before employ it into the Combined Harvester Machine. In conclusion, the chute and loader system of the Combined Harvester Machine could improve and maintain the quality of FFBs before the next process take places in Mills of Oil Palm (MOP).

© Universiti Teknikal Malaysia Melaka

DEDICATIONS

This thesis I dedicated to my beloved parents and my family for their love, support, and sacrifice throughout my whole life. It is with immense gratitude that I acknowledge the support to my supervisor, Mr. Herdy Rusnandi and my teammates that helped in all the time to finish my thesis.

© Universiti Teknikal Malaysia Melaka

ACKNOWLEDGMENTS

I am grateful to God for the blessing to accomplish this task. First and foremost, I would like to take this advantage to express my gratitude to my supervisor, Mr. Herdy Rusnandi. Thank you for your guidance, vast knowledge, opinion, and expertise in many scopes towards my final year project thesis. I appreciate with your patience, suggestions, and constructive criticism in improving this study. With your precious suggestion, guidance, and credence, I am able to complete this study. My appreciation is also extended to all lecturers and staff of Universiti Teknikal Malaysia Melaka, my course mates and friends in their assistance, ideas, and advices to provide research design and findings towards this project which helps me a lot in order to finish this thesis report. I would also like to appreciate my family for the support, motivate and encourage me to be successful in life and take this project as a challenge and for all the prayers that they made towards me for my success. Last but not least, I would like to express my sincere gratitude to the Government of Malaysia, especially Ministry of Higher Education, for giving me this precious opportunity to pursue the Bachelor's degree in Universiti Teknikal Malaysia Melaka (UTeM).

© Universiti Teknikal Malaysia Melaka

TABLE OF CONTENT

© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

LIST OF TABLES

© Universiti Teknikal Malaysia Melaka

LIST OF FIGURES

© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

© Universiti Teknikal Malaysia Melaka

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

%	–	Percentage
FFB	–	Fresh Fruit Bunches
MPOB	–	Malaysian Palm Oil Berhad
MOP	–	Mills of Oil Palm
CATIA	–	Computer Aided Three-dimensional Interactive Application
FELDA	–	Federal Land Development Authority
FELCRA	–	Federal Land Consolidation and Rehabilitation Authority
RISDA	–	Rubber Industry Smallholders' Development Authority
DOF	–	Degree Of Freedom
CG	–	Center of Gravity
RM	–	Malaysian Ringgit
m	–	mass
g	–	gram
k	–	Kilo
M	–	Mega
N	–	Newton
m	–	metre
°	–	degree
psi	–	pounds per square inch
A	–	Area

© Universiti Teknikal Malaysia Melaka

σ	–	Stress
ϵ	–	Strain
$>$	–	More than
Pa	–	pounds per square inch
m^2	–	metre square
E_K	–	Kinetic Energy
V	–	velocity
HP	–	Horse Power
P	–	Pressure
Q	–	Flow Rate
F	–	Force

© Universiti Teknikal Malaysia Melaka

CHAPTER 1

INTRODUCTION

1.1 Background

The palm oil industry grows importantly to the Malaysia as it helps to put Malaysian economy into promising state. Due to global population growth and higher oils consumption, vegetables oils demand rates has increased around the world. Malaysia is the second largest producers of palm oil in the world, contributed 17.6 million tonnes in 2009 (Alang Mahat 2012). Additionally, Malaysia also is the second largest exporters of the palm oil in the world which is 29% of global rates in 2013 (International Trade Centre, 2013). Since the last three decades, Malaysia focuses on this oil palm industry because it is the source of sustainable and renewable raw material for the world‘s food, oleo-chemical and biofuel industries.

The Malaysian Palm Oil Board (MPOB) is the premier government agency entrusted to serve the country‘s oil palm industry. The MPOB is responsible to provide and promote strong scientific and technological support for development of the palm oil industry in Malaysia. Since the operation began officially in 2000, MPOB manage to develop new products including biodiesel and develop the uses of biomass (Ministry of Plantation Industries and Commodities). Furthermore, MPOB also contributes development of farming vehicle or equipment to increase the productivity in oil palm industry (Ministry of Plantation Industries and Commodities). For instance, MPOB doing research and development project by doing partnership and competition with several universities in Malaysia and foreign country in order to improve working condition and researches in oil palm industry.

Oil palm tree in Malaysia shows that the height can be reach up to 30 meters above the ground which arise various method of harvesting process. The age of the

© Universiti Teknikal Malaysia Melaka

oil palm tree can be described through the height of the tree. As the oil palm tree grows, the height at which the FFBs are located increases correspondingly. At 15 years of age, the oil palm tree grows up to 20 metres above the ground (Ng et al. 2013). In addition, the oil palm tree has an average lifespan phase of Nursery (10 to 12 months), Immature (24 to 30 months), and Production (more than three years). Commercial palms have an economic lifespan of 20 to 30 years (Panapanaan 2009). The process of harvesting the fresh fruit brunch (FFB) from tall oil palm tree is a hard job for the human and require extremely large amount of energy in performing the tasks.

In Malaysia, the oil palm plantation needs a wide area for increasing the production capacity and exporting more sustainable and renewable raw material of oil palm, thus increasing Malaysia's economy. More importantly, the process of harvesting, collecting and transporting in a wide area need a machine that can improve the working efficiency. In 2011, the oil plantation area in Malaysia reached about 5,000,000 hectares (Malaysia, European Union Report, 2012). A decade ago, 3,313,393 hectares were planted with oil palm with 2,051,595 hectares (61.9%) in Peninsular Malaysia, 941,322 hectares (28.4%) in Sabah and 320,476 hectares (9.7%) in Sarawak (plantation Abridged report produced for the WWF Forest Information System Database, 2000). Figure 1.1 shows the distribution of planted area by state which the states of Sabah dominated the planted area of 1.432 million hectares of palm oil. In order to collect and transport the FFB from deep peat area of the estate to the factory, the machine or vehicle needs to be developed for an efficient process of collecting and transportation. There are several factors were taken into consideration when developing a collecting and transporting machine such as productivity, fuel consumption, repair and maintenance costs, and labour requirement for the machine team. This enabled the FFB to be sent to the factory for milling process at the estimated time of arrival to maximize productivity in terms of quality and quantity.

© Universiti Teknikal Malaysia Melaka

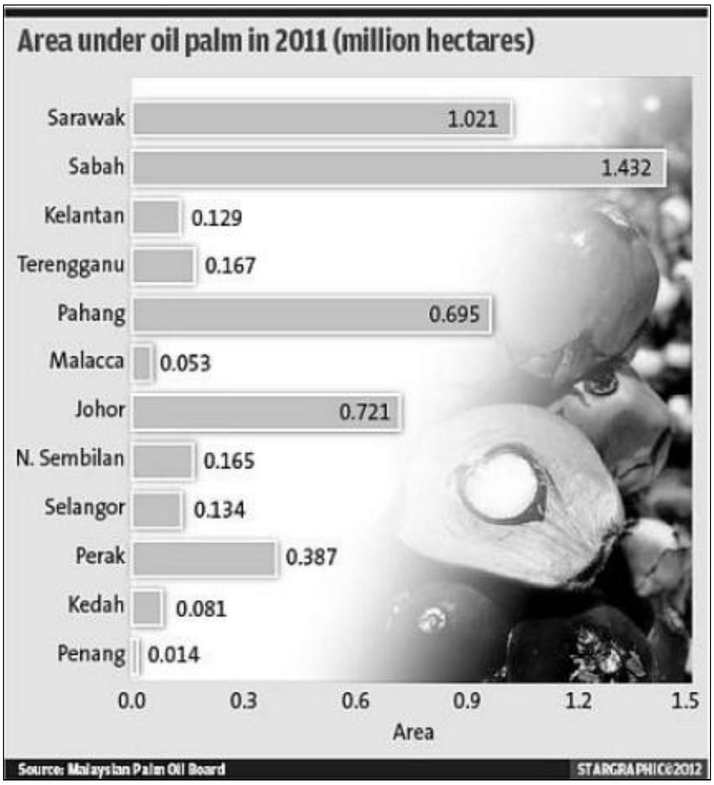

Figure 1.1: Distribution of planted area by state, 2011 (MPOB, 2012).

There are several groups of producers in Malaysia that play important role on upstream sector of oil palm industry in order to ensure the sustaining supply this vegetable oil to the world (Alang Mahat 2012). The privates estates shows the biggest per cents of cultivated area which is 60.7 percent. The rest category that dominated cultivated area are FELDA, FELCRA, RISDA, Other Government/States Agencies, and Independent Smallholders, as shown in Table 1.

Category	Hectare	Percentage (%)
Private Estates	3,037,468	60.7
FELDA	703,027	14.1
FELCRA	162,259	3.2
RISDA	79,743	1.6
Other Government/States Agencies	319,786	6.4
Independents Smallholders	697,826	14

Table 1: Oil palm planted area by category, 2011 (MPOB, 2012).

© Universiti Teknikal Malaysia Melaka

Nowadays is a modern technology, many research was conducted by the scientists to create or developed a different kind of machinery for harvesting fresh fruit brunch (FFB) from the palm tree. The goal of the research is to find the easiest way to do the process of harvesting which lead to maximizing profit, reduce cost and also increase productivity. In recent years, there are a lot of equipments and machineries have been developed for harvesting process, which is Cantas tool, Lifting platform, Vacuum operated cutters, and advanced robotic (Engineers et al. 2015). In developing the harvesting machine, there are several factors need to be taken into consideration like the ground condition, the weight of the machine, the engine power needed, the technique for harvesting, and most important is safety to the workers during handling the harvesting machine.

As an engineer, the problem that occurs should be overcome by doing research and test. One of the problem in the oil palm industry is the operation of harvesting, collecting, and transporting is carried out by different people, equipment and machine. The other problem is the tall oil palm tree, the height above 8 meter which required a lot of effort for the worker to carry out the harvesting process. Combined Harvester Machine is a farming vehicle that does all three operations of harvesting, collecting, and transporting (Herdy et al., 2015). Moreover, for the process of harvesting, the machine has the telescopic arm which can be extend or move the arm for cutting process. The benefit of this Combined Harvester Machine is that the harvesting, collecting, and transporting operation become more efficient and it will increase labour productivity.

Combined Harvester Machine consists of several main parts to become a complete farming vehicle (Herdy et al., 2015). One of the parts is the Chute and Loader system. The function of chute is to catch, trap, and directs the falling FFB to the bucket, while the function of loader is to move and lift the FFB from the ground to the bucket. There are few considerations for designing and fabricating the chute and loader system such as the material selection, the design, the required power for lifting and others. The chute and loader system is important as it function is to bring the FFB to the bucket which known as collecting process.

© Universiti Teknikal Malaysia Melaka

For the design of Chute and Loader system, the power sources for the Loader system to lifting the FFB will be hydraulic power. So does the power sources for the chute system to moving and locating in the position of exact under the direction of the falling FFB. Hydraulic energy is important as it provides energy to lift up all the heavy things based on the design of hydraulic system (Adam 2012). To increase the working efficiency, the hydraulic system of loader working device needs to reduce the energy consumption (International Journal of Computer Applications in Technology, 2012). Accordingly, the power from a backhoe loader's gasoline or diesel engine is to drive all hydraulic functions at full displacement and maximum pressure. Thus, hydraulic system needs energy from the engine power to create a great force.

1.2 Problem Statement

Since the last decade, the oil palm industry is the agriculture that contributes many benefits to Malaysia‘s economy, social and politics. The government keeps recruiting the foreign workers to work in the oil palm industry. Therefore, almost all the jobs in the oil palm plantation are taken by the foreign workers. The problems with foreign labor increase the social problem in our society and increase the money draining out to other country. The problem can be solved by attract the local worker with the great invention to do all these jobs such as the equipment and machinery. With this Combined Harvesting Machine, the local worker indeed will work in the estate oil palm industry because it saves energy, safe, and only required skills to handle the machine.

The harvesting process become difficult when it comes to the tall tree (8-15 meter height) as it needs lot of physical efforts (Ng et al. 2013). The other problem is the process of harvesting, collecting, and transporting are not efficient because these three processes required different persons to carry out the job. Other than that, for the Chute system, the problem that is might arise is how to prevent the falling FFB to the ground caused by the impact and direct it towards the dumper. In addition, the FFB

© Universiti Teknikal Malaysia Melaka

that fall from the high places are the causes its quality get low as its fruit bruised caused by the impact to the ground. While in the Loader system, the power source required to lift up the FFB in the ground to the bucket. The falling FFBs is always scattered on the ground. These problems can be solved by doing detailed research, design and select right materials, for the Chute and Loader system.

1.3 Objectives

Based on the problem statement, the objectives of this study are stated as below:

1. To design the Chute and Loader system for Combined Harvester Machine.
2. To analyze the design of the Chute and Loader system for Combined Harvester Machine.

1.4 Scope of Study

From the objective stated as above, the work scope for this study has been drawn as below:

1. Studying the suitable system for chute and loader system in Combined Harvester Machine through the literature review.
2. Designing the chute and loader system for Combined Harvester Machine by using CATIA software.
3. Analyzing the designed chute and loader system for Combined Harvester Machine through stress analysis in CATIA software.

© Universiti Teknikal Malaysia Melaka

1.5 Significant of Study

This study is about to design and analyze the Chute and Loader system of farming vehicle which is a several criterion need to be taken into consideration such as lower cost, right material selection, and able to withstand the force of falling FFB for Chute system, and the parameter required for the Loader system to lift up the FFB to the bucket. With this Combined Harvester Machine, it is not only can increase the productivity but also can attract the local people to work in the oil palm plantation and thus it can reduce dependent to workers especially to foreign worker which give negative effect to our country such as social problem and a lot of money draining out to other country. The good quality of FFB is maintained as the fruit doesn‘t bruise caused by the impact of kinetic energy from the top tree to the ground. Moreover, it only required one operator to do all three operations of harvesting, collecting, and transporting.

© Universiti Teknikal Malaysia Melaka

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discussed literatures on the mechanism and the design of Chute and Loader system. The Loader system consist of two parts which is the dumper and loader design while the Chute system has three designs to discuss about. Other than that, this chapter will discussed a little bit about hydraulic model being used and parameter of the system. In addition, this chapter also will discuss about the degree of freedom (DOF), structural analysis, stress analysis, and mathematical model software that used in our study that is CATIA.

2.2 Loader System

The Loader system is divided into two parts which is the loader and the dumper. Figure 2.1 shows the loader system and dumper system.

Figure 2.1: Kubota Wheel Loader (Left) and Kubota Crawler Dumper (Right). (Kubota Europe SAS, 2014).

© Universiti Teknikal Malaysia Melaka