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Fully Manual Pineapple Collector Tool

Muhammad Imran Mazlan[1], Muhammad Hamiemi Harun[1], Muhammad Hakimie Sudirman[1], Mahmod Abd Hakim Mohamad*[1,2], Nurfarahin Onn[1]

[1] *Department of Mechanical Engineering, Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600, Pagoh, Johor, MALAYSIA*

[2] *Sustainable Product Development (S-ProuD), Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600, Pagoh, Johor, MALAYSIA*

*Corresponding Author: hakim@uthm.edu.my
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Abstract

Pineapple (Ananas comosus) in the Bromeliaceous family is a large, succulent, and tasty fruit with immense health benefits. Among all the cultivation activities of pineapple, harvesting is the most difficult, time-consuming, and energy-intensive process due to the higher plant density and spiny leaves of pineapple plants. Although many types of pineapple collecting tools are available in the market, they are mainly for large-scale pineapple plantation operators, and the cost is very expensive. Until now, no research study has been conducted about developing a device to harvest pineapple in Malaysia. This project aims to design and develop a tool that could help in pineapple harvesting, from cutting the pineapple fruit from its plant to picking the pineapple fruit from its plant. The project will mainly focus on helping small-scale pineapple farmers. The tool's operation will be manually operated as it is easier to use and manufacture.

1. Introduction

The pineapple is a tropical plant with an edible fruit from the Bromeliaceae family [1,2]. It is native to South America and has been cultivated for a long time [1,2]. The pineapple has spiky, tough skin and sweet, yellow flesh [3]. The name pineapple comes from its resemblance to a pinecone [3]. The pineapple is a major crop in the tropics and subtropics, especially in Hawaii [1]. However, pineapple (Ananas comosus var. comosus) is one of the most widely produced fruit varieties, with pineapple ranked third in world production after mangoes and bananas. Pineapple is the main choice for cultivation to meet nutritional needs and is essential for the producing fresh fruit.

The main production of pineapples is universally in Costa Rica, with as many as 3,418,155 tons produced in one year [4]. Malaysia is also included in the world ranking list, where Malaysia produces 329,365 tons in one year. In Malaysia, the pineapple plant (Ananas comosus) especially the premium variety MD2, is gaining popularity today. Pineapple is a crop from the Bromaliaceae family of which there are ten varieties registered from AC1 (Moris pineapple) to AC10 (Nanas Golden Diamond) in the Department of Agriculture and pineapple industry led by the Malaysian Pineapple Industry Board (LPNM) [5]. This MD2 variety is often commonly sold in retail outlets and supermarkets throughout Malaysia. Generally, the leaves are about 3 feet long (0.9 m), the fruit weighs between 1.3 kg to 1.8 kg and has a yellow filling. The fruit is cylindrical and has a high sugar content, low acid content and a high content of vitamin C [5].

However, a common problem during the harvest of pineapples is low back pain and cuts to the hands due to the exposure of thorns on the leaves around the pineapple. So, this pineapple collector tool is needed using a knife or machete, which is unsuitable as it can cause injury to the body and kidney pain. In terms of bodily injury, it is caused by the thorny leaves around the thorny pineapple. If they want to take the fruit, they have to cut the pineapple stem below so the thorns on the tree can hit the hands of the cutter when cutting the stem. Besides, this act can also cause kidney pain because the cutter will bend his body to reach the pineapple stem. Therefore, this pineapple collecting tool is built to make things easier for farmers in pineapple fields and prevent them from getting hit by thorns and body pain. Among the improvements found in our tool is the adjustable shaft, where the farmer can maintain a distance from being hit by thorns and does not need to bend down. After that, the expected result from our final project is the pineapple collector can fully operate with the manual system. The tool can function without any problem. Furthermore, the harvest yield for this tool increases significantly more than the existing method.

2. Literature Review

A literature review is the procedure used to gather information on all relevant topics or criteria for the research project. It is one of the most important steps in the engineering design process. If incorrect data is gathered, the project will not succeed because the results will not turn out as expected. Thus, gathering and selecting the correct data for usage in this project is important. Numerous methods and tools, such as books and journals, can gather information. Patents and product comparisons are two other key components of knowledge gathering.

The pattern search is crucial since it provides a basic overview of how a pineapple collection tool should be created. By drawing inspiration from existing pattern designs, this process enables the generation of original and unique ideas. Better and more sustainable designs will arise from this. An appropriate and adequate pattern must be selected to guarantee that the pineapple collecting instrument's design will satisfy this research project's needs and goals.

The first pattern, as shown in **Fig. 1**, is the design pattern of the mechanical pineapple harvester by P.D Kahandage [5]. The harvester consists of a fruit picker, stalk holder, stalk cutter, handle, and operating levers. The description of the components is the handle carries all the components together and determines the length of the harvester. The material for the handle is a lightweight galvanized iron pipe with a 25 mm diameter. The total length of the handle was 2000 mm [5].

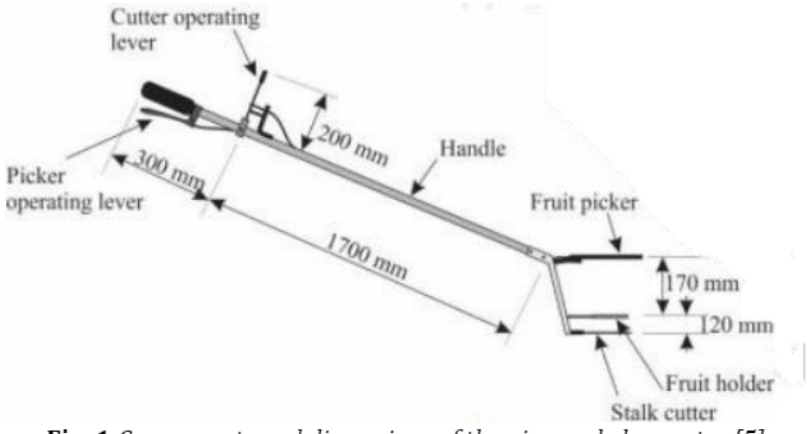
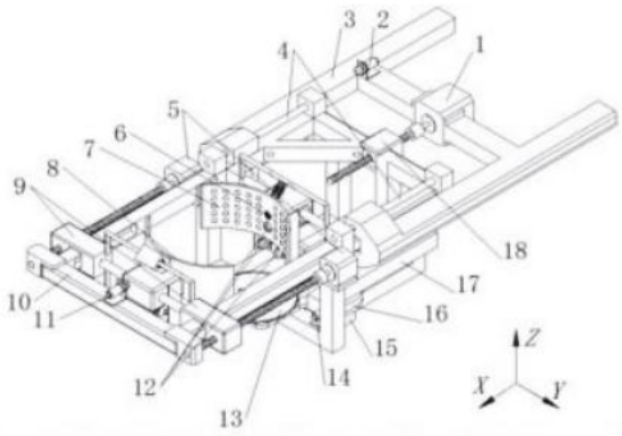


Fig. 1 *Components and dimensions of the pineapple harvester [5]*

Furthermore, the pattern design of the end-effector by X. Du is presented in **Fig. 2**. Based on this figure, it has four degrees of freedom, including the ability to move in the Z direction, the X direction for frame II, the X direction for the front finger, and the Y direction for the cutting blade. It may be mounted to the harvesting robot's robot arm. The robot arm completes the movement in the Z direction, and the end-motor effector's control actuator handles the remaining three degrees of freedom. The gripping and cutting mechanisms are the two main parts of the end-effector. To ensure that the end-effector precisely aligns the stalk and securely grasps the pineapple, the gripping mechanism consists of a front finger that moves on the guide rail, a back finger fixed to frame II, and a feedback system that uses a sensor. A blade and a cutter transmission box make up the cutting mechanism, which enables the blade to spin swiftly and feed in the X direction to cut the stalk quickly and precisely [6].



1 – Stepper motor I, 2 – Hall sensor, 3 – Frame I, 4. Guide bar, 5 – Stepper Motors II and III, 6 – Pressure sensor, 7 – Back finger, 8 – Front finger, 9 – Precision ball screw structure, 10 – Frame II, 11 – Hall sensor II, 12 – Infrared radiation sensors I, II, and III, 13 – Cutting blade, 14 – Hall sensor III, 15 – Stepper motor IV, 16 – Transmission case, 17 – Rack and 18 – Trapezoidal screw structure

Fig. 2 *A pineapple-picking end-effector [6]*

3. Methodology and Materials

The pineapple collector tool has gone through design and development progress. The main method is to do a literature review of the available product and registered patent either online (website) or offline (observation). Each product is evaluated and compared according to the material, weakness, strength, mechanism, and price.

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Table 1 *List of main components' materials with weights*

Main Component	Types of Materials	Weight (g)
Pull type trigger	Stainless steel	75
Grip	Rubber	5
Shaft	Stainless steel	500
Cable	Stainless steel	50
Branch Cutter	Steel	250
Claw	Stainless steel	400
	Total	1280

From **Table 1**, most of the main components use stainless steel because this iron alloy is resistant to rusting and corrosion. Furthermore, it contains at least 11% chromium and may contain elements such as carbon and other nonmetals to obtain desired properties. Stainless steel's resistance to corrosion results from chromium forming a passive film that can protect the material and self-heal in the presence of oxygen [7]. So, this material is durable and lightweight.

3.2 Method

Fig. 3 presents the fabrication process flow of the Pineapple Collector Tool. These activities involve measuring, cutting, machining, screwing, bending, and drilling.

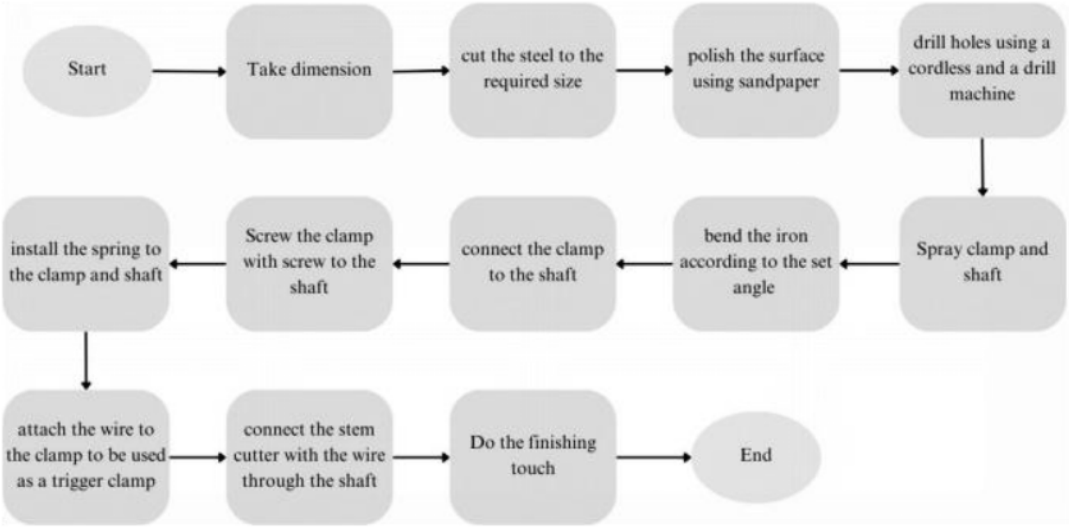


Fig. 3 *Fabrication process of pineapple collector tool*

4. Results and Discussions

The general operating procedures for The Pineapple Collector could be explained as below:

i. Point the clamp at the pineapple.
ii. Pulled the wire to open the clamp.
iii. Put the pineapple in the clamp area.
iv. Release the wire so that the clamp is closed and hold the pineapple.
v. Pulled the type of trigger to trigger the branch cutter and cut the stem.

Table 2 *Cost Estimation*

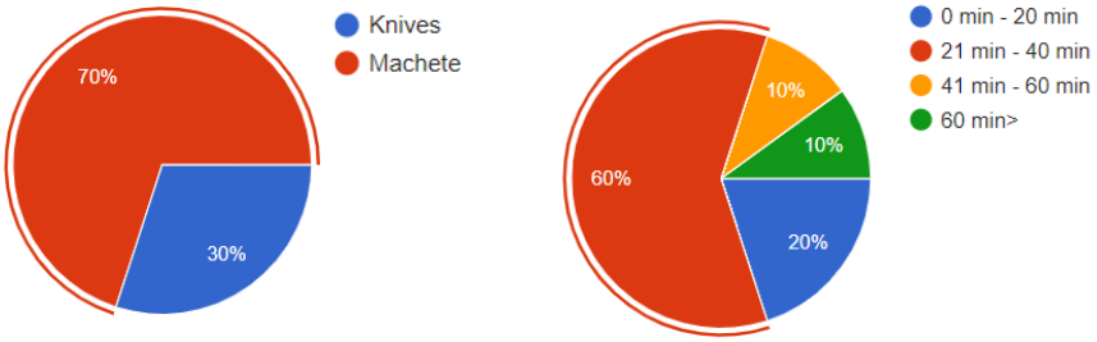
No.	Component	Quantity	Cost per Unit (RM)	Total Cost (RM)
1	Hanger Hook 1.5in 20s	1	2.00	2.00
2	Screw Set	1	2.00	2.00
3	Clamp	4	4.00	16.00
4	Spring Set	1	13.80	13.80
5	Steel Wire	2	3.50	7.00
6	Pull Type Trigger	1	16.80	16.80
7	Branch Cutter	1	22.50	22.50
8	Shaft	1	20.50	20.50
9	Washer Set	1	12.90	12.90
10	Nut Set	1	4.80	4.80
	Total		102.80	118.30

Table 2 lists all the costs for every component of the prototype. The estimated cost to construct this prototype is around RM 118.30. In addition, this project is to lift pineapples of different sizes where we build a clamp that can hold pineapples from 8 cm to 17 cm in size. The mechanism used for this clamp is shown in **Fig. 4**. For **Fig. 4(a)**, when the wire is pulled, the clamp will be wide open, and when the wire is released or in a static state, the clamp will be closed as shown in **Fig. 4(b)**. It is due to the spring attached to the clamp that is used to pull the clamp so that it is closed. Therefore, the energy used to hold the pineapple is the tension energy of the spring.

(a) (b)

Fig. 4 *Clamp mechanism (a)open; (b)closed*

After that, we studied this tool in terms of ergonomics to be used for a long period where this tool is paired with a long rod to reach the fruit at a long distance and also, the user does not have to bend his body. For example, they can cut a pineapple while standing up. According to **Fig. 5**, ten respondents that we have found indicate that the use of knives or machetes causes them back pain at certain times.



(a) Tools used to harvest pineapple fruit or other related situations

(b) How long does it take before back pain occurs when using the tool

Fig. 5 *Result using knives and machete*

However, the pineapple collector was given to ten respondents to know their responses in using this tool. Therefore, the results of using this tool to help them reduce body pain. So, this survey compares a knife or machete with this pineapple fruit-picking tool.

5. Conclusion

In conclusion, the Pineapple Collector tool is one of the tools that can help pineapple farmers harvest pineapples easily, it is equipped with cutters, clamps and a long shaft. In terms of clamping, it can clamp pineapples that are 8 cm - 17 cm in size. Next, the long shaft is one of the solutions to the ergonomic problem, where can reduce the user's back pain in using this tool for a long period. Furthermore, this device can accommodate different pineapple weights, especially the average pineapple weight which is 2 kg. Therefore, this tool is very suitable for pineapple farmers to facilitate their work in harvesting pineapples.

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Conflict of Interest

There is no conflict of interest with this paper, as it was identified by the authors.

Author Contribution

The authors have contributed to this past of the paper as follows: ***study conception and design:*** *Muhammad Imran Mazlan and Muhammad Hakimie Sudirman;* ***data collection:*** Muhammad Hamiemi Harun*;* ***analysis and interpretation of results:*** Muhammad Hamiemi Harun *and Muhammad Imran Mazlan;* ***draft manuscript preparation:*** *Mahmod Abd Hakim Mohamad, Nurfarahin Onn and Muhammad Hamiemi Harun. All authors reviewed the results and approved the final version of the manuscript.*

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