

**TO DESIGN AN INNOVATION COCONUT PLUCKING ROD
WITH ADVANCE MECHANISM**

CHONG FEI MING

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**TO DESIGN AN INNOVATION COCONUT PLUCKING ROD
WITH ADVANCE MECHANISM**

CHONG FEI MING

**A report submitted
In fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering (Design and Innovation)**

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2017

DECLARATION

I declare that this project report entitled “To Design an Innovation Coconut Plucking Rod with Advanced Mechanism” is the result of my own work except as cited in the references

Signature :

Name :

Date :

APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design and Innovation).

Signature :

Supervisor's Name :

Date :

DEDICATION

To my beloved mother and father

ABSTRACT

Coconut is one of the industrial crop in Malaysia and it has a great influence on the social economic of the Malaysia. This industry requires new invention in the harvesting method which not only to fulfill its mass distribution around the world but also able to consider the safety to the user and reliability. It is usually seen that the cultivators used the traditional method such as climbing method or pole method in the harvesting of coconut. The purpose of this project was to design a coconut plucking rod and proposed a mechanism system which to be cooperated with the existing rotary blade. The designing of the coconut plucking rod was carried out through the design methodology which provide a systematic approach and guidelines in produces a product. The concepts of design the coconut plucking rod is generated according to the customer requirements which translated into the engineering characteristics and generated the product design specifications. As a result of this study, a coconut plucking rod with a gear mechanism is selected as the final concept for the product. The mathematical and CAD analysis was carried out and showed that the mechanism system able to generate the required force and the structure of the rod able to support the applied force. By designing the coconut plucking rod, the users can pick the coconut with ease and low energy.

ABSTRAK

Kelapa merupakan salah satu tanaman industri di Malaysia dan ia mempunyai pengaruh yang besar terhadap ekonomi sosial Malaysia. Industri ini memerlukan ciptaan yang baru dalam cara penuaian kepala untuk memenuhi pengedaran massa di seluruh dunia tetapi juga untuk mempertimbangkan keselamatan untuk pengguna dan kebolehpercayaan. Petani biasanya menggunakan kaedah tradisional seperti memanjat ke atas pokok kelapa atau menggunakan galah untuk memetik kelapa. Tujuan projek ini adalah untuk mereka bentuk pemetik kelapa dan mencadangkan satu sistem mekanisme yang akan berfungsi dengan bilah berputar yang sedia ada di pasaran. Penghasilan reka bentuk pemetik kelapa telah dijalankan melalui kaedah reka bentuk yang memberi pendekatan yang sistematik dan garis panduan dalam menghasilkan produk. Konsep reka bentuk pemetik kelapa telah dihasilkan mengikut keperluan pelanggan yang diterjemahkan ke dalam ciri-ciri kejuruteraan dan menghasilkan spesifikasi produk. Hasil daripada kajian ini, pemetik kelapa dengan mekanisme gear dipilih sebagai konsep terbaik bagi produk. Analisis matematik dan CAD telah dijalankan dan menunjukkan bahawa sistem mekanisme mampu menjana tenaga yang diperlukan serta produk struktur dapat menyokong daya yang dikenakan. Dengan pemetik kelapa ini, pengguna boleh memetik kelapa dengan lebih mudah dan kos yang rendah.

ACKNOWLEDGEMENTS

I would like to acknowledge with much appreciation the crucial role of Dr. Mohd Asri bin Yusuff, who gave permission for me to complete my final year project under his supervision. He is willing to teach patiently and guide me well in these two semesters of my final year project. He gives a lot of advices and encouragement to lead me to a correct way to complete my project.

Next, many thanks go to my course mates. Throughout these two semesters, we are giving supports and helps to each other. I am very appreciate with their full effort of helping when I am encountered with problems.

Last but not least, I would like to express my gratitude towards my parents for their kind encouragement which help me in completion of this project. With their supports, finally I am able to complete my project smoothly.

TABLE OF CONTENTS

CHAPTER	CONTENT	PAGE
	DECLARATION	i
	APPROVAL	ii
	DEDICATION	iii
	ABSTRACT	iv
	ABSTRAK	v
	ACKNOWLEDGMENTS	vi
	TABLE OF CONTENTS	vii
	LIST OF TABLES	xi
	LIST OF FIGURES	xiii
	LIST OF ABBREVIATIONS	xv
	LIST OF SYMBOLS	xvi
	LIST OF APPENDICES	xvii
 CHAPTER 1	 INTRODUCTION	 1
	1.1 Background	1
	1.2 Problem Statement	2
	1.3 Objectives	3
	1.4 Scope of project	3
	1.5 Expected Result	4
 CHAPTER 2	 LITERATURE REVIEW	 5
	2.1 Introduction	5
	2.2 Morphology of Coconut Palm	5
	2.3 Harvesting	7
	2.3.1 Pole Method	8

2.3.2	Climbing Method	8
2.3.3	Trained Monkey	9
2.4	Limitation of Harvesting Method	10
2.5	Harvesting Tool in The Market	9
2.5.1	Motorized Cutter	9
2.5.2	Mechanical Harvesting Machine	11
2.5.3	Clip and Pick Fruit Picker	12
2.5.4	Rotary Blade Picker	13
2.6	Material of Plucking Pole	14
2.7	Design Process	15
2.7.1	Customer Requirement	16
2.7.2	Market Analysis	16
2.7.3	Specifications	17
2.7.4	Conceptualization	17
2.7.5	Concept Evaluation	17
2.7.6	Embodiment Design	18
2.7.7	Detailed Design	18
2.8	Mechanism	19
2.8.1	Sprockets and Chain	19
2.8.2	Gear Trains	19
2.8.3	Cam Mechanism	20
2.8.4	Pulleys and Belts	21
2.9	Bevel Gears	22
CHAPTER 3	METHODOLOGY	24
3.1	Introduction	24
3.2	Customer Requirements	26
3.2.1	Market Analysis	26
3.3	Specifications	26
3.3.1	Quality Function Development	26
3.3.2	Performance Specification Method	27
3.4	Conceptualization	28
3.4.1	Morphological Chart	28

3.5	Concept Evaluation	28
3.5.1	Decision Matrix Method	29
3.6	Embodiment Design	29
3.7	Detail Design	29
3.8	Design Tool	30
3.9	Result Analysis	30
CHAPTER 4	RESULT AND DISCUSSION	31
4.1	Introduction	31
4.2	Customer Requirements	31
4.2.1	Research Analysis	31
4.2.2	Survey	33
4.2.3	Relative Importance of the Customer Requirements	34
4.3	Specifications	35
4.3.1	Quality Function Development	35
4.3.2	Performance Specification Method	37
4.4	Conceptualization	38
4.4.1	Morphological Chart	38
4.4.2	Conceptual Design	39
4.5	Concept Evaluation	44
4.5.1	Decision Matrix Method	44
4.6	Material Selection	45
4.6.1	Rod	45
4.6.2	Gear Housing	45
4.6.3	Gear Housing Cover	46
4.6.4	Bevel Gear	46
4.6.5	Shaft	47
4.6.6	Rod Support	47
4.6.7	Rod Support Cover and Hand Grip	47
4.7	Result of Analysis	48
4.7.1	Design Analysis by Using Theorem Equation	48

4.7.2	CAD Analysis	56
4.8	Product Structure	59
4.8.1	Product Structure Tree	60
4.8.2	Detailed of Structure Modelling	63
4.9	Product Costing	65
4.9.1	Cost of Customize Parts	66
4.9.2	Cost of Standard Parts	66
4.9.3	Assembly Cost	67
4.9.4	Total Production Cost	69
CHAPTER 5	CONCLUSION AND RECOMMENDATIONS	70
5.1	Conclusion	70
5.2	Recommendations	71
	REFERENCES	72
	APPENDICES	76

LIST OF TABLES

TABLE	TITLE	PAGE
2.1	The formula for standard straight bevel gear	23
4.1	Determination of relative importance of customer requirements by using digital logic method	34
4.2	Weighting factor for customer requirements	35
4.3	House of quality for coconut plucking rod	36
4.4	Product design specifications for coconut plucking rod	37
4.5	Morphological chart	38
4.6	Concept design evaluation using the matrix method	44
4.7	Part specifications of rod	45
4.8	Part specifications of gear housing	46
4.9	Part specifications of gear housing cover	46
4.10	Part specifications of bevel gear	47
4.11	Part specifications of shaft	47
4.12	Part specifications of rod support	47
4.13	Part specifications of rod support cover and hand grip	48
4.14	Parametric of the first bevel gear set	50
4.15	Parametric of the second bevel gear set	52
4.16	The parameter of the chain and sprockets system	54
4.17	Properties of aluminum 6061-T6	57

4.18	Manufacturing cost of customize parts	66
4.19	Cost of standard parts	67

LIST OF FIGURES

FIGURE	TITLE	PAGE
2.1	Coconut palms (Cadiz, n.d.)	6
2.2	Inflorescence (Cadiz, n.d.)	7
2.3	Pole method (Michael, 2015)	8
2.4	Climbing method (Nethrapalli, 2005)	9
2.5	Trained Monkey (Wlnograd, 2016)	10
2.6	Motorized cutter Cantas (Etani, 2015)	11
2.7	Mechanical harvesting machine (Pellenc, n.d.)	12
2.8	Clip and pic fruit picker (Sears, n.d.)	13
2.9	Rotary blade (Nur, 2015)	14
2.10	Untreated bamboo pole (Schoder, 2014)	15
2.11	Sprockets and chain (Sclater and Chironis, 2001)	19
2.12	Example of the external and internal gear (Sclater and Chironis, 2001)	20
2.13	General form of a plane cam mechanism (Sclater and Chironis, 2001)	21
2.14	Pulleys and belts (Sclater and Chironis, 2001)	21
2.15	Dimension and angles of bevel gear	22
3.1	Flow chart of design process	25

3.2	HOQ of configuration (Squires, n.d.)	27
4.1	Objective tree of customer requirements	32
4.2	Interview session with coconut labour	33
4.3	Coconut farm	33
4.4	Sketch view of concept 1	39
4.5	Sketch view of concept 2	40
4.6	Sketch view of concept 3	41
4.7	Sketch view of concept 4	42
4.8	Sketch view of concept 5	43
4.9	Transmission system of the coconut plucking rod	49
4.10	Illustrate diagram of bevel gear set	50
4.11	Chain and sprockets system in the rotary blade	54
4.12	Default configuration of the rod	57
4.13	Von Misses Stress of the rod	58
4.14	Displacement of the rod	58
4.15	Structure of coconut plucking rod	59
4.16	Rod sub-assembly	60
4.17	Gearbox sub-assembly	61
4.18	Bevel gear set sub-assembly	62
4.19	Rod support sub-assembly	63
4.20	The connection between the aluminum rod	64
4.21	The connection between the rotary blade and the rod	64
4.22	Bolted joint of aluminum rod and gear housing	65
4.23	Bolted joint of support rod and gear housing	65
4.24	Assembly process flow	68

LIST OF ABBREVIATIONS

QFD	Quality Function Development
HoQ	House of Quality
CRs	Customer Requirements
ECs	Engineering Characteristics
CAD	Computer Aided Design

LIST OF SYMBOLS

V	=	pitch-line velocity
d	=	Gear diameter
n	=	Gear speed
W_t	=	Transmitted load
H	=	Power
T	=	Torque
L	=	Radius of gear
F_c	=	Force transferred by chain driver
r_s	=	Radius of sprocket

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A1	Gantt chart for PSM 1	77
A2	Gantt chart for PSM 2	78
B1	Isometric drawing of coconut plucking rod	80
B2	Exploded drawing of coconut plucking rod	81
B3	Orthographic drawing of rod support cover	82
B4	Orthographic drawing of rod support	83
B5	Orthographic drawing of bolt	84
B6	Orthographic drawing of gear housing	85
B7	Orthographic drawing of sealing ring	86
B8	Orthographic drawing of rotary handle	87
B9	Orthographic drawing of pinion shaft	88
B10	Orthographic drawing of ball bearing	89
B11	Orthographic drawing of pinion	90
B12	Orthographic drawing of gear 2	91
B13	Orthographic drawing of gearing housing cover	92
B14	Orthographic drawing of hand grip	93
B15	Orthographic drawing of rod	94
B16	Orthographic drawing of long shaft	95

B17	Orthographic drawing of gear 3	96
B18	Orthographic drawing of gear 4	97

CHAPTER 1

INTRODUCTION

1.1 Background

Coconut is the one of the oldest agro-based industries in Malaysia. It ranks fourth in the industrial crop of Malaysia after the oil palm, rubber and paddy in terms of total cultivated area. Coconut contributes very little to the overall economy of Malaysia. Recent, the total area of coconut cultivation is declined as the result of the competition with the oil palm for land. However, coconut now still has a great influenced on the social-economic of the Malaysia as it involves 80,000 households. There is about 63% of the total coconut production is used for domestic consumption while the 37% is for export and industrial processing purposes (Sivapragasam, 2008). In the world production of coconut, more than 50% is processed to copra. While some portion is used to produce end-products of coconut such as desiccated coconut, coconut milk powder and activated carbon. The rest of the production is taken in the form of fresh coconut and tender coconut for domestic demand (Punchihewa and Arancon, 2001).

As the high demand on the coconut, the coconut harvesting method become an important matter to be consider to ensure the production able to fulfill the demand of the country. Harvesting of the coconut can be done in different ways which depend on the size of the tree. In many popular coconut cultivating countries, the traditional harvesting method is used to pick the coconut from the tree. This traditional method is done by a skilled and experienced picker who has to climb up 30 to 80 feet high above the ground with bare handed

or the aid of a rope and taps the nut with its harvesting knife to test its maturity (Abraham et al., 2014).

In Malaysia, Indonesia and Thailand the pig-tailed monkeys are trained to climb the coconut tree and throw down the ripe nut (Raffauf, 1985). According to the National Primate Research Center at the University of Wisconsin, Madison, a height-savvy monkey to pluck the fruit from the trees up to 80 feet is safer than a human. Other than that, the harvesting of coconut also have been done with the help of a curve knife which attached to a long bamboo pole. The ripe nut are cut from the trees and collected from the ground. Furthermore, another simple method to harvesting coconut is to wait the nuts fall to the ground by themselves then collected by farmer.

Nowadays, there are many invention of the coconut harvesting device to help the farmer in plucking the nuts. Most of the invention is in form of the climbing machine to ensure the safety of the pickers. On the other hand, there has a design of rotary blade which can be used for the plucking coconut. However, this new design of rotary blade do not have any mechanism to cooperate with it. Therefore, a mechanism to be designed to cooperate with this rotary blade for the coconut harvesting purpose.

1.2 Problem Statement

Coconut plays a very important role in the economy of many developing countries. Unfortunately in spite of its mass distribution around the world, the coconut harvesting is still done without consider the safety and reliability which can lead to the casualties. Most of the coconut harvesting in cultivating countries is done by trained, skillful and experienced picker. The job of coconut picking is risky and unglamorous cause the number of coconut tree climbers has declined sharply in recent years as many young people is not interesting in this work. Therefore, the alternative method to pluck the coconut is done by a knife that

attaches to the long bamboo pluck. This method requires a lots of energy and causes the picker get tired easily. Recent, there has been an array of coconut palm climbing devices developed to assist and claim the safety during harvesting. However, there is still an acute shortage of trained coconut climbers for harvesting activities (Mani and Jothilingam, 2014). Furthermore, the coconut palm climbing devices is considered expensive for the smallholders who unable pay for the high cost. Therefore, a cheap and effective technology of coconut plucking device is required to allow the coconut harvesting process become easier and solve the problem of shortage of skilled picker.

There was a rotary blade that has been designed specialized for plucking the coconuts. This rotary blade is used the rotary mechanism to pluck the nut. However, there was lacked of the designing of the pole to operate with the rotary blade from the ground. Therefore, the designing of the pole is required to complete this equipment.

1.3 Objectives

The objectives of this project are:

- 1.3.1 To design a coconut plucking rod with advance mechanism.
- 1.3.2 To propose a mechanism system which to be cooperating with the existing rotary blade.

1.4 Scope of Project

This project focuses primarily on designing the coconut plucking rod with advance mechanism and how it cooperates with the existing rotary blade. The design of the coconut plucking rod is emphasized on the coconut tree which tall less than 5m. The analysis on the design will be done by CAD software. However, other aspects such as the production and marketing of the coconut plucking rod are not covered in this project.

1.5 Expected Result

This project is to design a coconut plucking rod with advanced mechanism which allows the user to pick the coconuts easily. A mechanism system with the ability to transmit the rotating mechanical to be proposed which to be cooperating with the existing rotary blade.