UNIVERSITI PUTRA MALAYSIA

FEASIBILITY DESIGN STUDY ON A RAPID PLANTER BASED ON GUN-TYPE MECHANISM

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APPROVAL SHEET

This project report attached here to, entitled "**FEASIBILITY DESIGN STUDY ON A RAPID PLANTER BASED ON GUN-TYPE MECHANISM**" prepared and submitted by **Aminudin Bin Kaulan** in partial fulfillment of the requirement for the degree of Bachelor of Engineering (Agricultural and Biosystems) is hereby accepted.

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ABSTRACT

A project on the feasibility design and fabrication of pineapple planter was conducted to replace the manual method of pineapple in field operations. Increasing of the soil depth and texture will result in longer time for planting due to the manual method using lot of energy and needs time to dig the ground. The factors considered in developing the pineapple planter are the demand of the user especially for the workers to make a hole and planting the pineapple shoot both in the same time. The length and size of the pineapple planter is 841 mm x 80mm (height and diameter) is to reduce low-back pain of workers for planting the pineapple seeds. Every worker is estimated to be given 32m x 16m area per day for planting depending on the weather and soil condition. This project is done by designing the tools in free-hand sketches, 2D drawing and 3D modeling. The model is then fabricated in the workshop and data is collected for analyzed.

ABSTRAK

Satu projek mengenai reka bentuk kelayakan dan fabrikasi penanam nanas dijalankan untuk menggantikan kaedah manual nanas dalam operasi lapangan. Peningkatan kedalaman tanah dan tekstur akan menghasilkan masa yang lebih lama untuk ditanam kerana kaedah manual menggunakan banyak tenaga dan memerlukan masa untuk menggali tanah. Faktor-faktor yang dipertimbangkan dalam membangunkan penanam nanas adalah permintaan pengguna terutamanya untuk pekerja membuat lubang dan menanam menembak nanas kedua-duanya dalam masa yang sama. Panjang dan saiz penanam nanas ialah 841 mm x 80mm (ketinggian dan garis pusat) untuk mengurangkan kesakitan pada tulang belakang pekerja untuk menanam benih nanas. Setiap pekerja dianggarkan diberi ruang 32m x 16m sehari untuk penanaman bergantung kepada cuaca dan keadaan tanah. Projek ini dilakukan dengan merancang alat dalam lakaran tangan bebas, lukisan 2D dan pemodelan 3D. Model kemudiannya dibuat di bengkel dan data dikumpulkan untuk dianalisis.

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Ha	Hectare
g	Grams
%	Percentage
^{o}C	Degree Celsius
Kg	Kilogram
mm	Millimeter
cm	Centimeter
J	Joule
hp	horse power
Kw	Kilowatt
m^3	Meter cube
kg/ m^3	Kilogram per meter cube
N	Newton
N/mm	Newton per millimeter
S	Second

CHAPTER 1

INTRODUCTION

1.1 Introductions to mechanization in the pineapple industry

Mechanization is important for the pineapple plantation industry in Malaysia, not only to overcome the labor shortage and enhance productivity but also to reduce the total cost of field operation and provide better working environment. In other words, the improvise mechanization can help to make the process of changing pineapple plantation industry to be more magnificent, futuristic, sustainable and be competent with the other countries. Indirectly, implementation of mechanization in the sector is in line with the government policy to gradually reduce the country dependence's on the foreign worker to 1.5 million in the year 2005 (Bernama, 2005)

Malaysia has an all-out region under pineapple over the most recent 5 years was just around 7-8 thousand ha and 5,000 ha are overseen by industries which develop pineapple for canning. New pineapple generation just the smallholders with a consolidated zone around 1,200 ha. The pineapple business in Malaysia is special in fact that 90% of the harvest is planted on peat soil. The present innovation for development of pineapple on peat seems sufficient in spite of the fact that the failure to automate on this sort of soil is an inconvenience even with the insufficient of labor work and increases in costs.

Mechanization for the estate operation is among the best long haul alternatives to beating the issue underway limitations. The presentation of homestead automation in many harvest generation frameworks has empowered makers to scatter their stresses over ranch work deficiencies, particularly amid pinnacle hours. Significantly, bigger ranches become possib;e with motorization. There are various pineapple machines accessible in the neighborhood or abroad markets. Be that as it may, the activity and working efficiencies of this hardware has not been tried under nearby climatic and soil conditions or adjusted for pineapple generation. The Malaysian Agricultural Research and Development Institute (MARDI) have embraced an investigation on the advancement of an automation bundle for business scale development of pineapple on mineral soil from planting to collecting. The investigation has demonstrated that the hardware framework assessed has some potential for use in vast scale generation of pineapples for both local and fare markets (Economical Transformation Programme Annual Report, 2012)

1.2 Problem statement

Mechanization of planting pineapple seeds has not been fully developed. The problem is planting the pineapple on peat soil manually is taking much time. In current practice, two workers are needed, one to dig hole and one to plant the seeds. This labour-intensive operation is not a sustainable practice. Development of a planting mechanism, suitable for local practice is needed.

There are many ways to dig holes into the ground. A widely used method is by an auger type hole digger, which can be manually operated or motorized. However, this method is slow. A rapid linear hole digger mechanism is needed to plant pineapple on the field. In this project a method based on gun-type mechanism will be studied. Digging and planting will be done in one pass.

1.3 Objectives

The main objective of this Final Year Project is to develop a prototype planter for pineapple seeds based on the Gun-Type Mechanism for faster operation. The specific objectives of this project are as follows:

a) To design and fabricate a hole digger mechanism.
b) To test and evaluate the functionality of the hole digger mechanism.

CHAPTER 2

LITERATURE REVIEW

This chapter covers critical and comprehensive reviews of current practice in planting pineapple, soil types, devices for the soil digging and brief review on Gun-Type Mechanism to identify and summarize the current research problems for the study.

2.1 Current practice in planting pineapple

The process of land preparation in large scale conventional operations can be summarized into these practices which are bush clearing, knock down, fluffing, burning trash, ripping and dragging, ploughing, soil conditioning, harrowing, pitch layout and cutting, field layout, rock removal and also fumigation and mulching. For the land preparation, lots of chemicals are used which are Glyphosate, paraquat, sulphur, lime, brimstone, rock phosphate and telone ll.

Samuel (2014) mention that planting is carried out manually using a planting iron. Every planter is given 32m x 16m area per day. Planting is done at the marks in the mulching polythene. There is no fertilizer applied during planting. Right after planting, irrigation follows within the first two weeks. In most cases, overhead irrigation is used to firm the soil around the planting material. If the ploughing tilth was fine, drip irrigation is used. From planting, in the absence of rain, irrigation is done once per month until the crop is ready for harvesting in the 19th month.

2.2 Soil types for planting Pineapple

Lal and Bruce, (1999) mentioned that good agricultural practices can reduce the emission of carbon if it was managed efficiently. This is important because it can educate the society to learn appreciate the needs for sustainable agricultural practices. The clearing of land for agriculture will change the environment the environment and peat swamp area needs to be drained as peatlands are waterlogged by nature. From a chemical point of view, soil acidity is the most relevant characteristic in connection with pineapple cultivation (Py et al., 1989). Knowing the pH of the soil is important for ensuring the proper soil management. The value of pH show the correlations with the soil type, vegetation type, profile horizon and, crops growth, lime requirement and mineral nutrition (Etherington, 1975). Unless the control of the pH is effective, even the compatible fertilization will not produce satisfactory results. The pineapple prefers acid (pH 4.5 to 5.5), weakly saturated soils and therefore maintaining the pH at the optimum values is difficult, mainly when the desired levels are low (Py et al., 1987).

Yield manor on peat soil is normal in Malaysia as the territory of peat soil in Malaysia is very wide and it happens to be situated close to the high populace zone where it is effectively can be available (Hashim, 1984). There are numerous sort of manor from the gigantic oil palm estates possessed by the enormous organizations to the self-sustenance planting of paddy rehearsed by the nearby ranchers.

Today, this is being cleared and we can look at the industrial profits, pineapple are planted on the peat soil and the sensibility of peat for agriculture has been researched and recollecting at 1970s (Joseph et al., 1974). The planting of harvests on the peat soils are at present done in a few territories in Malaysia particularly in Johor, Selangor and Sarawak. There is an expected about 2.4 million ha of peat soil in Malaysia and the greater part of this territory is situated in Sarawak. What is uncommon about the peat zone, with regards to farming to be known as a risky soil and connected with a high support cost as a result of the absence of specific minerals that are required for a solid development to certain yields (Joseph et al., 1974).

Anyway today, peat isn't something that has negligible qualities to the agribusiness as development on peat has turned into a typical practice. A few analysts remarkably from Malaysian Agricultural Research and Development Institute (MARDI) have been taking a shot at discovering the appropriateness of peat soil for the rural purposes (Tay et al., 1968; Joseph et al., 1974; Chew 1977; Tay and Lwings, 1985). The utilization of peat for horticulture has raised some critical natural issues and one of them is on the grounds that peat swamp must be depleted and hence this will influence the biological part of the dirt and condition.

Hanafi et al., (2009) state that the dry issue aggregation and apportioning of five pineapple cultivars into roots, stem, leaves, peduncle, organic product, and crown differed generously. The extent of full scale and micronutrients varied uniquely with pineapple plants parts and cultivars. All in all, all the pineapple cultivars develop well under winning soil conditions, for example, in exceptionally high causticity (pH – 3.) on tropical peat to high corrosiveness (pH 4.2) on mineral soil from sloping region . Lower pH of tropical peat is credited to the nearness of a lot of humic acids. Soil acridity is the most significant factor adding to effective pineapple development (Pye, Lacoueuilhe, and Teisson, 1987).

2.3 Devices for soil digging

Andriesse (1988) stated that it is hard to describe the physical properties of natural soils in light of the fact that the extents of the 4 segments change upon recovery or seepage for land usage. The top layer of peat soil is dim to extremely dull dim, made out of clayey mineral, and is 10-17 cm profound. A chunk of peat soil is lighter in weight than mineral soil when dried. Postponed depleting, low-bearing limit, irreversible property changes subsequent to drying, and profound flooding in the wet season are the fundamental constraints of peat soil. Drying of peat is viewed as risky on account of the irreversible subsidence of the ground level (SRDI staff, 1973 and 1985-1993).

There are many tools that we use for the soil digging. To make a machine that can dig with the depth required, we must choose the tools that suitable with the purpose and the soil type. Table 2.1 shows the tools and their function:

Table 2.1: Example of soil digging tools and their functions

TOOL	FUNCTIONS
Square shovel	Digging in hard-packed soils, scooping and moving soil, gravel, mulch, sand or rock.
Trench shovel	Digging and clearing trenches. Laying irrigation pipes or removing deep-rooted plants.
Plumber's shovel	Designed for digging drains, holes, laying pipe and shifting and spreading soil. It has an extra-long handle for greater leverage.
Post hole pincer	Break through loose soil and dig holes to sink fence posts or patio supports and to plant bulbs.
Mattock	Digging and chopping. They have a long handle, and a head with an axe blade and a cutter for digging up and cutting tree roots.
Crowbar	Digging in soft or hard soil. They can also be used to break up rocks and concrete or as a lever to move heavy objects.
Auger	Removes the material out of the hole being drilled. Augers are ideal for digging post holes, hanging gates and planting trees and shrubs.

Hardy (1938) found out that in case of tools designed to cut plant roots, the blades are to be swept back at an angle between 20 and 50 degree to increase cutting effectiveness. Soil working tools causing the soil to fail as it moves through it. The models of soil failure are extremely complicated in agricultural soils and vary with soil and tool parameters. The dynamic soil reactions are of prime importance from the point of view of digging tool design.

Chase (1942) while analyzing lift angle of tiller blades, observed that a low lift angle (rake angle) of 16 degree accelerated soil cutting and higher lift angles accentuated the upheaval of soil around the tool and that the soil shattering was satisfactory at higher lift angle of 35 degree for dry and brittle soils.

Kawamura (1952) reported that minimum draft occurred at a lift angle of 25 degree for shallow tillage tools. Payne (1956) suggested that at 20 degree lift angle, the draft for a 10 cm wide chisel was minimum.

Kaburaki and Kisu (1959) saw that an expansion in methodology edge diminished draft until an edge of 40 deg. Osman (1964) contemplated the conduct of more extensive cutting sharp edges and saw that the draft was least at a lift edge of 20 deg. Hettiaratchi et al (1966) built up a two dimensional model for soil disappointment before a more extensive instrument cutting the dirt. Gill and Vanden Berg (1967) likewise announced that draft constrain was least at 20 deg lift plot for slanted instruments which are working at shallow profundity. Luth and Wismer (1971) characterized the edges upto a width of 254 mm as restricted cutting edges and expressed that the draft was identified with the square of speed. Hettiaratchi and Reece (1974), Godwin and Spoor (1977), Mckyes and

Ali (1977), and Perumpral et al (1983) connected the method to limit culturing instruments and it was streamlined to an offer lift edge of 20 deg for least draft.

Mckyes and Ali (1977) decided a disappointment display comprising of a straight rupture plane starting from the cutting edge to the soil surface and it was concluded that the draft force was minimum at a lift angle of 20 deg. Godwin and Spoor (1977) and Grisso et al (1980) indicated that the performance of a soil working tool depended on its shape, orientation during movement and initial soil conditions. It was concluded that the draft force of a soil working tool is directly proportional to the tool width and increases exponentially with operating width.

Jan et al (1991) inferred that control necessities of culturing executes assume a vital job in the plan of culturing actualizes. Studies were directed on chosen actualizes, for example, back mounted three base form board furrow, back mounted three base plate furrow, and back mounted pair circle harrow in dirt topsoil soil at dampness substance of around 16 percent at a profundity of 150 mm. The power necessities of executes under investigation were determined and proposed appropriate furrow for that dirt.

Wulfsohn et al (1996) talked about horticultural shear quality based models and presumed that dirt water attributes decide the dirt conduct. It was anticipated that for an instrument width-profundity proportion of 5, working at 150 mm profundity and 40 deg rake edge, the draft of the device expanded to 12.2 kN up to 15 percent dampness content, while the draft expanded to 5.5 kN when the dirt dampness was diminished to 13 percent.

2.4 Review on Gun-Type Mechanism

A gun is a weapon that uses the force of an explosive propellant to project a missile. Guns or firearms are classified by the diameter of the barrel opening. This is known as the calibre of the gun.

The building blocks of a smart gun technology system are the key, the discriminator, and the latch. There are three types of trigger mechanism. When the trigger is pulled the hammer hits the firing pin. The firing pin then hits the primer which causes the powder to burn hence producing lots of gases. This causes the volume behind the bullet to fill with extremely high pressure gas. The gas pushes on every surface it encounters, including the bullet in front of it and the base of the gun barrel behind it. The increase in pressure caused by the gases causes the bullet to be forced into the barrel hence causing the bullet to come out the muzzle at very high speeds. Once the bullet is fired, it remains in motion from its momentum. The momentum will carry the bullet until it strikes an object or gravity pulls the bullet towards the earth. Conservation of momentum is the law that is held true when the gun is fired and a "kick" is felt. When a bullet is fired from a gun, total momentum before is zero since nothing is moving. After firing the bullet there is a momentum in the forward direction. The gun must therefore have the same magnitude of momentum but in the opposite direction so that they cancel each other out leaving the total momentum still equal to zero (School Work Helper, 2017).

In agriculture, there are many tools or machine that followed the mechanism of a gun. As an example, the hand powered with trigger mechanism, hand powered with lever mechanism, battery operated grease guns and push type grease guns. All these tools are applied in agriculture sector for a faster and better ways. But for the digging purpose, conventional method still widely used in agriculture especially in pineapple planting. Shovels and spades are the tools that small farmers used in their daily operation. The square edge of a spade allows you to cut into the soil by pushing down on its back edge with our foot, pulling back the handle like a lever and then turning over the dirt.

Soil augers are the most suitable tools that can be implied with the gun type mechanism. The benefits of this tool are access tubes installed in good contact with the soil, rapid and consistent installation, simple system that adapts to most soils, easy to carry and robust. This augering method can be used in any type of soil. Augering can dig a hole deep enough. For the short tubes, it can insert to 0.55m and the long tubes can insert to 1.15m (Delta-T Devices Ltd, 2005). The holes for the pineapple to be planted are only about 0.1m-0.15. So a shorter tube can dig a hole to that measurement.

2.5 Vegetative Parts of Pineapple

There are many parts of the pineapple plants that can be growth. The parts that can produce a new plant are called vegetative parts. In this modern era, there is huge variety of types of vegetative material and both of cultivar and environment give impact to the availability and quality of material used to plant these commercial crops. The most well-known vegetative parts used in the pineapple cultivation are crown, slips, hapas and suckers. Crowns are the part from the top of the fruit. Slips are from the peduncle below the fruit. Next is hapas, which is developed in the transition zone between the stem and peduncle. The last part is sucker, which is the most bottom part below the stem-peduncle transition zone (Py et al., 1984). Suckers that produced on the lower part of the stem with roots that grow into the ground are called ground suckers.

There is another method besides using vegetative parts which is the planting materials may obtained under field or nursery conditions by human interference by applying specific techniques. The first technique is using the plantlets. Plantlets obtained by cutting the sectioning parts of the plants, to allow the development of lateral buds or the small stem of the conventional types of planting material. Second technique is the plantlets forced to develop by stopping the apical growing point of vegetative plants and stimulate the growth of lateral buds. The last technique is plant treatment with chlorflurenol at flower initiation to let the plantlets (propagules) formed instead of flowers and fruitlets (HEPTON, 2003).

Finally, there is micropropagation method which is the multiplication of pineapple in vitro, a technique for the rapid multiplication of breeding programs to produce the new cultivars. Each type of planting material will be classified according to its characteristics, practical aspects and recent advances related to crop management and multiplication techniques.

CHAPTER 3

MATERIALS AND METHOD

The project is started by examining by the current method used in planting the pineapples in the field of agriculture by smallholder farmer. Once the problem is identified, the study of characteristics of pineapple and the best methods that can be used to dig and plant in the area of small- scale farmers in fields are identified. In this section we will discuss and propose the methods that will be use along the design of the project. There are procedures in producing a tool that we will discuss in this section. For this project, the methods that we use are freehand sketches concept, design model and the proof of concept.

3.1 The Principle of Machine

The hand tool machine was designed based on the principle of pineapple seed failure due to shear, and soil or root failure due to impact and abrasion. The machine design calculations used the principle of machine component design to determine the power, speed and torque for the pushing system in the machine and other component parts. The component parts and assembly drawing of the hand tool machine was carried out.

3.2 Design concept

Design concept is the imagination and idea that we have in a design. It is where we plan the solution of the design problem. It is underlying logic, thinking and reasoning for how we will design our project. In theoretical, we have to design a tool which can dig a hole in the same time planting the pineapple. To get this whole idea, we have to get to the pineapple plantation and observe the conventional ways of planting pineapple. Through the observation, we will understand more about the problems and help to improve the producing of the tools.

For the study of gun type mechanism, we are using the You Tube channel, journal and other research to study the mechanism. The design of the rapid planter is likely to be a digger but using the Gun-Type mechanism. To adapt the push mechanism into a soil digger is we have to undergo some trial and experiment in a workshop.

3.3 Design Criteria

In developing the soil digger, there are five criteria that must to be considered before we fabricate it. This planter prototype consists of tube and the digger. The criteria must be implemented to the prototype parts. The five criteria of soil digger are hopper, path tube, storage mechanism, opening furrow mechanism and closing furrow mechanism.

3.3.1 Hopper

For the prototype hopper, we must consider the size of the pineapple seeds. LPNM stated that the seeds are classified to three sizes which are big, moderate and small. The big sizes of seeds are in the range of 60 cm, moderate sizes in are the range of 45cm and the small size are in the range of 30 cm. The diameter for the seeds are measured in the average of 6 – 8 cm. Based on the criteria of the various type of seed, we have choose UPVC PIPE BS 3506 50mm as the hopper. For this size of PVC, only the small seeds of pineapple can be put into the hopper. The pineapple seeds must be put into the hopper one by one. More than one of seeds at one time can cause the hopper stuck.

3.3.2 Path tube

Path tube is the tube that keeps the seeds flow to the ground in one way direction. The path tube used for this prototype is the same PVC that used for the hopper part. The length of the path tube is to be considered at the level of operator's waist. The size of path tube is important to allow the seeds flow without restrictions and ergonomic enough to be used by the operators. For the path tube, the length that we considered is in the range of 70 – 80 cm. The diameter of the path tube is 8 cm which allow only the small type of seeds through pass.

3.3.3 Storage mechanism

Storage mechanism is important part of planter as it allows numbers of seeds to be planted. For this prototype, the seeds are allowed to plant only one seed per time. The operator must carry the remaining seeds at their back. Conventional way is used in carrying the basket with numerous seeds. To operate, the operator only needs to take a seed per time and put into the prototype. The seed will fall to the ground due to the gravity force. These procedures have to be repeated until all the seeds are planted.

3.3.4 Furrow opening mechanism

Peat soil has low bearing capacity which means the soil is soft and small force is needed to dig the soil. For opening the furrow, we have to use the digger with the suitable diameter and length. The material that we use for the digger is aluminum alloy pipe. The weight of the digger material helps to increase the impact between the soil and the digger. LPNM stated that the suitable depths of the holes are in the range of 4 – 6 inch.When the furrow is opened, the operator need to pull up the planter and release the seeds. The digger length should be more than 6 inch to minimize the errors in digging the holes

3.3.5 Furrow closing mechanism

After the seeds are planted, the holes need to be compacted and closed. An adjustable furrow closing assembly enhances upper seed groove coverage and closure with soil resulting in sustained relative humidity levels and optimum seed-to-soil contact for faster seed germination. . Adjustable down-force systems are provided to vary the down force applied to the closing wheels and the press wheel to maintain optimum soil contact in irregular terrain and in varying soil densities and conditions to provide optimum soil coverage and compaction of the seed bed. For this operation, the operator has to step on the peat soil until the surface of the peat soil is compacted.

3.4 Experimental Methods for Machine Testing

The performance evaluation of the fabricated pineapple planter was conducted at the experimental field of Faculty of Engineering University Putra Malaysia The planter hand tool was tested on the mapped out plots to determine the planting efficiency and time motion study.

The performance of the planter was investigated by considering the effects of two types of pineapple seeds on the success of planter on the peat soil. The data were measured at the position of seeds after planted for 10 times. The steps are repeated to three trials each type of seed. The mean for the three trials are taken as the last results.

The planter success rate and percentage of seeds planted in tilted position were determined by the following equations.

Percentage of tilted seeds = type of seed in tilted position/total seed planted x 100%

Planter Success Rate = [(total seed planted) - (tilted seed)] x 100%

Time motion study is the time taken of the planter to complete both digging and planting operations. The data were recorded by observing the operations starting from the pushing of planter on ground and end after the seeds were planted on the ground. The data is taken to 10 seeds planted.

The speed of the planter to complete the operation is calculated by:

Speed (m/s) = total distance between holes (meter)/time taken to complete an operation

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Design of Pineapple Planter

4.1.1 Free hand sketches

The freehand sketches methods are used in the early design concept. By doing the freehand sketches, we produced two or more ideas to get the best design. The concept that we use related to the Auger which is a digging tool for the soil sample. Auger is the most suitable tools to be implied with the Gun-Type mechanism. With these ideas, we will produce a tool that can dig a hole and plant the pineapple at one time. The images that we sketch have to be annotated and no ruler needed in this method.

The parts by part of the hand tool machine were drawn based on the available part in the workshop and machinery shop. The whole parts will be assembly together to be a completed hand tool machine. After the ideas of freehand sketches complete, we will further our sketches in 2D and 3D drawing. The sketches will be turn into a more realistic image with the help of Auto Cad or Inventor. The drawing is based on the best freehand sketches that we choose. In a conclusion, free hand sketch method helps us to get the ideas about the tool that we produced for our project.

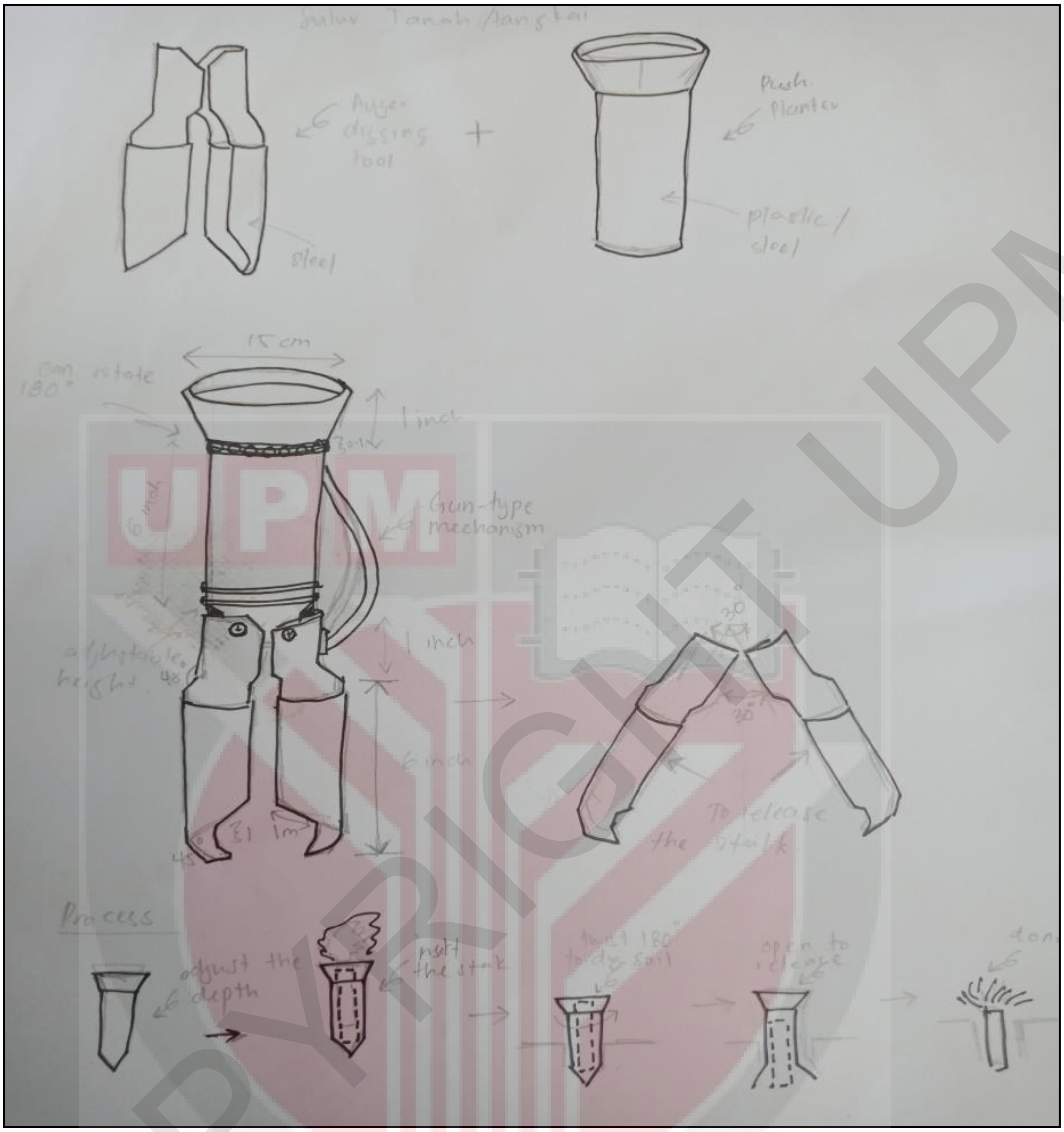

Figure 4.1: Earlier stage of freehand sketches

4.1.2 2D Drawing

1. First model of Pineapple Planter

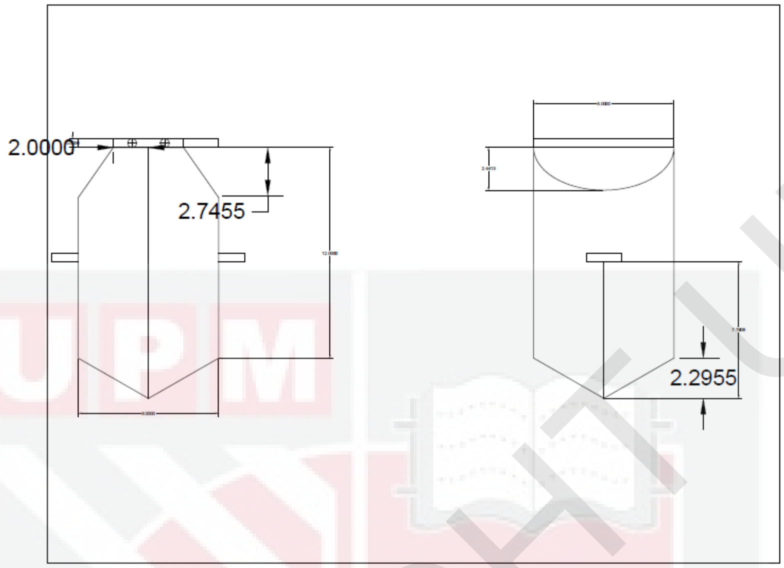

Figure 4.2: 2D drawing 1st model of digger

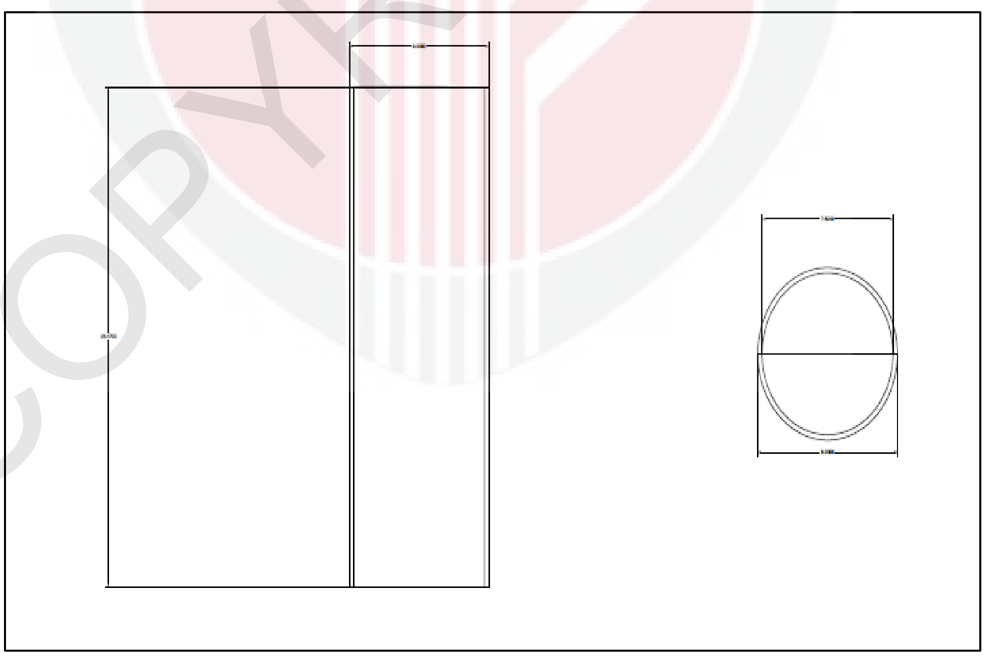

Figure 4.3: 2D drawing 1st model of inner cylinder

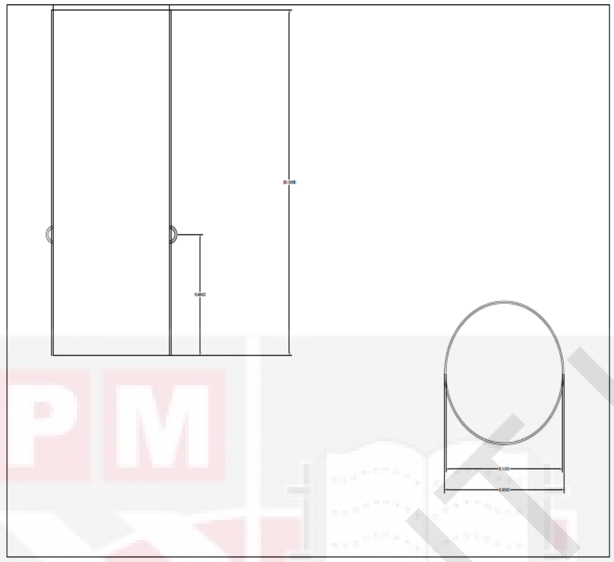

Figure 4.4: 2D drawing 1st model of outer cylinder

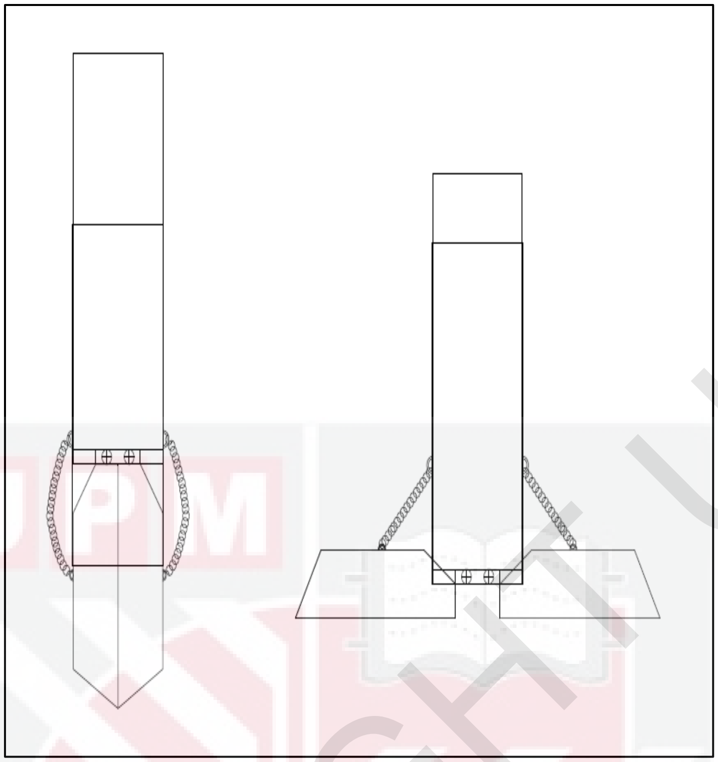

Figure 4.5: 2D drawing 1st model of full planter

2. 2nd model of Pineapple Planter in 2D

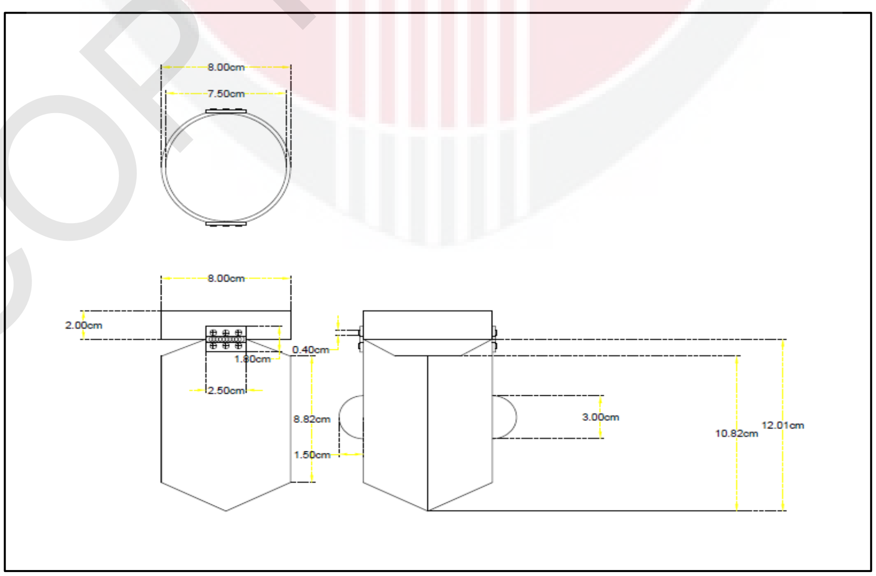

Figure 4.6: 2D drawing 2nd model of digger

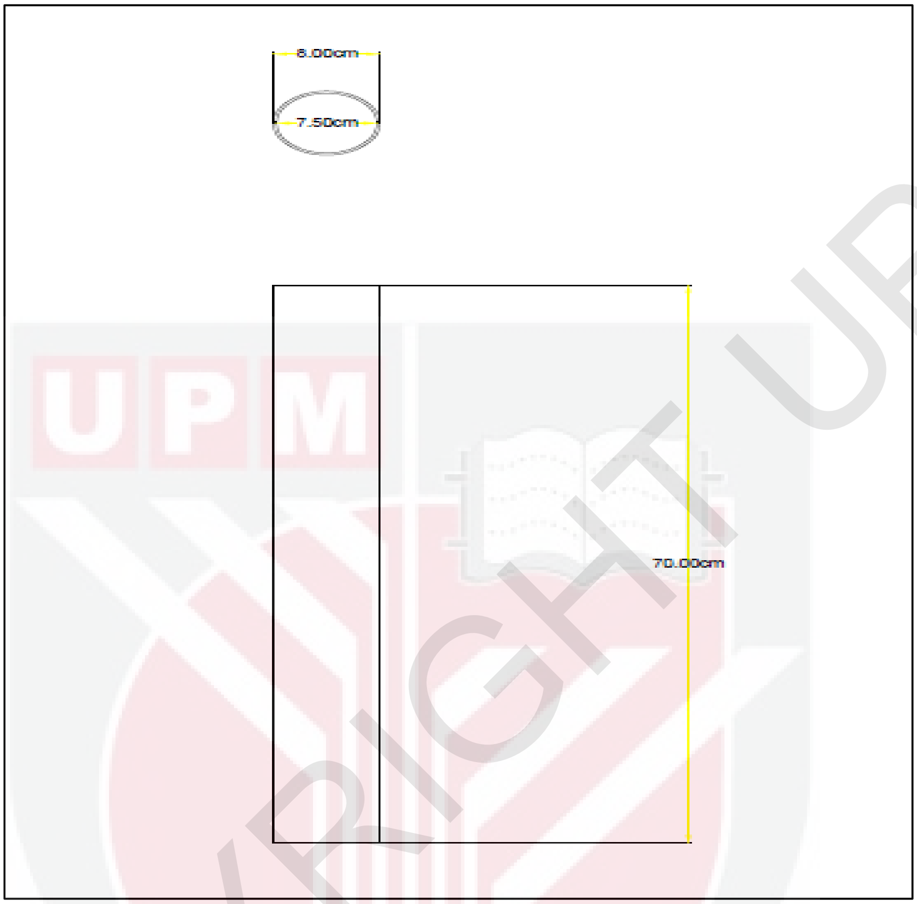

Figure 4.7: 2D drawing 2nd model of inner cylinder

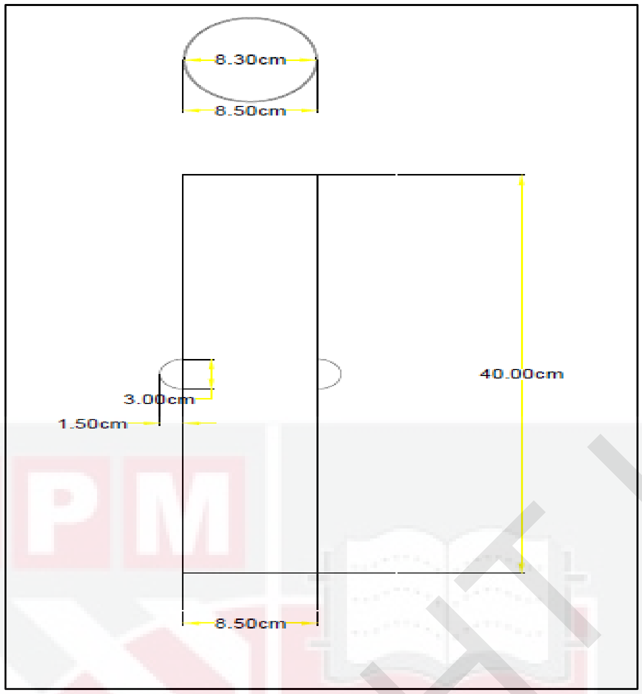

Figure 4.8: 2D drawing 2nd model of outer cylinder

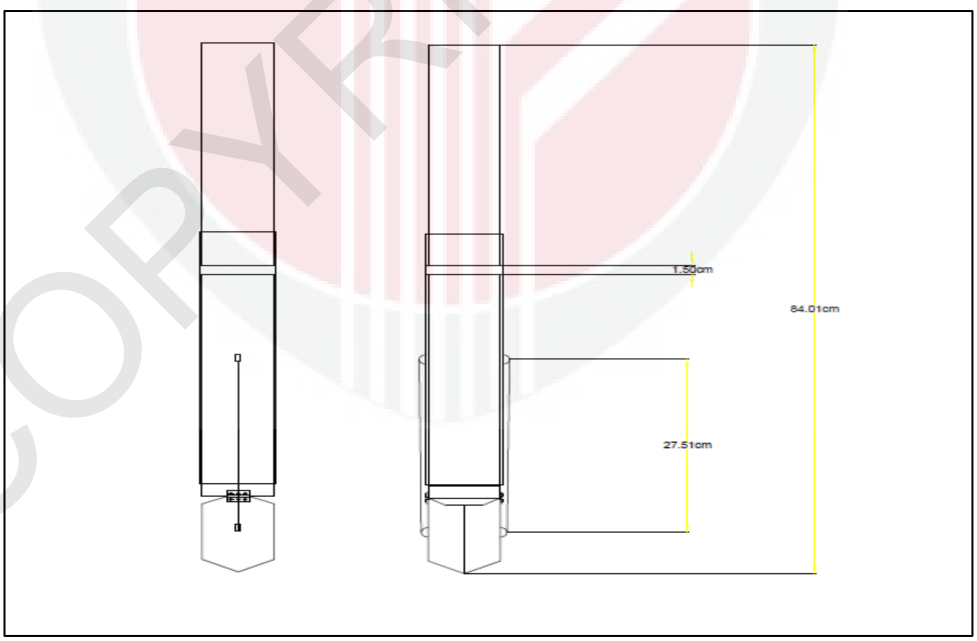

Figure 4.9: 2D drawing 2nd model of full planter

4.1.3 3D Drawing

1. 1st model of Pineapple Planter in 3D

Figure 4.10: 3D modeling of 1st model in shaded display

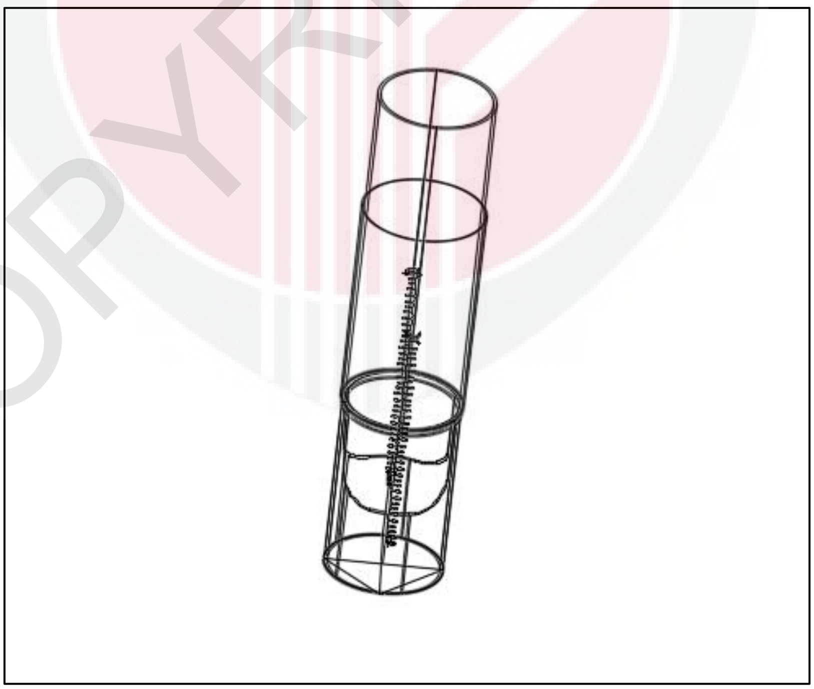

Figure 4.11: 3D modeling of 1st model in wireframe display

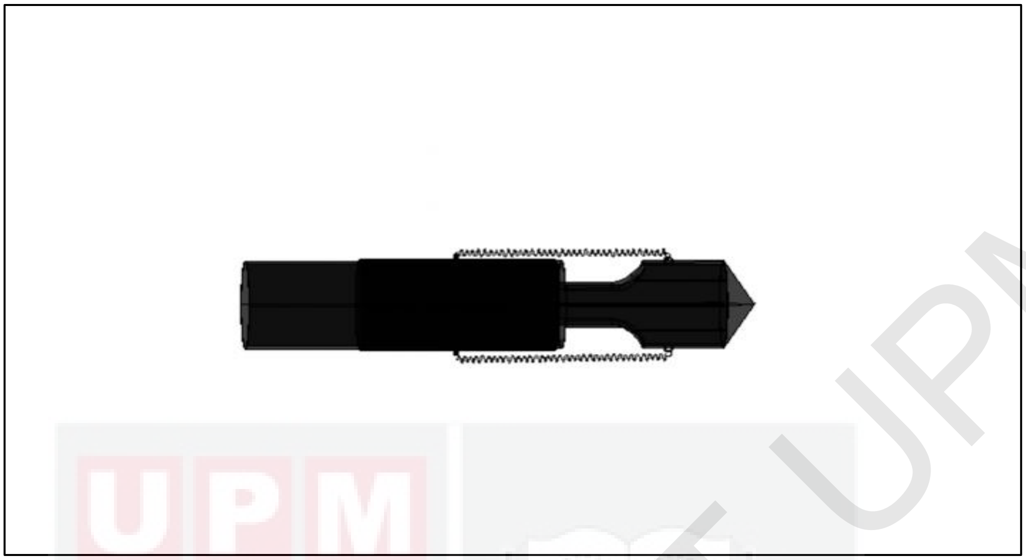

Figure 4.12: 3D modeling of 1st model in x-ray display

2. 2nd model of Pineapple Planter in 3D

Figure 4.13: 3D modeling of 2nd model in shaded display

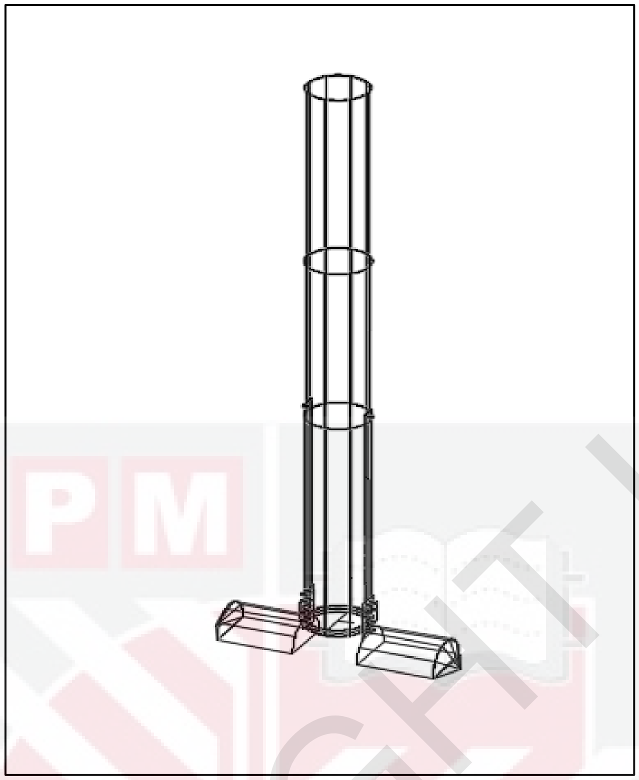

Figure 4.14: 3D modeling of 2nd model in wireframe display

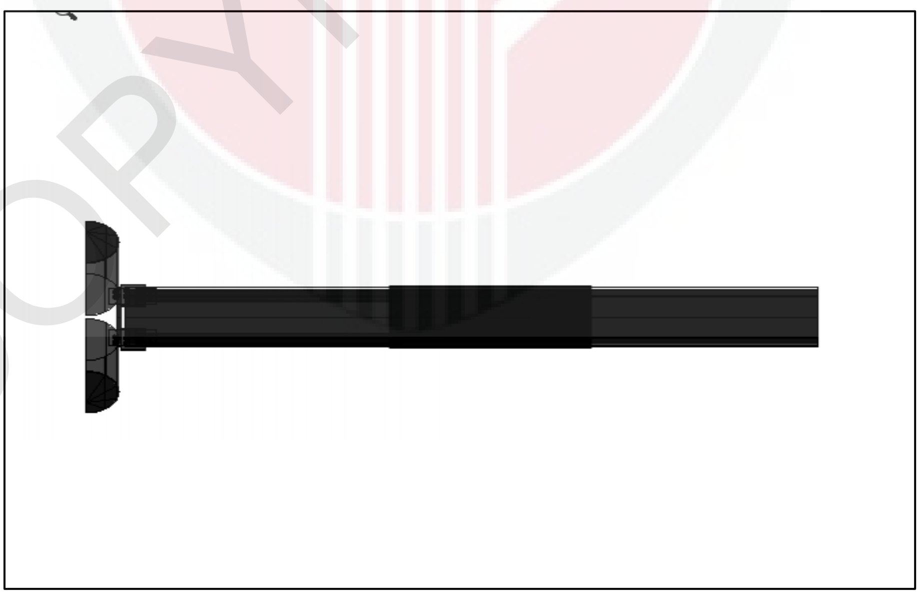

Figure 4.15: 3D modeling of 2nd model in x-ray display

4.2 Design Model

Design model is an object that describes the analysis of the force, kinematic and dynamic those serve as an abstraction of the implementation model. This model is important as it will be used in our implementation and test activities. In another terms, design model is the working model. All the calculations involved will be applied in this step. It is important to have the design model as this method will give us the information and suitable materials for our project.

Strength of materials is important in mechanization. For the agriculture purposes, many factors those are essential to ensure a better and faster process. Safety is one of the main reasons to have a suitable strength material used in machinery. Thus, in this design model we have to draw each component that is used in our project. The assembly part drawing will let the manufacturer know the components that are used in the tools. For this planter, we should have a simple machine to save the cost and maintenance.

The next step is fabrication which is the production of the tools. The design model or drawing that is completed will be send to the manufacturer for the fabrication. Each part of drawing must be detailed to avoid any misconception in fabrication. Exceptional to the parts which already have in the market such as screw and bearing where they already have the fix measurement. In fabrication, the bills of each material have to be attached to let the customer know from where we get the supplies from.

4.2.1 Design Assumption and Design Calculations

The assumptions made in the design of the pineapple planter were considered with reference to the field conditions and force requirement

- width of digger, d cm = 8 cm
- Effective depth of hole, w cm = 10 – 15 cm
- Bearing capacity of peat soil = 0.2 Mpa

4.2.2 Digging Force Calculation

Digging force is force required by the planter to dig the holes. These forces are exerted at the tip of the digger. Generally digging force is calculated at maximum breakout condition of the linkages. Maximum breakout condition is the condition at which the planter generates maximum digging force. Due to digging force involved;

$P = F_D / A$ equation (4.1)

P = Bearing capacity of peat soil

A = Area of holes

F_D = Digging force

Find the digging force needed by using equation (4.1)

$F_D = P \times \pi r^2$

r = radius of the digger

F_D = [0.2 Mpa x [π x (0.04 m)²

$F_D = 1.005 \times 10^{-3}$ KN

For easier operation of the planter, it is important that the digging force must be greater than the resistive force offered by soil. Digging force needed, $F > F_B = 1.005 \times 10^{-3}$ KN

4.3 Proof of Concept

In mechanical engineering, proof of concept (PoC) is a critical and important part of the design process. In this method, we will determine the part of assembly that must perform a function. So a basic physical model in manufactured to prove that the machine can be produced. The proof of concept is not a prototype but it is a machine which is still under the trial session. When PoC having failure during the trial session, it still can be improved and changed. PoC is not for marketing and have no value in the market.

To test the functions of the tools, we do several outdoor trials. For the earlier trial, we will test it on the soil around the faculty of engineering. There will be improvised before it can be applied at the pineapple plantation. The data will be taken in this section to be recorded and comparing it to the other ways of planting pineapple. Time motion study and the efficiency of planter are two important data that will be taken.

4.3.1 Fabrication Processes

The fabrication of the pineapple hand tool planter was done. The fabrication processes cutting, folding and grinding of different parts together. The planter was constructed in such a way that the digger and outer cylinder PVC can be detached manually without damaged.

Figure 4.16: Open and close mechanism of planter

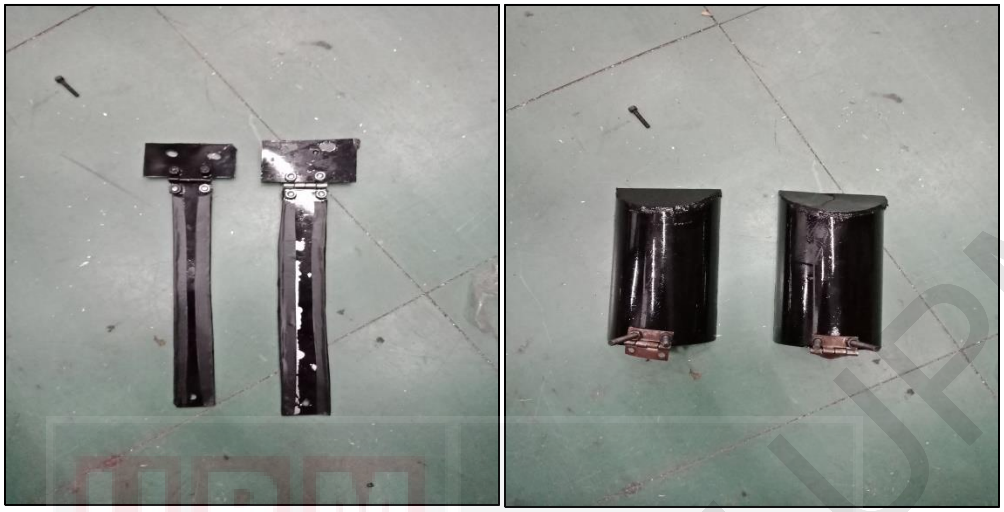

Figure 4.17: T-shape plat pusher & digger parts

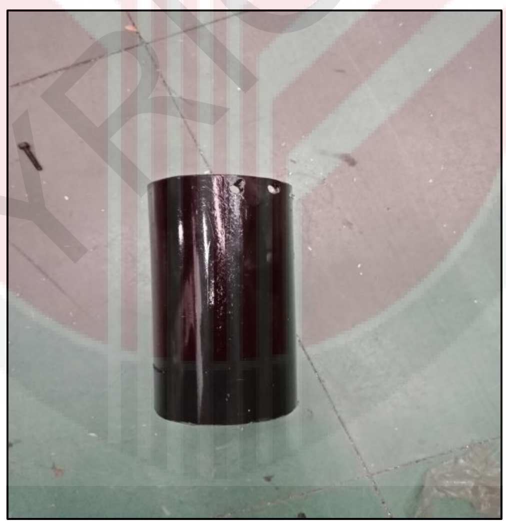

Figure 4.18: Cut part of steel pipe

Figure 4.19: PVC for outer cylinder part

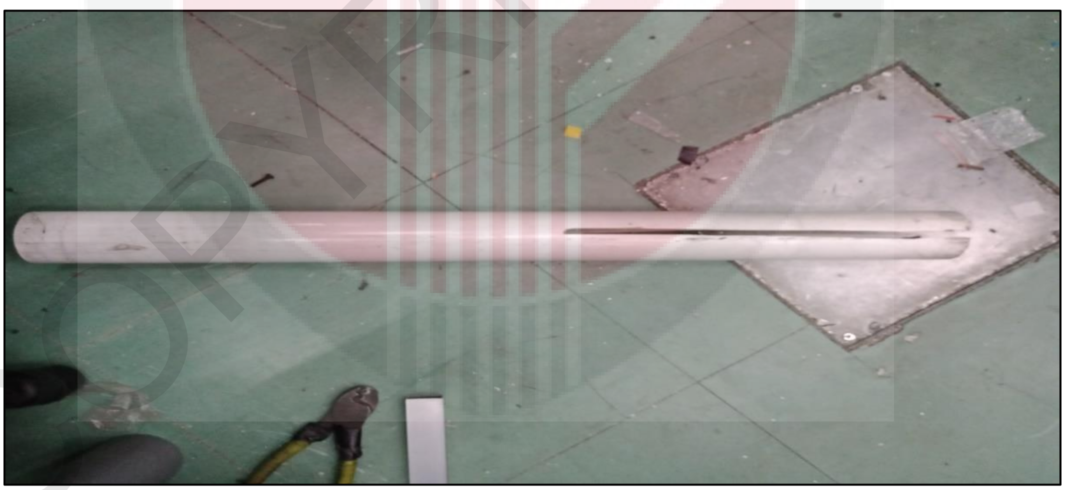

Figure 4.20: SWV Pipe for inner cylinder part

4.3.2 Background of the Invention Hand Tool

This planter relates to an improved dig and plant method which is using 100% labor work and can affected the body of workers. The holes digging for the pineapple seeds in the field can be accomplished by using mechanical tools. The conventional method possesses the disadvantages of using their lower back to dig a hole and planting the shoots. The method also required high consumption of energy where most of the smallholders are exceed of their working ages. Ergonomic is an important factor in developing or invent a new machine towards society.

Mechanical pineapple shoots planter, to be effective, requires planting of different types of pineapple. There is various size of pineapple that needs to be considered. Depending on the size of the pineapple shoots to be planted, the hole also can be different in diameter and depth. The shoots planted must be in a straight position or else there will be problems during the growth. Thus, a correct way must be performed by the workers in handling the pineapple planter.

The holes dig must be around 10 – 15 cm depth to get an optimum nutrient for the seeds. The digger of the planter is maximized to 15 cm of height as the workers can adjust the depth of the holes dig. The uses of the PVC for the hopper and handler are to minimize the power and energy required. The combination of these materials described herein offers that flexibility.

4.3.3 Brief Description of the Invention

Pineapple planter is performed and handled manually by human. There are three main parts in this planter which are the outer cylinder made from PVC, inner cylinder made from PVC and also a pair of digger made from steel. PVC used for both of the cylinders to reduce the weight of the planter. While digger are heavier as it act as a momentum for the planter as it dig a hole. All of these parts are detachable for maintenance purpose and also for the convenience of the workers.

The height of the planter is about 0.84 meter from the ground with the diameter of 0.08m which acts as hopper for the pineapple seeds entrance. The inner cylinder is attached with the digger while the outer cylinder acts as the adjustable cylinder which can be move up and down. This planter enables only one pineapple seeds to be planted per operation. More than one seeds will cause the problem in the cylinder as it may stuck with the another seeds.

To operate this planter, the user must make sure the digger is closed by pushing the outer cylinder downward. Then they have to put the pineapple seeds through the inner cylinder. Next, they just have to push the planter into the peat soil. The depth of the holes for the seeds can be determined by observing the digger. The digger dimension is made accordingly with the holes desired. When the digger is fully pushed in the peat soil, the user needs to pull out the planter and open the digger by pulling the outer cylinder upwards. This method will allow the seeds to be dropped into the holes.

When using the planter, the user can adjust the height of the planter in an optimum position to reduce the stress at the lower back and knee when pushing the planter in operation which is ergonomically desirable. All the user need is changing the inner cylinder with the different length of PVC with same diameter. This detachable tool enables the user to perform the operation without bending down. The handle was positioned above the hip height so as to avoid the bending posture; this was reported by Nwuba, (1982) to have contributed mostly to the high energy demand of most manually planting. Hence, this planter has considered as good at 840 mm height above the ground. The planter dimension (840mm x 8mm) is suitable for planting operation on the peat soil.

4.4 Materials Used in Pineapple Planter

Table 3.2 shows the materials used in the fabrication of the planter. The dimension of each material was measured for detailed design of the various part of the component. Most of the material used was modified to make it suit with its function such as the digger. Some moving part of the planter attached with another material which is using 1mm aluminum plate and drilled with 24.5 mm of diameter. All the elements were designed with changeable without damaged for maintaining purpose. The overall cost for this planter is only RM 35.00 not included the steel, screw and nut that readily available in the workshop.

Table 4.1: List of material used available in market

No	Figures	Description	Quantity	Market price
1.		UPVC PIPE BS 3506 50 mm CLASS O	1	RM 2.00 x 2 ft = RM 4.00
2.		UPVC SWV PIPE MS 1063 2 inches	1	RM 2.00 x 2 ft = RM 4.00
3.		Stainless steel 304 machine bolt	8	RM 13.90 for 100 pcs
4.		Metric M4 Hex Nut 304 Stainless Steel DIN 934	10	RM 9.80 for 100 pcs

5.		Alloy steel countersunk Hex Socket Knurled Bolt M2.5 x 20 mm	8	RM 18.10 for 100 pcs
6.		2 inches x 2 inches mild steel hinges	4	RM 1.40 x 4 unit = RM 5.60
7.		Aluminum Alloy Pipe 6082	1	RM 7.53 per Kg X 1 Kg = RM 7.53
8.		Bopla 27000300 Front Plate Aluminum 1mm thickness	1	RM 37.36
			Total cost	RM 100.29

4.5 Efficiency of prototype mechanism

Table 4.1 shows the percentage of upright suckers, tilted suckers and success rate for the planter to plant suckers in right position. While in Table 4.2 shows the percentage of upright crown, tilted crowns and success rate for the planter to plant crowns in right position. The condition of peat soil and length of the seeds affected the success rate due to the digger cannot control the positioning of the seeds planted.

The results show that planting crown has a bit higher success rate than planting the suckers by using this planter. Figure 4.1 and 4.2 shows the differences between two levels of seeds length. The crown length gives more success rate by having most of the hole planted with the upright position without tilted compared to the suckers.

TRIAL	PERCENTAGE OF SUCKERS (%)			
	TOTAL SUCKERS	UPRIGHT SUCKERS, **S**up	TILTED SUCKERS. **S**td	SUCCESS RATE (%)
1	10	7	3	70
2	10	6	4	60
3	10	7	3	70
MEAN	10	6.67	3.33	66.7

Table 4.2: Upright, tilted position and efficiency of planter in planting suckers

TRIAL	PERCENTAGE OF CROWNS (%)			
	TOTAL CROWNS	UPRIGHT CROWNS, **C**up	TILTED CROWNS. **C**td	SUCCESS RATE (%)
1	10	9	1	90
2	10	9	1	90
3	10	8	2	80
MEAN	10	8.67	1.33	86.7

Table 4.3: Upright, tilted position and efficiency of planter in planting crowns

4.6 Time Motion Study

Time motion study of the pineapple planter was observed by how many holes dig and seeds can be planted against the time. 10 holes and seeds are planted and the time is taken to complete all the 10 seeds planted. This time motion study is to observe the speed of the planter in digging and planting.

Num. of holes	Distance between holes (meter)	Time taken (seconds)	Speed (m/s)
1	0.2	8	0.025
2	0.2	8	0.025
3	0.2	8	0.025
4	0.2	7	0.028
5	0.2	8	0.025
6	0.2	9	0.022
7	0.2	9	0.022
8	0.2	10	0.02
9	0.2	8	0.025
10	0.2	7	0.028
MEAN	0.2	8.20	0.0245
TOTAL	2	82	0.245

Table 4.4: Time taken and speed for digging and planting operation

The result shows that each hole takes an average of 8.2 seconds to complete an operation. The total time to plant 10 seeds is about 1.5 minutes with distance for each hole is 0.2 meter. The time recorded is divided with the total distance between holes to get the speed of planter. The speed for each planter to dig and plant a seed is 0.025 m/s. The speed of planter is important to evaluate the duration of the whole operations in planting the pineapple on the field.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Based on the planting operation of the developed machine in the field that classify as peat soil, the result of planter success rate increased with the decreasing of seed size. The results show that planting crown has a bit higher success rate than planting the suckers by using this planter. The crown length gives more success rate by having most of the hole planted with the upright position without tilted compared to the suckers. The success rate in planting the crown has reach to 90% respectively. However for the suckers, the planter may need some modification to be made to suit the length of the suckers.

In time motion study, we can observe that each hole planted with the seeds take the average of 8 seconds to complete it. The speed of each hole is 0.0245 m/s respectively. For the small field that requires 1000 of pineapple planting may take to 8200 seconds equivalent to ~2.5 hours of working durations if there is no problem occurred during the process. Last but not least, the objectives of the project are achieved by designing, developing and testing the pineapple planter to dig and plant completed.

5.2 Problems and Recommendation

During planting operation, several problems with the planter were observed. The digging process on the ground been quite terrible because of the digger material and shape do not very fit with the soil condition. The operator used a lot of force to push the planter into the peat soil. The hinges connected between the digger and the PVC pipe is not strong enough to support the two materials. In future, the hinges may changes to bigger size so that it can support the weight of the digger and make it easier to push it on the ground. The depth of the holes created also affected by the improper shapes of the digger used.

There are many deficiencies in fitting the part of the planter. Many nuts and bolts are used on the planter. The vibration or shock occurred on the planter causing the fitting between the nuts and bolts become loose. The improper welding during fabrication process may cause more damages to the planter.

The fabrication of the planter is mostly made by the materials that are available and can be reused in the workshop. Due to limited time and minimizing the cost of fabrication, some materials used seem not suitable and fit to be used as the part of the planter. Some parts of the planter such as the digger is modified by own creativity and thus the efficiency of the digger may not suitable to the other type of soil. This planter in future may be used for another type of crops using different mechanism. The push and pull system that been applied in this planter is important and can be improved by using the spring to drive the open and close of the digger.

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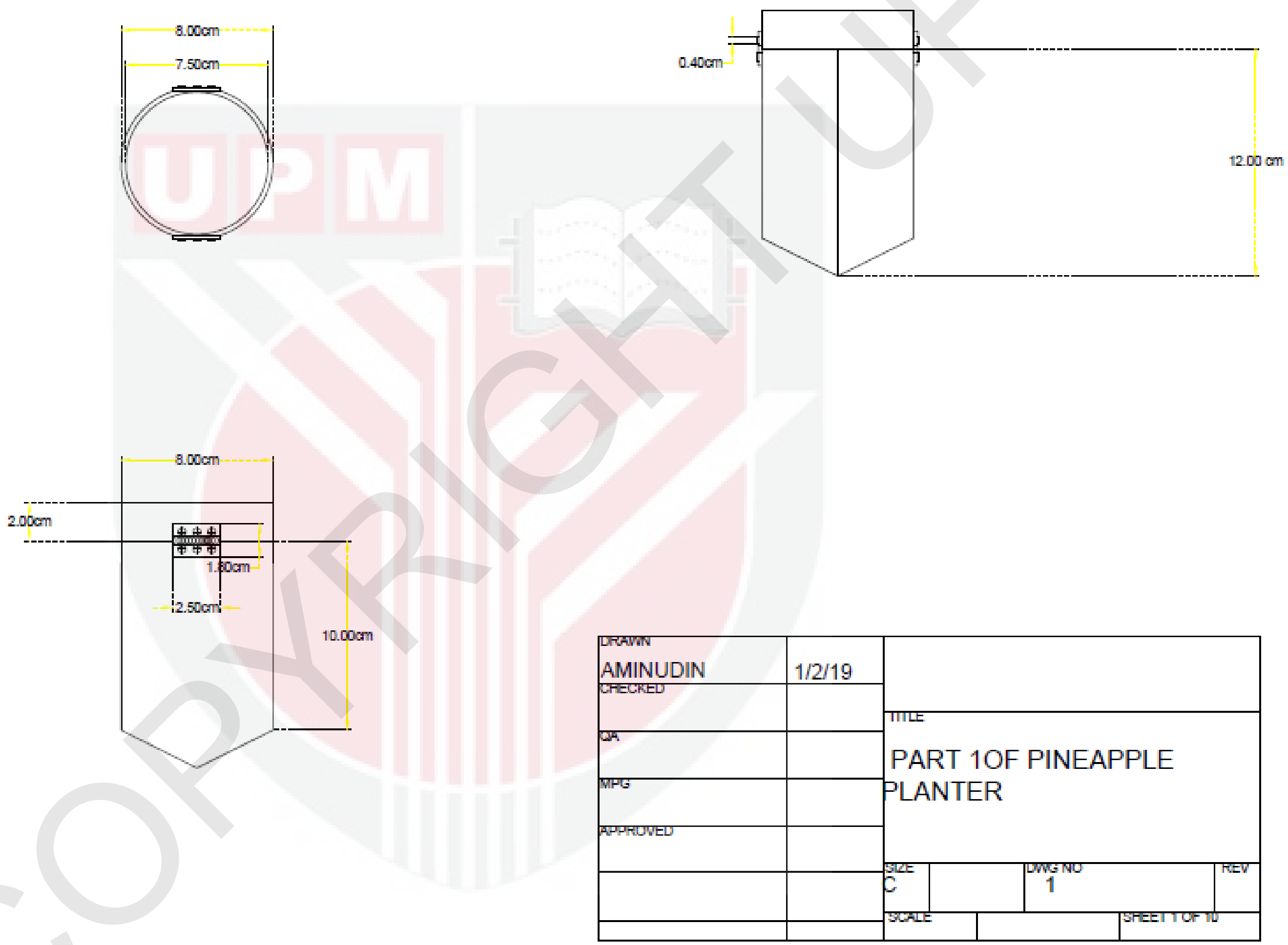
APPENDICES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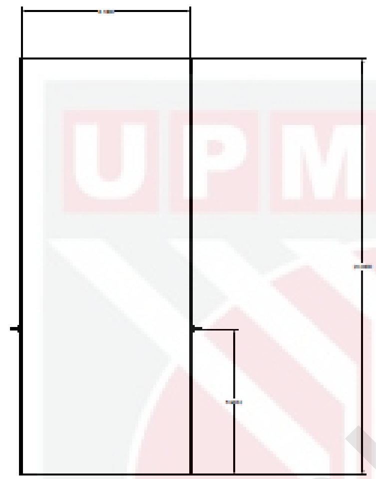
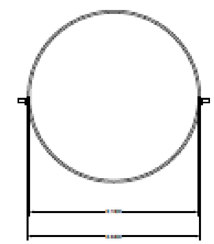


SIDE VIEW



FRONT VIEW

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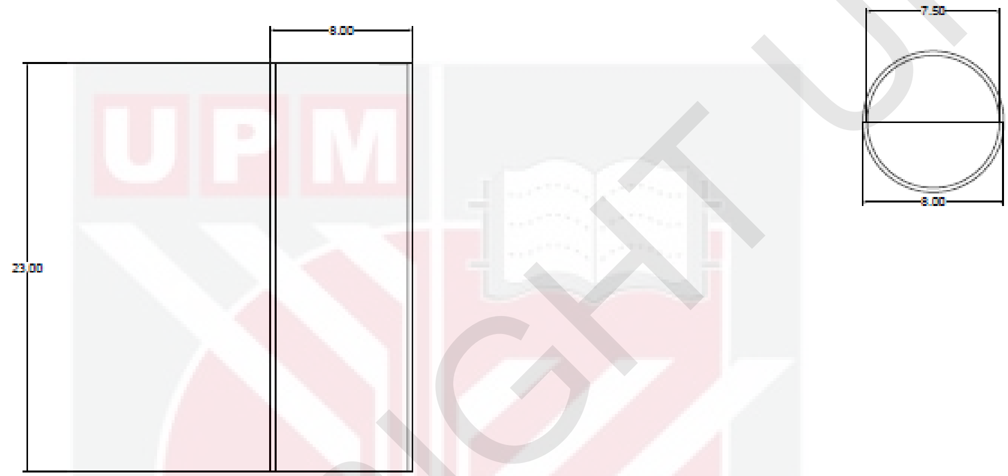

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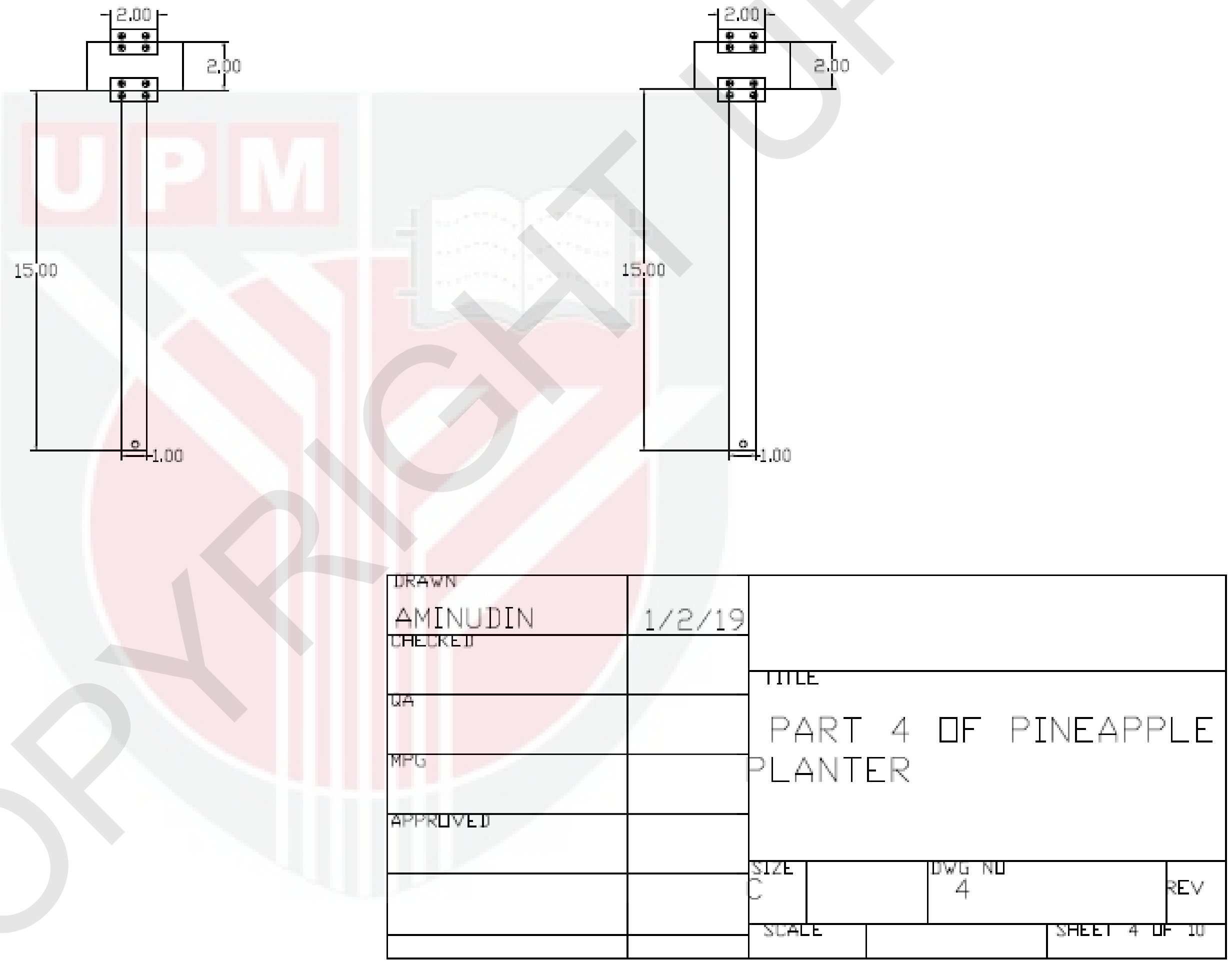
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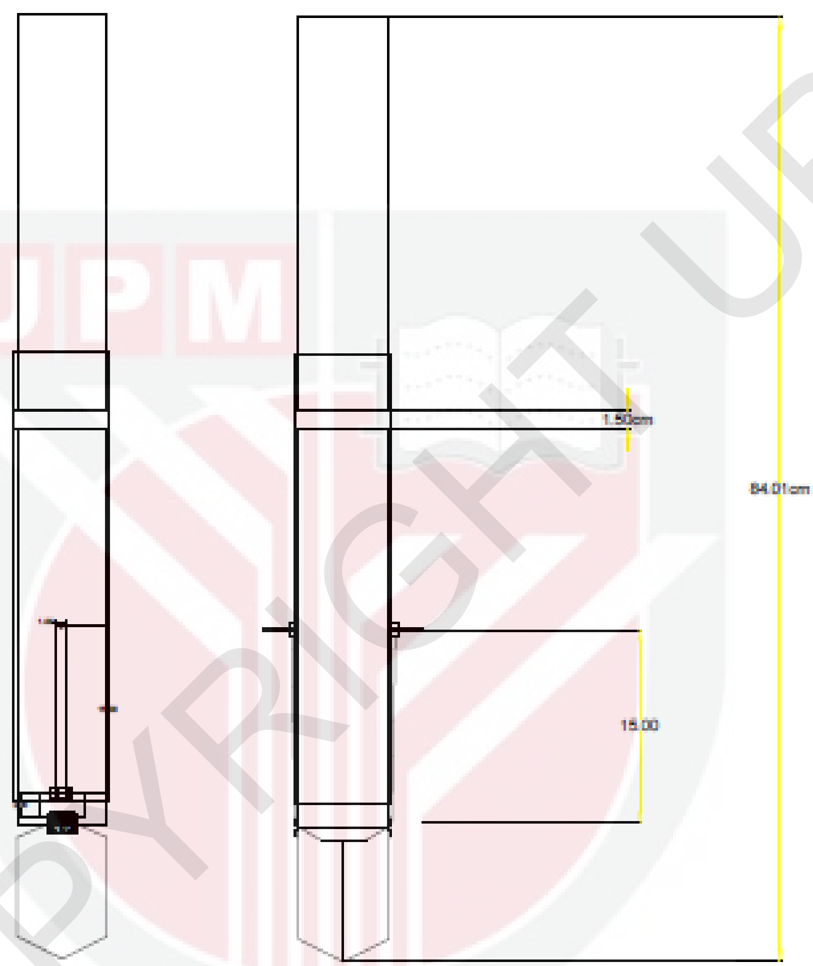

AMINUDIN 1/2/19

PART 5 OF PINEAPPLE PLANTER

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FULL ASSEMBLED PART OF
PINEAPPLE PLANTER
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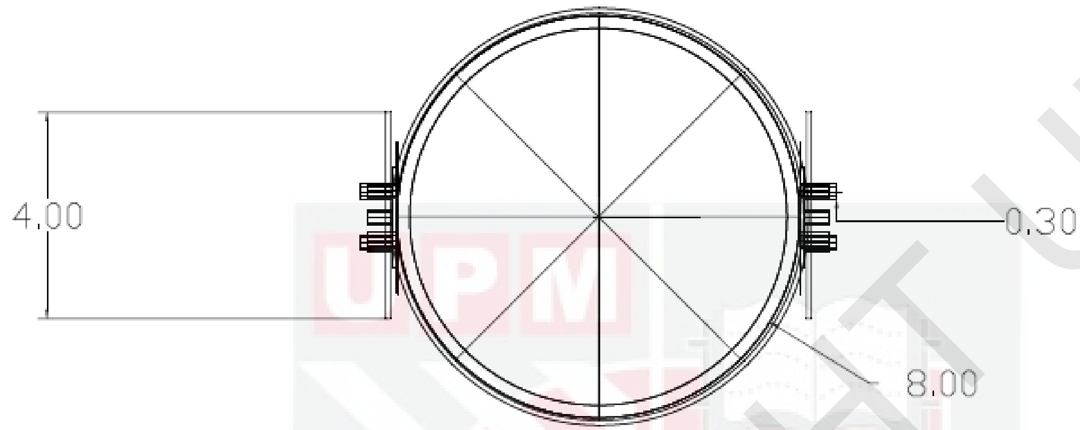

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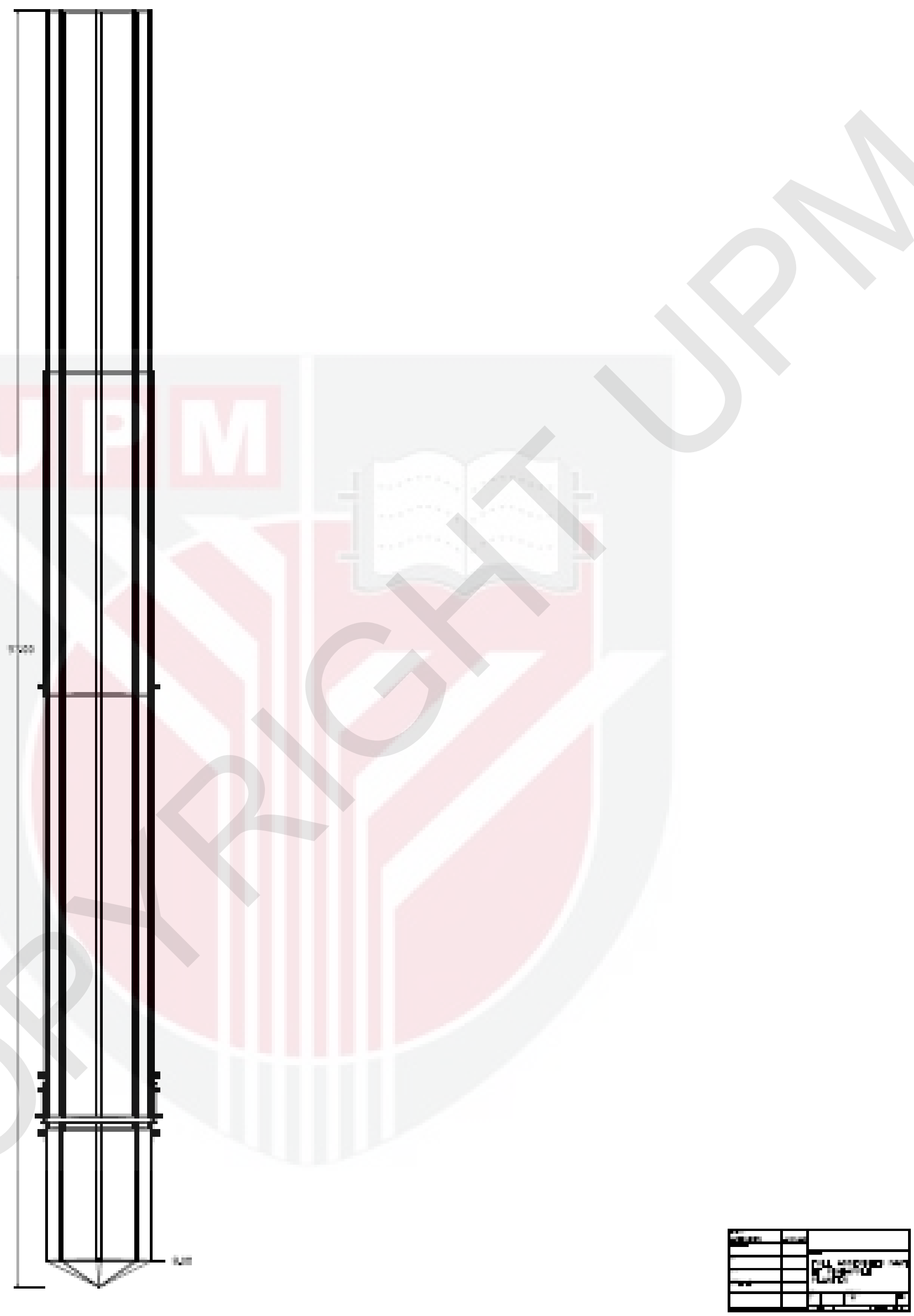

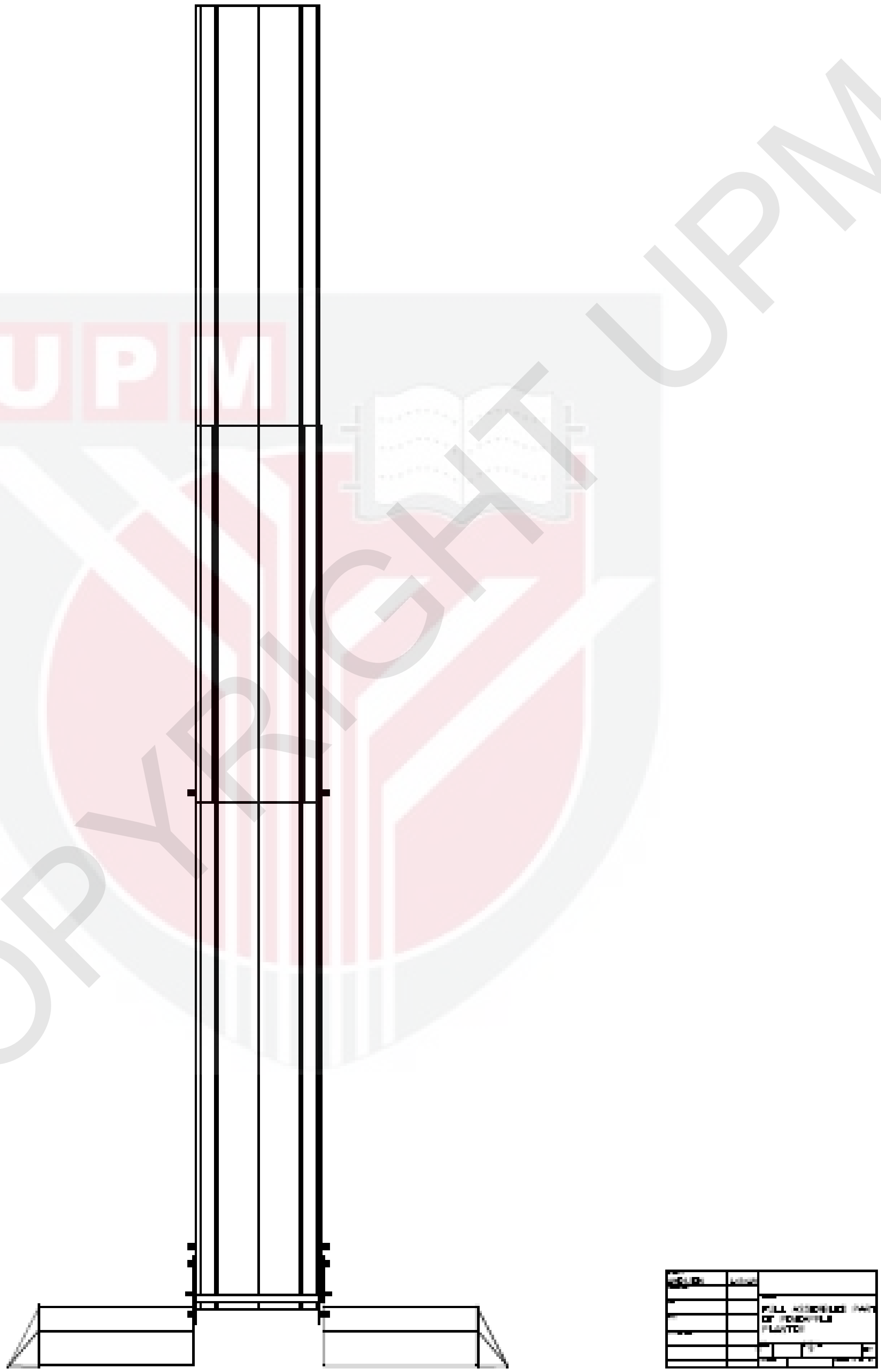

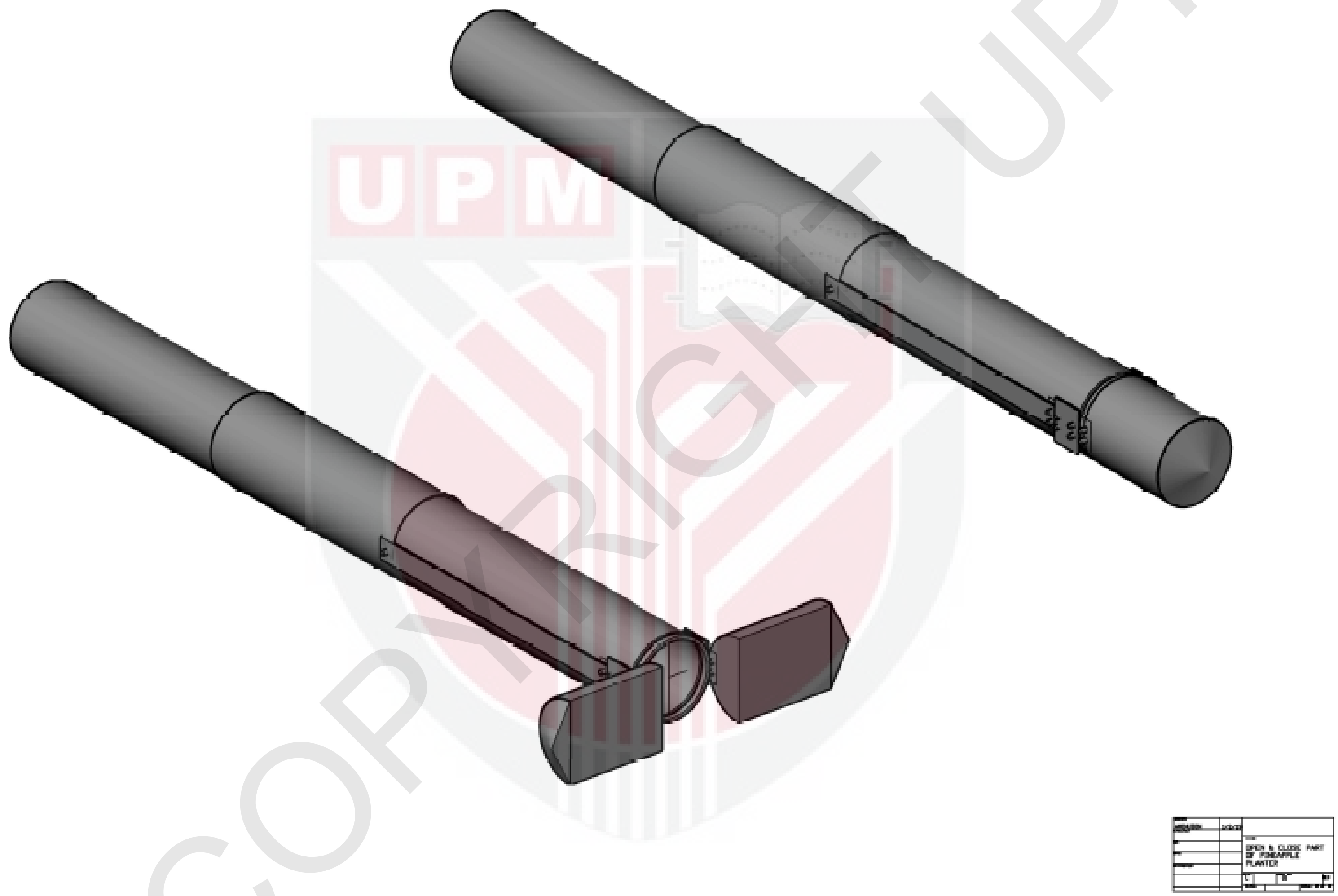
OPEN & CLOSE PART
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