UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE DESIGN AND DEVELOPMENT OF A PINEAPPLE PLANTER MACHINE

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A thesis submitted
in fulfilment of the requirements for the degree of
Bachelor of Manufacturing Engineering Technology (Product Design) with Honours

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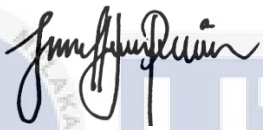
2023

DECLARATION

I declare that this thesis entitled "The Design and Development of a Pineapple Planter Machine" is the result of my research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

Signature : 

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (Product Design) with Honours.

Signature : 

Supervisor Name : *Umi Hayati Binti Ahmad*

Date : 20 / 01 / 2023

DEDICATION

I dedicated my dissertation work to my family. A special feeling of gratitude to my loving parents, Mr Roslin Bin Othman and Mrs Roslina Binti Ahmad, whose words of encouragement and push for tenacity ring in my ears; who gave me supports, not just financially but also morally and physically supported me to my success of this venture. My siblings Intan Nor Zalina, Iqwan Arif, and Izzah Nur Ain have never left my side and are very special. This thesis is also dedicated to my lovely friends and comrades who have also lent a hand and support throughout my journey of doing this research. I highly appreciate the time and effort that they have given to me.

I had promised to make my family proud by achieving these monumental academic goals, and I hope that I have fulfilled that promise. I hope that I can celebrate my success on my graduation day.

ABSTRACT

This research seeks to improvise the current technology for pineapple planting in Malaysia from mechanization and automation aspects. Based on this research, it is known that pineapple production continues to rely significantly on human labour. The only technology applied in pineapple planting is soil ploughing using tractors and a rotary tiller to form crop beds. The production of pineapple from the cultivation phase until the harvesting phase requires a huge amount of manpower throughout the process. While developing countries such as China, Italy, and Thailand have led far ahead of the mechanization in the pineapple planting system, Malaysia still lacks technology implementation in the pineapple production specifically in the phase of cultivation. The aim of this research is to design and develop a versatile design concept for pineapple planter machine that is adaptable to every cultivation practice with the target of minimizing the use of labour and save time consumption regarding pineapple cultivation work for pineapple cultivation in Malaysia. The research approaches implemented is to interpret the mechanism of the pineapple planter machine and the designed concept used to communicate the machine's visual and function. The finalized concept of the pineapple planter machine design has been developed by using the approach of engineering design process model introduced by Karl T. Ulrich and Steven D. Eppinger (2004) which is the process of Product Design and Development. This research utilized Solidworks computer-aided design (CAD) software in designing the mechanical system to deliver the function of the pineapple planter machine. Hence, the results obtained through this method had produced a very reliable outcome since the data obtained provide better outcomes in terms of conceptual design compared with the current existing machine, indicating that this study is legitimate. As a result, the pineapple planter machine's designed mechanism and design concept was successfully developed through rapid prototyping that produces an alpha prototype for visualisation and was eligible to proceed to the next development phase.

ABSTRAK

Penyelidikan ini bertujuan untuk menambah baik teknologi semasa penanaman nanas di Malaysia dari aspek mekanisasi dan automasi. Berdasarkan kajian ini, didapati bahawa penghasilan nanas terus bergantung dengan ketara kepada tenaga manusia. Satu-satunya teknologi yang digunakan dalam penanaman nanas ialah membajak tanah menggunakan traktor dan alat pembajak tanah untuk membentuk batas tanaman. Pengeluaran nanas dari fasa penanaman sehingga fasa penuaian memerlukan sejumlah besar tenaga kerja dalam proses tersebut. Walaupun negara-negara membangun seperti China, Itali, dan Thailand telah mendahului mekanisasi dalam sistem penanaman nanas, Malaysia masih kekurangan pelaksanaan teknologi dalam penghasilan nanas khususnya dalam fasa penanaman. Tujuan penyelidikan ini adalah untuk mereka bentuk dan membangunkan konsep yang versatil bagi mesin penanam nanas yang boleh diadaptasikan kepada pelbagai amalan penanaman dengan matlamat mengurangkan penggunaan buruh dan menjimatkan penggunaan masa berkaitan kerja-kerja penanaman nanas untuk ladang nanas di Malaysia. Pendekatan penyelidikan yang dilaksanakan adalah untuk mentafsir mekanisme mesin penanam nanas dan konsep yang telah direka bentuk untuk menyampaikan visual dan fungsi mesin. Konsep reka bentuk mesin penanam nanas telah dibangunkan dengan menggunakan pendekatan model proses reka bentuk kejuruteraan yang diperkenalkan oleh Karl T. Ulrich dan Steven D. Eppinger (2004) iaitu proses Reka Bentuk dan Pembangunan Produk. Penyelidikan ini menggunakan perisian reka bentuk berbantu komputer, Solidworks dalam mereka bentuk sistem mekanikal bagi mengetengahkan fungsi mesin penanam nanas. Oleh itu, penemuan yang diperoleh melalui kaedah ini telah menghasilkan dapatan yang sangat boleh dipercayai kerana data yang diperolehi memberikan hasil yang lebih baik dari segi reka bentuk konsep berbanding dengan mesin yang sedia ada pada masa kini, membuktikan bahawa kajian ini adalah sah. Hasilnya, mekanisme reka bentuk dan konsep reka bentuk mesin penanam nanas telah berjaya dibangunkan melalui prototaip pantas yang menghasilkan prototaip alfa untuk visualisasi dan berkeupayaan untuk dilanjutkan ke fasa pembangunan seterusnya.

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LIST OF SYMBOLS AND ABBREVIATIONS

1D	-	One-dimensional
2D	-	Two-dimensional
3D	-	Three-dimensional
BOM	-	Bill of Material
CAD	-	Computer-Aided Design
CAE	-	Computer-Aided Engineering
CSG	-	Constructive solid modelling
DOA	-	Department of Agriculture
ED	-	Engineering Design
EDM	-	Engineering Data Management
EDS	-	Engineering Design Specifications
FAMA	-	Federal Agriculture Marketing Authority
GCS	-	Global Coordinate System
GDP	-	Gross Domestic Product
GNI	-	Gross National Income
ha	-	hectare
HoQ	-	House of Quality
LPP	-	'Lembaga Pertubuhan Peladang'
MAFI	-	Ministry of Agriculture and Food Industries
MARDI	-	Malaysia Agriculture Research and Development Institute
MOA	-	Ministry of Agriculture
MPIB	-	Malaysian Pineapple Industrial Board
NA	-	Non-available
NKEA	-	National Key Economic Area
PDD	-	Product Design and Development
PDS	-	Product Design Specification
QFD	-	Quality Functional Deployment
R&D	-	Research & Development
RP	-	Rapid Prototyping

SDG	-	Sustainable Development Goals
USA	-	United State of America
WCS	-	Works Coordinate Systems
FAO	-	Food & Agriculture Organization of the United Nations
UN	-	United Nation
OECD	-	Organisation for Economic Co-operation and Development

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter presents the fundamental about the background of fruit industry in Malaysia focusing on pineapple fruit and current situation relating the mechanization and automation level of pineapple cultivation. Other than that, this chapter portrays the problem statement for this research. Next, this chapter will continue with research objective which explains the aim and purpose this study is conducted. This chapter also describes about the scope of research that is going to be focused along the project.

1.2 Background

The pineapple (Ananas comosus) is a fruit-bearing tropical plant (Morton, Julia F., 1987). In the Bromeliaceae family, it is the most commercially important plant. The pineapple is native to South America, where it has been cultivated for hundreds of years. The pineapple became a prominent cultural image of luxury with its arrival to Europe in the 17th century. Pineapple has been cultivated commercially in greenhouses and on numerous tropical plantations since the 1820s. Pineapple is recognized as one of the fifty plants that changed world history. Pineapples can be consumed fresh, canned, or made into a juice (Adzahan et al., 2011). The variety of downstream products derived from the fruit makes it an attractive commodity (Mohd Ali et al., 2020).

Figure 1.1 The pineapple plantation site in Segamat, Johor

In Malaysia, the pineapple industry has been around for over a century (Rajendran, S. D., 2013). Most of the pineapple production is attributed to extensive peat soil farming, as example in the state of Johor as shown in Figure 1.1. There are five different varieties of pineapples grown across the world: Spanish, Queen, Cayenne, Pernambuco, and Perolera, with the first three being widely grown in Malaysia. With relation to plant density, Mohammed et al. (2006), Stephen (2008), and Norman (2009) conducted several studies on pineapples to boost its output. This is due to the planting of suckers still relies on labour manually which is time-consuming and a load of work to do. In relation to the technology implementation, the status of mechanization in pineapple production varies across the planting stage (Cotabato, 2015). Figure 1.2 shows the stages of pineapple production. Land preparation is the first step in ensuring proper conditions for crop production. Pineapples can be planted on a variety of land (Hossain, 2016).

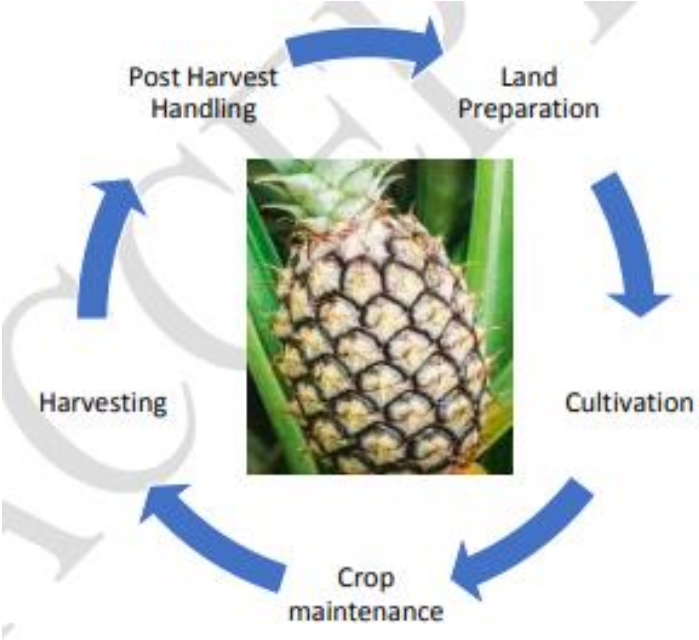

Figure 1.2 Stages of pineapple production (Abu Bakar, B. et al., 2021)

Tilling the land and bed preparation are fully mechanised during the land preparation stage. Malaysian researchers have been working upon this mechanisation issue. In the planting stage, a semi-mechanized pineapple planter was developed (Hassan et al., 2009; Ahmad et al., 2013). Pineapple suckers are loaded into a bin mounted on a tractor driven by an operator. While two more operators sit at the back of the bin, they take the sucker one at a time and plant them in the ground while being pulled by a tractor. Surprisingly, only a handful amount of research has been conducted on modernising pineapple production. The common issue encountered within that industry are similar to those encountered in other crops. Inefficient farm management is a widespread issue across all crops. Pineapple production is no exception. Even though pineapple production-related technologies have attributes of the second industrial revolution, there is a tremendous opportunity to push the entire sector towards Industry 4.0 in order to implement modern technology in agricultural sector (Abu Bakar, B. et al., 2021).

1.3 Problem Statement

From the cultivation phase to the harvesting phase, pineapple production necessitates a huge quantity of manpower. While other countries, such as China, Italy, and Thailand, have been far ahead of Malaysia in terms of mechanisation in the planting system, Malaysia still lacks technology implementation in pineapple production, particularly in the cultivation phase. This is because sucker planting still dependent on labour manually, which again is time-consuming and labour-intensive. Thus, the purpose of this research is to overcome the current challenges encountered by pineapple farmers and to develop an improvisation to the level of mechanisation of the pineapple planting system, specifically in Malaysia.

1.4 Research Objective

The objectives of this research that need to be achieved in this case study are as follows:

1) To study the types of engineering design process.
2) To implement the suitable engineering design process model in designing a versatile pineapple planter machine concept.
3) To fabricate an alpha prototype for visualization purpose.

1.5 Scope of Research

The scope of this research are as follows:

1) To perform literature review on topic-related journals, articles, and books.
2) The study for current state of the art for pineapple production in Malaysia from the perspective of mechanization and automation.

3) The study on implementation of modern technology in agricultural sector which is broadly aimed at improving productivity and quality of crops by their farm mechanization and a better management of machineries.

4) The utilization of Solidworks CAD software to design the mechanical system to deliver the function of the pineapple planter machine.

5) To apply rapid prototyping in fabricating the visual prototype of the pineapple planter machine based on fundamental of engineering design process with relation to the design and development of a product.

1.6 Summary

To summarize this chapter, the background of this project is discussed, the purpose of this project is to investigate the most versatile design concept for the pineapple planter machine and built a visual prototype as an alternative to communicate the design. The research objectives and scope of research are determined in order to ease the understanding towards the needs of this project. A pineapple plantation in Segamat, Johor will be used as the project research site to fulfil the objectives. Other than that, the literature review research to the engineering design process (EDP), product design and development (PDD), rapid prototyping (RP), fundamentals of pineapple fruit, global market demand on tropical fruit, international food security issues, and several of other research-related topics will be conducted in the Chapter 2.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter discuss and explains the info about fruit industries in Malaysia focusing on pineapple fruit and the development of technology in pineapple cultivation with utilization of engineering design process model. Developing a product without a proper channel and correct phase can cause a major issue to the product. This chapter also emphasizes about Malaysia fruit industry which will portray mainly about the pineapple industry, the theories of international food security issues, global market demand on tropical fruit, approaches in engineering design process (EDP), fundamental of product design and development (PDD), and including visualize prototype fabrication for delivering or communicating concept of the designed product which is pineapple planter machine. All the mentioned topics are crucial and important as it acts as the main approaches implemented to initiate this research. The study recommends the need for designing appropriate intervention mechanisms focusing on the aforementioned factors to improve industry's performance in the global market and uplift the status of smallholder pineapple farmers.