DESIGN OF MINI PLANT FOR PROCESSING OF

COMPOST FERTILIZER FROM DRIED LEAVES

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

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DECLARATION

I declare that this project report entitled "Design of Mini Plant for Processing of Compost Fertilizer from Dried Leaves" is the result of my own work except as cited in the references.

Signature : ....

Name : ....

Date : ....

APPROVAL

I have 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 : ....

ABSTRACT

In many agriculture works worldwide, the need to keep up with production demands is becoming a necessity. However, there are some factors, which play a role in preventing the current agriculture processing machinery to synchronize with the fluctuating production demands. Regardless of these factors, many researches are creating new innovative designs that will deal with these factors effectively. The purpose of this thesis is to present a conceptual design of a mini plant for processing of compost fertilizer from dried leaves for large-scale production that will be used by the small farmers in the agricultural field. The research explores for the machine of the current literature and design approaches used to develop a conceptual design of mini plant for processing of compost fertilizer from dried leaves. This thesis also provides detailed methodologies to be used for concept selection, detail design, structural analysis and part simulation of the machine. The parts design, analysis and simulation are done by using CATIA V5R21 software and ANSYS software. The result of the static analysis, which is to find the bending total deformation, equivalent stress and factor safety at the analyzed parts. The results for the factor of safety is quite large because the compost fertilizer mini plant need to withstand high load. Besides that, some calculation are presented to show the bending moment diagram, sprocket ratio, sprocket torque, and shafts speed in the prototype. Moreover, a cost analysis for this product is calculated to get the exact selling price if the product managed to get into the market. Lastly, the thesis is concluded and some recommendations have been suggested for further studies on this project.

ABSTRAK

Dalam banyak kerja pertanian di seluruh dunia, keperluan untuk memenuhi keperluan pengeluaran menjadi keperluan. Walau bagaimanapun, terdapat beberapa faktor yang memainkan peranan dalam menghalang jentera pemprosesan pertanian semasa untuk menyegerakan tuntutan pengeluaran yang berubah-ubah. Walau tanpa faktor-faktor ini, banyak penyelidikkan mencipta reka bentuk inovatif baru yang akan menangani faktor-faktor ini dengan berkesan. Tujuan tesis ini adalah untuk menyampaikan reka bentuk konsel sebuah kilang mini untuk pemprosesan baja kompos dari daun kering untuk pengeluaran berskala besar yang akan digunakan oleh petani kecil di ladang pertanian. Penyelidikan ini meneroka mesin dari pendekatan pembacaan hasil penulisan dan reka bentuk semasa yang digunakan untuk membangunkan reka bentuk konsept tanaman mini untuk pemprosesan baja kompos dari daun kering. Tesis ini juga menyediakan metodologi terperinci untuk digunakan dalam pemilihan konsep, reka bentuk terperinci, analisis struktur dan simulasi bahagian-bahagian mesin. Reka bentuk bahagian-bahagian, analisis dan simulasi dilakukan dengan menggunakan perisian CATIA V5R21 dan perisian ANSYS. Hasil analisis statik adalah untuk mencari ubah bentuk jumlah lenturan, tekanan setara dan keselamatan faktor di bahagian yang dianalisis. Keputusan untuk faktor keselamatan agak besar kerana tanaman mini baja kompos perlu menahan beban tinggi sebelum gagal. Di samping itu, beberapa pengiraan dibentangkan untuk menunjukkan rajah momen lentur, nisbah sproket, tork pemancuan, dan kelajuan shaf dalam prototaip. Selain itu, analisis kos untuk produk ini dikira untuk mendapatkan harga jualan yang tepat sekiranya produk berjaya masuk ke pasaran. Akhir sekali, tesis disimpulkan dan beberapa cadangan telah diberikan untuk kajian selanjutnya mengenai projek ini.

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GDP	Gross Domestic Product.
MARDI	Malaysia Agricultural Research and Development Institute.
ICT	Information and Communication Technology.
R&D	Research and Development.
MPOB	Malaysian Palm Oil Board.
MAHA	Malaysia Agriculture, Horticulture, and Agrotourism International Show
SME	Small and Medium
TEKUN	Tabung Ekonomi Kumpulan Usahawan Niaga.
MARA	Majlis Amanah Rakyat.
PUNB	Perbadanan Usahawan Nasional Berhad.
NH_4NO_3	Ammonium nitrate.
$K_4P_2O_7$	Potassium pyrophosphate.
NH_3	Ammonia
NPK	Nitrogen-phosphorus-potassium.
PDS	Product Design Specification.
QFD	Quality Function Deployment.
HOQ	House of Quality.
CAD	Computer Aided Design.
SOP	Standard Operating Procedure.
BOM	Bill of Material.
CNC	Computer numerical control.
MIG	Metal inert gas.

FEA	Finite Element Analysis.
RPM	Round per minute.
STP	Standard for the Exchange of Product
FOS	Factor of Safety.

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CHAPTER 1

INTRODUCTION

This chapter covers the background of study, problem statement, objectives, scope of project, project significance and organization of report. The chapter overview is also included in this chapter.

1.1 Background of Study

The agricultural sector has played an important role in social and economic development in Malaysia. Before this, agricultural activities were subsistence and traditional farming. Until in1887, the industrial crops were introduced which was the industrial rubber planting in Kuala Kangsar, Perak. This has made Malaysia as the world's major natural rubber producer for centuries until the late 1980s. The advancement of technology has increased crop yields dramatically. This can be seen in Malaysia's GDP of 12% formed from agriculture. About 16% of Malaysians are involved in agriculture.

The government now focuses more on the agricultural sector because agricultural activity is not necessarily self-sufficiency anymore, but it has also benefited its entrepreneur. Now, agriculture can be as a business. It aims to transform Malaysia from an industrial country to an agro-industrial state. The government has made many changes to the development in agriculture. This situation can be seen as one of the government's efforts to improve the standard of living of Malaysians and thus help increase the revenue of the country. Communities need to change their perceptions of the agricultural sector that is deemed to be of no benefit to them. This is because the government increasingly emphasizes the vision of ‘Agriculture is a business’ that the involvement of the people in this area will continue to thrive. Communities need to be more encouraged to take the risks and try to engage in agricultural activities and start serving the land. Agriculture is not limited to the age factor but needs to be cultivated by all levels of society.

The agriculture industry has played an important role in the early 1920s to the country through the rubber industry, which raised Malaysia's name as the world's major natural rubber producer until the 1980's. For developing countries like Malaysia, agriculture is the most important area for the country. The agriculture industry is an area that contributes to the nation's development and the country's economic growth in the post-independence era.

Nowadays, the agricultural sector is gradually silent with the rapid development and progress of the country. Young generation are no longer interested in continuing their hereditary works and are more keen to migrate to cities seeking more employment opportunities and offer higher and more secure income in the industrial sector. This is because the image of employment in the industrial sector is seen to be higher and has better social facilities. The Government has made various efforts to develop this agricultural field. The government wants to see that agriculture has a bright and profitable future. The field of agriculture can actually make a big contribution to the country. The National Agricultural Policy becomes the guideline for the development of this field.

Productive and efficient agriculture activities are important for the generation of abundant food resources. The importance of agriculture can be seen as high as demand for agro-based materials such as vegetables and other resources used daily. The agriculture industry supplies raw materials to the country's secondary economic sector and food processing. As a result of this agricultural field, inputs are used in the production process of foodstuffs which can be used as export products. Among the food exports that use agricultural products are butter, cocoa powder, black pepper powder and so on. Production costs can also be minimized as the price of raw materials supplied by agriculture is cheaper compared to international markets. In addition, the importance of agriculture to the country are:

i) Avoiding food supply crisis and ensuring adequate supply of food.

Malaysia is one of the countries that makes rice as a main food. The government has been trying to develop rice harvesting twice a year. Traditionally, paddy production in the past only once a year. However, with the advancement of technology and infrastructure has enabled paddy production for twice a year. This situation can accommodate the demand of the people of Malaysia and the government wants to reduce rice imports from Thailand. Reducing dependence on foreign countries can reduce currency flows to foreign countries and enhance the country's internal economy. The government is also conducting research to produce rice production five times a year. This is because of the growing population of the nation. In addition, Malaysia has land that is suitable for development in agriculture such as coffee, cereals and cocoa. If this requirement is sufficient to accommodate the needs of Malaysians, then materials imported from outside countries can be reduced.

ii) Creating job opportunities and reducing the number of unemployed.

The field of agriculture can provide broad employment opportunities to Malaysians. This is because our country has vast land to work on depending on the individual craft. Labor force can be supplied through open employment opportunities when land use for agricultural purposes is carried out. The definition of employment in agriculture not only works in farms but also includes processing and marketing. This field does not require high approval. Various government agencies related to agriculture are opening up courses offered to people interested in agriculture to gain knowledge and so on. Agriculture can reduce the number of unemployed countries and increase household income. The poverty gap can be achieved through the development of this agricultural field. Social justice and balanced wealth distribution can be achieved. As one of the effective government efforts is the Felda scheme where extensive agricultural land is distributed in equal proportions to the villagers to be developed.

iii) Increase national income and socio-economic community.

Farming is not only beneficial to its entrepreneurs but it can also increase the nation's income and subsequently socio-economic society. Countries will add gross domestic product (GDP) through the export of commercial crops such as oil palm and black pepper. Malaysia is the world's second largest producer of palm oil and palm oil production. The government through implementing agencies has made many changes in the aspects of process and machinery needs. Through the Malaysian Agricultural Research and Development Institute or MARDI, Malaysia has produced many new varieties, clones and plants with the latest ICT technology support. Consequently, farm operators can use these technologies and further increase the quantity and quality of production. With this in mind, the country's revenue will increase by exporting high-quality crop production to foreign countries. The Malaysian currency flows out of the country can be reduced and it is beneficial to the country's economic growth. The country's financial position through the development of agriculture can be strengthened through the balance of the Balance of Trade Index ie the export price index and the import expense.

Figure 1.1: Palm oil plantation in Malaysia (retrieved from Wikipedia.com)

However, it is not easy to put agriculture into business. It needs to compete with existing areas that are stronger and more focused by society. In transforming agriculture as a business has found various challenges and obstacles in realizing it. Among the challenges and obstacles in the field of agriculture-based businesses are as follows:

i) Optimal source requirement.

Land, water and labor are the resources needed in agriculture. Most of the land in Malaysia is developed for industrial and residential purposes. This has caused land bidding to be quite limited and the price of land becomes expensive. The use of land for agriculture is influenced by this condition. In addition, land ownership issues are also among the challenges and obstacles that make the field of agriculture-based business. Land ownership by farmers is in small lots and dispersed. The division of land has resulted in a reduction in the size of the garden and this complicates the use of good production techniques. These scattered land lots require more time, energy and spending, equipment and other agricultural materials. Solving these lots makes it difficult to use new infrastructure or new techniques and inputs.

Employment in agriculture is also one of the challenges and obstacles to agriculture-based business. Most of the labor force is more focused on industrialization. Malaysia is forced to use labor force from Indonesia and Bangladesh in this field of agriculture. The involvement of generations of young people today is less interested in venturing into the field of agriculture. They feel that the farming sector does not generate lucrative income and is more focused on manufacturing and industrial areas where those areas are more secure and stable. The limited labor force makes it difficult to compete with other fields in the business.

ii) Lack of financing from the banking institutions.

The banking sector is more interested in financing this field if it is to create an agricultural insurance to reduce the risk of farmers and lenders. This is a challenge and a barrier to making agriculture a business. Banks are not very interested in financing this agriculture because the risks are higher. It is also difficult to predict and predict. Examples include disease, floods, landslides, droughts and other natural disasters.

The weakness in preparing paperwork for financing purposes is also one of the challenges and obstacles to making the business of agriculture-based business. This condition makes the banking institution less interested in financing this farm.

iii) Capital shortage for modern technology use.

The lack of capital to get the use of modern technology is also a challenge and obstacle to making the field of agriculture-based business. Modern technologies have the potential to be of great benefit and can bring great results. As a result of these problems, farmers and entrepreneurs in this field also lack the most advanced and up-to-date seed or clones. In addition, the use of fertilizers and chemicals optimally and correctly also can not be used to increase production volume. Capital is also needed to cover production costs. Agricultural entrepreneurs face problems for capital rounds in agricultural activities. Agricultural production can be increased if there is a credit facility and the use of agricultural inputs and the use of latest agricultural technology and is well designed in terms of delivery and use.

Various programs are designed and implemented by government agencies in the development of the Small and Medium Scale Agriculture Industry. The field of agriculture can provide new sources of growth from the outcome of various initiatives to promote the growth of new industrial groups such as agroforestry, special natural products, bamboo and rattan, biotechnology products, floriculture and ornamental fish. The Ministry responsible for providing assistance and support to agriculture-based businesses is the Ministry of Agriculture and Agro-Based Industry. The Ministry is fully responsible for agriculture, including fisheries and livestock. Among the government's assistance and support to agricultural-based businesses are:

i) Research and Development (R & D)

The Malaysian Agricultural Research and Development Institute (MARDI), was established to meet the goals of developing and promoting new appropriate technologies through research conducted in this field of agriculture. The purpose of the research is to increase production and effectiveness by modernizing agriculture as well as helping to increase returns to entrepreneurs and farmers. The Malaysian Palm Oil Board (MPOB) also helps in agriculture especially in oil palm plantations. The Board aims to develop the country's palm industry. This industry is a major export material out of the country such as marketing to the United States. The results of this research and development also led to the discovery of new technologies and innovations for commercialization. For example, the use of biomass and biodiesel, farming and control of insects and diseases.

ii) Marketing and Distribution

Malaysia Agriculture, Horticulture and Agrotourism International Show (MAHA) is an agricultural exhibition held by the government for marketing and distribution purposes. With such exhibition activities, it can attract agricultural field abroad to jointly develop agriculture. It can also help connect Malaysia's bilateral relations with other foreign countries. Downstream agriculture can also be done to market a longer product into the international market. For example, banana fruits are made into banana chips and sold to international markets.

iii) Financial Assistance and Consultation

Agricultural banks in particular are able to provide funding to farmers to start their agricultural projects. In addition, financing can also help to buy machinery to replace manpower and buy better quality seeds. Low loan lending schemes need to be provided primarily to smallholders. For example, Agro Bank helps provide financing to SMEs based on agriculture. Funding from government agencies such as TEKUN, MARA, PUNB and the Youth Economy Fund also provide facilities for entrepreneurs and farmers. This agency helps a lot in providing financing and initial capital in a business. With the help of the agency, it can reduce the burden borne by entrepreneurs.

The agriculture field is not a field categorized as a second class. This is because the agricultural sector is important in supplying food to the community. If there is no effort to develop this agricultural field then the country will have a food supply crisis due to insufficient food supply to accommodate the growing population. In addition, this situation leads to interrelated issues such as unearned state revenues and this agricultural field will be left buried. There is no miracle that can advance agriculture but with the efforts of all parties. The field of agriculture can not only increase the household income and reduce the amount of poverty, but it has the potential to earn profits. The development of modern technology and aspects of business management in agriculture should be taken seriously. Agricultural production will be of higher quality, higher value and increase if it uses optimal sources. Agricultural-based businesses need to be given more attention and priority as they can benefit and benefit the society and the nation. Young people need to cultivate the knowledge of agriculture and try to take risks in this field. The shortage of young people in this area is significantly reduced. Basic knowledge of agriculture should start from home to nurture the interest of young people in this field. In addition, education in agriculture also plays an important role for innovation to be made and beneficial to the state. The government provides many support and support to farmers and entrepreneurs who want to make this farm as one of the business areas. Various projects and programs are organized by government agencies to support farmers and plantation operators. The development of this field will not be successful if it is done by one side only. All involved, including the whole community, farmers and entrepreneurs, governments and others need to play their part in the development and progress of this agriculture field.

1.2 Problem Statement

In this project, a machine will be designed to help farmers to produce fertilizers more easily and inexpensively by simply using the dried leaves of the surrounding trees. Here is a statement of problems related to the problems faced by farmers in Malaysia:

1. Mixture of fertilizers with soil is unbalanced in producing good quality compost fertilizers.

2. It takes a long time to prepare fertilizer using the traditional method.

3. Requires a lot of manpower to produce large quantities of fertilizer.

1.3 Objectives

This project is focused on producing a portable machine in making compost fertilizer consisting of ground mixing machines and a container for the dried leaves to be mixed with moisturized soils. The final product of the compost fertilizer will be in powdered form. Here is the objective of this project:

1. To provide a portable machine that can help farmers make compost fertilizers from dried leaves.
2. To shorten the time to produce a mixture of soil and the dried leaves that have been shredded into smaller pieces more smoothly.
3. To produce compost fertilizer in small size to ease the storage and use.
4. To reduce the workforce in producing compost fertilizer in large quantities.

1.4 Scope of Project

There are some requirements that need to be considered while doing the project to make sure it is still in the scope. First of all is the design of the compost fertilizer machine needs to be considered and detail researches need to be carried out before making the best design. After that, the fabrication process will undergo based on the chosen design. Then, the machine need to be tested whether it is safe and suitable to be used before the final product had been produced. The material for the compost fertilizer must be only from the mixture of soil and dried leaves that had been shredded into smaller pieces and some other supplements for the additional nutrients. The final product of the compost fertilizer must be in small size and can be made immediately.

1.5 Project Significance

This project is implemented by taking into account the importance of the need for farmers to produce compost fertilizer and its use as well as the production of agricultural products as a whole. The most important aspect to consider is that the process of producing more quality fertilizer, short time processing but low-term fertilizers storage is able to accelerate the production process of agricultural products and thus able to reduce the cost of farming.

The production of this machine can also help farmers in terms of manpower utilization in the effort to produce the fertilizer manually. Additionally, this machine is also capable of being owned by farmers as opposed to existing machines, which are imported at higher prices. Hence, it can increase the living economy of farmers.

1.6 Organization Of Report

Firstly, Chapter 1 covers the introduction of this study or project. It contains the general information about the project, problem statement, objectives, scopes and significance of the project. Chapter 2 covers the literature review of this project. It contains the literature review for the making and materials for compost fertilizer and the machine used for shredding or mixing the compost fertilizer that had already exist in the industry. After that, Chapter 3 contains the methodology of this project. It contains flow chart, literature review, execution of the experiment, data collection and data analysis. The report then will be continued with Chapter 4 which is the fabrication processes involved in the making of the mini plant in detail. Next, Chapter 5 contains the results and discussions of this project. The data from the experiment is collected and analyzed. Finally, Chapter 6 covers the conclusion of this investigation. This chapter also includes the recommendation for the future work and sustainability.

CHAPTER 2

LITERATURE REVIEW

This chapter contains the literature review that based on the objectives and scope of the project. This chapter is conducted in order explore the past research. This chapter contains the literature review for the materials and effects of different types of compost fertilizer, the machine used for shredding the compost materials, and the compost bins for mixing the compost fertilizer that had already exist in the industry.

2.1 Compost Fertilizer

2.1.1 Introduction

Compost or manure is actually an organic matter that has been deteriorated in a procedure called composting. This procedure reuses different natural materials generally viewed as waste items and produces a soil conditioner or fertilizer. Compost is wealthy in supplements. It is utilized for gardening, landscaping, horticulture, cultivation, urban agriculture and organic farming. The manure itself is good for the land from various aspects, including as a soil conditioner, a fertilizer, expansion of crucial humus or humic acids, and as a natural pesticide for soil. In the ecosystems, compost is valuable for disintegration control, land and stream recovery, wetland development, and as landfill cover. Figure 2.1 below shows the cycle of the composting process.

Figure 2.1: Cycle of the composting process (retrieved from differencebetween.info)

Cooperative Extension Service of University of Missouri stated that a great compost comprises of a little amount of soil alongside the deteriorated or partially disintegrated plant and animal matters. As a soil amendment, compost enhances both physical condition and nutrients. It is helpful for enhancing soils that are low in organic matter. The organic matter in the compost makes heavy clay soils better to work by restricting the soil particles together. The aggregation of the soil; particles enhance air circulation, root growth, and water flow, and decrease crusting of the soil surface. Other organic matter also enables sandy soils to store water and nutrients. In spite of the fact that compost has nutrients, its most benefit is in enhancing soil characteristics. Therefore, compost ought to be viewed as a profitable soil alteration, and not as a fertilizer, since, most of the time, extra fertilization will be important to accomplish the best growth and production. Compost is also a great mulching material to utilize around garden and farm plants. It might be utilized as a "topdressing" for lawns. Figure 2.2 below shows the final product of the compost that consists of decomposed organic matters and soils.

Figure 2.2: Final product of the compost that consist of decomposed organic matters and soils. (retrieved from thisismygarden.com)

2.1.2 Materials for Decomposition

Several organic matters such as leaves, grass, and food scraps can be utilized in the production of the compost. All of these will result to the quality and quantity of the compost. In this project, some literature review will be studied to make a comparison among those already published work from other peoples and agencies. From the reviews, the best concepts and ideas will be implemented in this project in order to get the best quality of compost.

Based on the work that had been published by the Cooperative Extension Service of University of Missouri, the organic materials that they used for composting ranging from sod, grass clippings, leaves, hay straws, weeds, chopped corncobs, corn stalks, sawdust, shredded newspaper, wood ashes, hedge clippings, and other kinds of plant residues from the garden. Twigs is not suitable for the composting process as they take a longer period to decompose. Besides, diseased or unhealthy plats from the flower or vegetable are not ideal although some of the disease are killed by heating during the compost process unless the compost is mix frequently and kept remain unused for several years. This is because some of the disease organisms might returned to the plant and will affect the growth and health of the plant. In addition, composting weeds that contains high laden of seed should be avoided. The quantity of seed, which is extremely high, will create an unnecessary weed problem. Garbage with organic matters may also be utilized in the compost but they must be free from grease, fat, meat scraps, and bones as these materials will attract dogs and other animals and may develop an odor during the decomposition. Fats take longer time to disintegrate before the compost can be used.

Niño et al. (2012) stated that the materials used for the composting process is worms and organic food waste from the garbage. The main characteristics of the worm species utilized are Eiseniafoetida or Californian red worm, which is the species most utilized in vermin culture usually in its adulthood. The length of the worm is between 5 and 9 cm with a diameter between 3 and 5 mm and weight in 1 to 1.2 gram in weight. The number of segments ranges from 80 to 120 with an average of 95. The organic waste is shredded into smaller pieces and in other case, the shredded organic waste is mixed with oxide of 5% magnesium to control the pH of the waste. The preparation of the organic waste utilized part of the Mexican Official Standard NMX-AA-15 Method of cracking. Figure 2.3 shows the cross section of the Californian red worm.

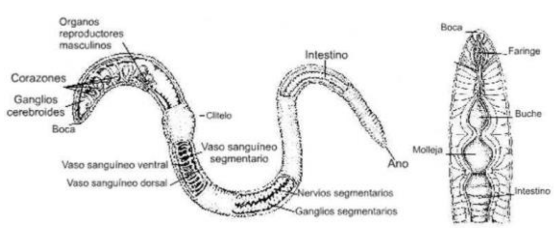


Figure 2.3: Cross section of the Californian red worm (Niño A et al, 2012).

Next, this review will study the research made by Gurav and Sinalkar (2013). The organic matter that had been used is from the waste tea powder. Usually, waste tea powder can not be used anymore and finally end up in the garbage. The research is conducted in order to analyzed the physico-chemical parameters of the compost from the tea powder. The materials was collected from houses, tea stalls, and hotels. The compost had been tested with different types of seed in order to analyze the efficiency. Below is the list of the seed that had been experimented:

1. Vigna Radiata.

   This type of seed generally called the mung bean had been commonly used in Asian foods for a long time. It is utilized in salad bars across the nation and considered as a "superfood" because they contain high nutrient qualities. Figure below shows the actual photo of the mung bean.

Figure 2.4: Vigna Radiata or mung bean seed. (retrieved from Wikipedia.org)

2. Cicer Arietinum.

   The other name of this seed is chickpea. It is rich in fiber besides a very good source of carbohydrates and proteins, which come from about 80% of the total seed weight. The carbohydrate source comes from the starch contained in the seed range from 41% to 50%

in Desi varieties than in Kabuli varieties. The total seed carbohydrates range from 52% to 71% and the protein range from 16% to 24% while the seed coat is rich with fiber. The actual seed can be seen in the figure below.

Figure 2.5: Cicer Arietinum or chickpea. (retrieved from Uniprot.org)

3. Tagates.

Tagates or marigolds flower varies in size from 0.1 to 2.2 m tall. Mostly these flowers is cultivated globally for their beauty in decoration and ornamental purposes. Besides, they are known for their antibacterial, insecticidal, and anithelminthic activities. Below is the figure for the actual photo of the marigolds flower.

Figure 2.6: Tagates or marigolds flower. (retrieved from Thegardenhelper.com)

Lopez-Mosquera et al. (2011) had made a research on composting fish waste and seaweed to produce the compost. The seaweed mostly collected from the beach coast that had drifted and washed up on beaches by the force of tides and wind. It has been used for a long time before as an organic compost in many coastal nations around the world. This organic matter helps in improving soil structure, and growth activators. In some area such as Venice, Brittany, Peru, and Argentina, the seaweed mostly becomes a waste product because of eutrophication. Therefore, some initiatives have been carried out to solve this kind of problem by taking the seaweed to composting, as it will help the economy and environment. Moreover, seaweed is rich in nutrients such as potassium, calcium and magnesium and can improve the quality of the compost, which is more hygienic and free of contaminants like heavy metals and phytotoxic compounds. Next, the other organic matter, the fish waste, has also been used traditionally as compost fertilizer because of the wealth in nutrients, mostly nitrogen and phosphorus, and their rapid decomposition. Other materials were also added into the mixture such as the pine bark in particle size from 10 to 35 mm in order to increase the carbon-nitrogen ratio. Table 2.1 below shows the main physical-chemical and chemical characteristic of the materials used in the compost.

Table 2.1: General classification of the different materials by mean values and standard deviation (Maria Elvira Lopez-Mosquera et al, 2011).

	Seaweed	Fish waste	Pine bark
%			
Humidity	80.30 ± 0.11	69.75 ± 9.01	62.75 ± 0.65
Carbon, C	27.19 ± 0.35	46.22 ± 2.80	50.41 ± 0.02
Nitrogen, N	1.15 ± 0.05	10.17 ± 2.29	0.16 ± 0.01
Phosphorus, P	0.20 ± 0.02	1.80 ± 0.90	0.10 ± 0.01
Potassium, K	5.03 ± 0.37	0.79 ± 0.46	0.17 ± 0.04
Calcium, Ca	1.23 ± 0.17	1.86 ± 1.85	0.13 ± 0.00
Magnesium, Mg	1.15 ± 0.11	0.15 ± 0.04	0.08 ± 0.00
Sodium, Na	4.80 ± 0.25	0.64 ± 0.16	0.44 ± 0.02
Carbon-Nitrogen, C/N	23.68 ± 1.31	4.79 ± 1.24	304.24 ± 11.84
E.C. 1:5	1.06 ± 0.02	4.81 ± 3.19	0.86 ± 0.02
pH 1:5	6.64 ± 0.06	5.89 ± 0.48	5.63 ± 0.04

Next, the other research that will be analyze is from Khan et al. (2013). The research focused on the effects of slow-release fertilizer or compost fertilizer using wastepaper on the development of Chinese cabbage. By recycling the wastepaper into making the compost, the economy and social will achieve great benefits and furthermore saving the environment from the excessive amount of wastepaper. The wastepaper can improve soil organic matter, moisture content, physical condition, and the arable layer. The plant that had been tested with the wastepaper compost is cabbage because it is consumed worldwide and rich in nitrogen nutrients. Other materials that was also included in the mixture are alum solution about 1-2% content, fibers, ammonium nitrate (NH_4NO_3) and potassium pyrophosphate ($K_4P_2O_7$) saturated solutions.

Galliou et al. (2017) had made a research on the production of organic fertilizer from olive mill wastewater. Nowadays, olive mill wastewater has been characterized as a source of organic matter, nutrients, and water. This organic matter has high content of organic carbon and potassium, and a significant amount of nitrogen, phosphorus, and magnesium. Unfortunately, there are some reported issues regarding the olive mill wastewater such as phytotoxicity, ground contamination, decreased soil porosity and increased salinity. Besides, different bulking agents were utilized like sesame bark, tree cuttings, poultry manure, and waste coffee grounds. Despite all of that, olive mill wastewater is produced only during the winter, so there might be a short of supply for the composting process during summer. Figure 2.7 below shows the olive fruit before cultivation been done.

Figure 2.7: Olive fruit before cultivation. (retrieved from Dreamstime.com)

In addition, some additives or supplements can be added into the compost fertilizer in order to increase the quality and nutrients. Research that had been conducted by Zhang and Sun (2018) showed that bean drags and crab shell powder had been added into the compost fertilizer mixture and the effects were investigated to identify whether these two materials were suitable for the compost fertilizer. The bean drags came from the by-product of soybean processing and they have high porosity, high surface area, and low density. These can help in air and water flow, and enhance the growth of microorganisms during decomposition. Moreover, bean drags have high quantities of carbon and nitrogen, which can act as nutrient sources for the microorganisms at the beginning of composting. They are also wealthy in vitamins, minerals, and phytochemicals that can improve the nutritional value of final compost. 90% of the soy beans contains proteins thus can help enzyme activity and fasten the organic matter decomposition. Next, the crab shell powder can act as an absorbent due to its porous structure, which can enhance the retention of nutrients and water. Crab shell powder can also decrease the release of ammonia (NH_3). Furthermore, crab shell powder contains carbon and nitrogen (chitin and chitosan), phosphorus, calcium, and magnesium. The chitin also has a high binding capacity and protein contents, which can increase the generation of water-stable aggregates. Last but not least, crab shell powder contains high quantity of chitinases that can decrease the development of fungal plant pathogens.

2.1.3 Effects of Compost Fertilizer.

Compost fertilizer, generally known, has a better effect to the soil nutrients, plant growth, and the surrounding environment compared to the chemical fertilizer. In this topic, review will be made based on some literature on the effects of compost fertilizer.

From the results of the research made by Minakshi Gurav and Smita Sinalkar (2013), the compost that they had made had some significance increase in the plants morphological features, which is mung bean, chickpea, and marigolds flower, where the leaf length, leaf density, germination rate and height of the plants were enhanced. The time taken for germination had been reduced. They had also experimented on the quantity of the compost that had been given to the soil, where the first experiment had more compost than the second experiment. It showed that the compost must be utilized in a suitable amount. Below shows the table of the result from the experiments.

Table 2.2: Results of pot assay. (Minakshi Gurav and Smita Sinalkar, 2013)

Parameters	Control			Positive Control (Expt. 1)			Positive Control (Expt. 2)		
	I	II	III	I	II	III	I	II	III
Leaf area (cm^2)	-	-	3	-	-	4	-	-	4
Leaf density	7	80	8	15	120	17	8	80	12
Height (cm)	5	15	8	7	18	13	3	12	7
Germination period (days)	5	3	3	4	2	2	5	3	3
Germination frequency %	80	70	80	90	80	90	80	80	80

Notes: I-Tagates (marigolds flower), II-Cicer arientinum (chickpea), III-Vigna radiate (mung bean)

Next, the results from the experiments that had been conducted by Khan et al. (2013) on the Chinese cabbage showed the increment in maximum length of the leaf that had been treated with chemical fertilizer and the compost fertilizer. At the first 30 days, the leaf growth rate of chemical fertilizer was better than the compost fertilizer, but then started to decrease after that. The leaf growth rate of the compost fertilizer was better after 30 days period and kept remain higher compared to the chemical fertilizer. Figure 2.8 below shows the graph of the changes in maximum leaf length of cabbage under two different types of fertilizer for a 70 days period.

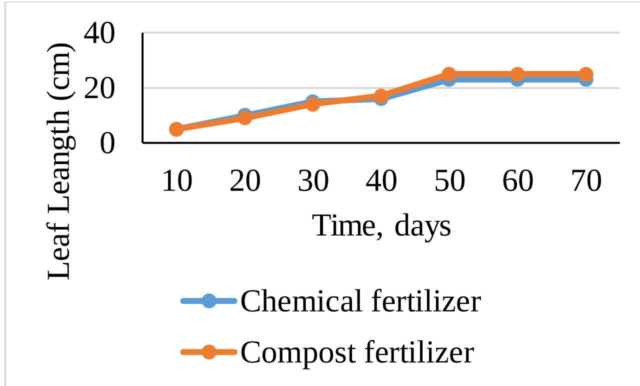


Figure 2.8: Changes in maximum leaf length of cabbage under two different types of fertilizer for a 70 days period. (Modabber Ahmed Khan et al, 2013)

Besides, there is a difference on the fresh weight of the Chinese cabbage on both type of fertilizer. Compost fertilizer gave more weight on the cabbage compared to the chemical fertilizer. Figure 2.9 below shows the graph of the fresh weight of the cabbage.

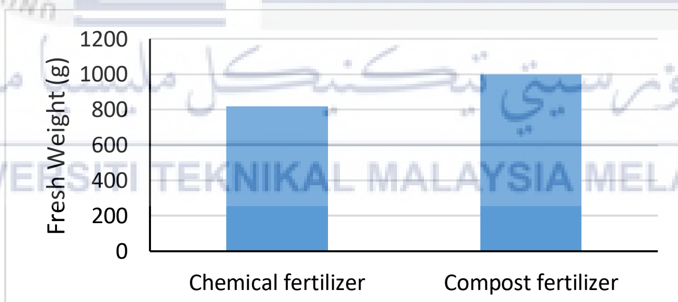


Figure 2.9: Fresh weight of cabbage under two different types of fertilizer for a 70 days period. (Modabber Ahmed Khan et al, 2013)

In addition, the length and width of head, and the number of leaves per head were recorded to see the effect of chemical and compost fertilizer. Below is the table that present the comparison between both types of fertilizer.

Table 2.3: The length and width of head, and the number of leaves per head of cabbage (Modabber Ahmed Khan et al, 2013)

Treatments	Head length (cm)	Head width	Number of leaves per head
Chemical Fertilizer	23.6	14.1	43
Compost fertilizer	24.4	16.5	46

Galliou et al. (2018) had found that the product of the fertilizer made from olive mill wastewater was actually quite the same as chemically nitrogen-phosphorus-potassium (NPK) fertilizer as the contents of both of them were significantly similar. Although, they had conducted an experiment on chili pepper plant to make sure their findings about the end product of the compost fertilizer. In Table 2.4 below, we can see that the growth of the plant for the NPK fertilizer is slightly better than the compost fertilizer made from olive mill wastewater.

Table 2.4: Growth and yield of chili pepper with three different types of treatment. (F. Galliou et al, 2018)

Parameter (per plant	Treatment		
	Compost fertilizer	No fertilizer	NPK fertilizer
Height (cm)	64 ± 10	59 ± 8	69 ± 13
Leaf number	53 ± 12	30 ± 9	54 ± 16
Fruit number	7.7 ± 2.8	3.5 ± 1.6	8.2 ± 3.1
Fruit production (fresh weight in gram)	218 ± 39	113 ± 35	227 ± 41

Based on the research about the effect of compost and chemical fertilizer in soil nematode in Chinese maize field by Hu and Qi (2010), the soils samples based on three different treatment, which is by compost fertilizer, chemical fertilizer, and controlled condition, showed that the soils with compost fertilizer was at the highest in organic matters and nutrients like nitrogen, phosphorus, and potassium. The pH value of the soils with compost fertilizer is at 7.17, which is lower than the other two soils samples indicated that it is better compared than the others. Moreover, the total nematode density of the soils with compost fertilizer is much greater than the other two soils samples.

2.2 Compost Bin

Several methods of composting can be implemented in order to produce a good quality of compost fertilizer. The methods including pile composting, bin or tumbler composting, sheet composting, and pit composting. In this project, the method that will be applied is the bin or tumbler composting as the objective of the project is to design and fabricate a mini plant for processing compost fertilizer. So the idea of bin composting is much likely suitable for this type of project.

The design of the bin composting should make composting easier and tidy as much as possible. Basic principle that need to be implemented in the design is that the bin must have a manual or automatic mixer located at the center in order to periodically mix the compost materials. Like other methods of composting, the compost needs to be turned repeatedly to ensure the flow of the air and water that is crucial for the decomposition process. By mixing the compost materials periodically, it will distributes oxygen and moisture throughout the compost and will prevent from any failure during the decomposition process.

Based on the research made by Bhaisare et al. (2017), they had designed an organic compost machine utilized for degrading the organic matter like food waste and green waste into compost rich in nitrogen in a nick of time. The temperature required in the machine is about 66°C and the moisture required for decomposition is about 60%. The organic matter is feed through the shredder with 10 inch X 10 inch feeder. The shredder will cut or chop the organic matter into smaller pieces. With the proper controlled of temperature and moisture content in the machine, it will help in decreasing the time taken for decomposition. The small size of composting drum or bin is made of cylindrical-shaped hollow galvanized steel pipe. Inside the drum contains a mixing blade connected to a shaft that can help in mixing the compost materials mixture. The drum's total volume can be calculated by using the formula below:

$$V = \pi r^2 l$$

where V is the volume of the drum, r is the inner radius if the drum, and l is the total length of the drum. The maximum volume of food waste and soils that can be inserted into the drum can be calculated by using the formula below:

$$VA = VD - VM$$

where VA is the actual volume of the inner cylindrical drum, VD is the volume of inner cylindrical drum, and VM is the volume of the mixing blade. The volume of the mixing blade is given by:

$$VM = 1/3\ (\pi r^2 T)$$

where r is the diameter of the shaft and T is the tolerance between drum and first mixing blade.

The machine also comprises of a heater stored on the lower side of the drum. This part acts as a heat source to maintain the inner temperature of the drum. The amount of heat generated by the heater can be calculated by using the formula below:

$$Q = MC\,(\phi 2 - \phi 1)$$

where M is the mass of the heating coil, C is the specific heat capacity of air which is 1.0035 J/Kg.K, $\phi 2$ is the final temperature of the heating coil, and $\phi 1$ is the initial temperature of heating coil. Figure 2.10 below shows the design of the compost machine.

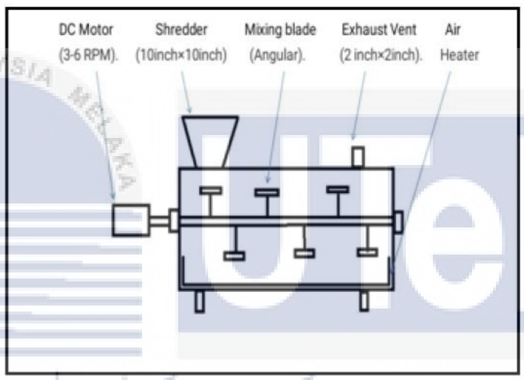


Figure 2.10: Design of the organic compost machine (Bhaisare et al, 2017)

Next, a report that had been made by Toumi (2017) about designing a composting bin were inspired by the tumbler type compost bin to ensure the compost can be turned easily and continuously. The total volume of the compost tumbler is about 0.209 m^3 with overall weight of 127 kg. The tumbler have a dimension of 28 cm length in radius and 85 cm length. It was chosen because of the turning action that can provide the compost with consistent amount of air as been told before that bacteria or the microorganism needs oxygen to keep up the decomposition process. Several aspects had been focused on the compost tumbler to ensure a good composting process. Firstly, the air circulation inside the compost tumbler must be in a good condition. In order to achieve that, a cylindrical metal pipe with 9 metallic sharp sticks with a length of 27 cm each had been installed. Furthermore, there are 6 holes with a diameter of 2 cm each were drilled on the upper side of the tumbler and also a door for inserting the compost materials mixture into the tumbler. For maximum aeration, only half of the compost tumbler was filled so that it will not close the upper 6 holes. Secondly, the composting temperature must be kept around 20^{o}C to 70^{o}C. The compost tumbler must be made of the suitable materials to keep the desired temperature. Therefore, the materials that had been selected is metal because it is known for its high capacity to retain heat. In addition, the compost tumbler was painted with anti-rusting paint to prevent from any rust or corrosion. Lastly, the compost tumbler must been produced to ease the task of composting. That is why the cylindrical metal pipe is connected to two-control handle located at the both side of the tumbler. The handle will allow a turning action making the 9 sharp sticks to rotate and mix the compost mixture inside the tumbler. In addition, the body of the tumbler is made of lightweight metal to ease the removal of the final compost fertilizer. The tumbler is attached with metallic belts to keep it from tumbling down or any movement during the mixing process. The tumbler is also put on a support to make it stable and easy to handle. Below shows the actual figure of the composting tumbler.

Figure 2.11: Composting tumbler (Toumi, 2017)

2.3 Shredding Machine

The mini plant for processing compost fertilizer also includes a shredding machine to shred or cut the organic materials into smaller pieces. A smaller size organic matter is better than the larger size because it can help in shortening the time taken for the organic matter to fully decompose. There are several works that had been made by other researchers in designing the shredder machine that will be reviewed in order to get inspiration or new ideas to be implemented into the mini plant for this project.

Firstly, Pavankumar S.B. et al. (2018) made a research on design and fabrication of organic waste shredding machine where it is used for shredding agricultural waste, kitchen debris, and waste food. The organic wastes are fed vertically into the machine through a hopper and will fall down to the cutters. The cutters or blades are installed on a shaft that is supported by bearings and mounted on the machine frame. The organic matters is shredded by the action of the blade that been driven by the motor with a speed of 1440 rpm and coupled with gear box in order to control the speed of the blades. Figure 2.12 below is the design of the blade.

Figure 2.12: Design of the blade. (Pavankumar S. B. et al, 2018)

Besides, the waste shredding machine parts have different types of materials and specification that can be seen in the table below:

Table 2.5: Materials specifications of the waste shredder machine (Pavankumar S. B. et al, 2018)

No.	Description	Materials
1.	Cutter and bushes	High carbon steel
2.	Shaft	Carbon (C11) grade
3.	Electric motor with planetary gear box	2 HP 3 Phase, output rpm 96
4.	Structural frame	Mild steel
5.	Base plate and supports	Mild steel
6.	Hopper and collecting vessel	Mild steel sheet
7.	Bearings	UCP 204
8.	Gears	EN 8

The final product of the waste shredder machine can be seen in the Figure 2.13 below.

Figure 2.13: Final product of waste shredder machine ((Pavankumar S. B. et al, 2018).

Ganesh U.L. et al. (2017), from their research named “Design and Fabrication of Organic Portable Shredder Machine”, designed the organic waste shredder machine with some working principles. Firstly, the organic matters are fed into the chamber through the hopper that is located at the top of the machine with inclined angle. After that, it will go through two parts of the machine, which are the sucker roller shaft and the blade shaft. The blades will cut or shred the organic wastes by shearing force and then the force comes from the rotation of the shaft will push the uncut matter and also provides a thrown force to throw the shredded waste. Next, the shredded organic matter will fall into the first dumping stage. For a smaller size of organic matter in powder form, powdering blades are provided and then will flow through the sieve to filter the fine grain size organic matter on the second stage. The clearance between the rotating blades can be varied according to the size of the crop residues. Below is the table that shows the details of the portable shredder.

Table 2.6: Designed details of portable shredder. (Ganesh U.L. et al, 2017)

No.	Design and Specification		
1	V-belt	Speed of the blade shaft	N_2 = 360 rpm
		Length of the V-belt	L = 1878.94 mm
		Velocity of the V-belt	V = 5.747 m/s
		Cross section of the belt	K_w = 0.89
		Correct center distance	C = 758.78
2	Shaft	Reaction support	R_B = 475 N, R_A = 475 N
		Torque	T = 39523.47
		Diameter	D = 24.43 mm
3	Chains sprocket	Speed of roller shaft	N2 = 384 rpm
		Pitch of the chain drive	P1 = 9 mm, P2 = 10 mm
		Velocity of chain drive	V_1 = 0.81 m/s, V_2 = 0.963 m/s
		Number of strands	J_1 and J_2 = 2
		Chain length in pitches	L_p = 74 pitches
		Length of chain	L = 740 mm
		Tangential tooth load	F_t = 329.11 N

4	Spur gear – pinion Weaker $\alpha = 20^0$	Circular pitch	P = 6.57 mm
		Velocity V_m	1.80 m/s
		Dynamic load	F_d = 1416.67 N

Figure 2.14 below shows the 3D model of the portable shredding machine.

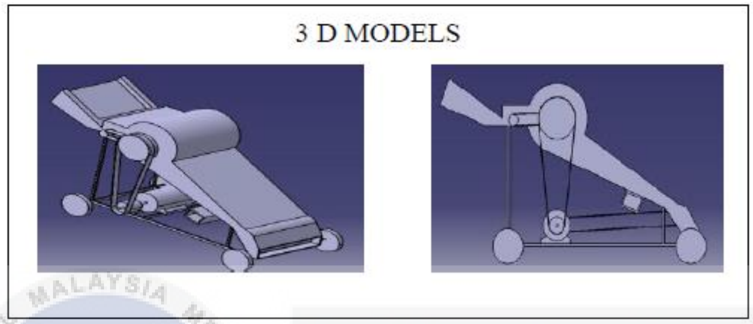


Figure 2.14: 3D model of the portable shredding machine. (Ganesh U.L. et al, 2017)

2.4 Conclusion

Based on all the above literature review, there is a conclusion on the ideas and information that can be taken as the guide for the project. First, the organic matter that can be used for the compost fertilizer must come from dried leaves. From the research by Khan et al. (2013), it is found that the research can be used as a guideline as it use wastepaper for the organic matter. The dried leaves can act like the wastepaper as both of them come from the trees. In addition, some supplements can be added in order to add more nutrients into the compost fertilizer. Bean drags and crab shell powder can be added as it have many beneficial nutrients for the plants and soils. The effects of the compost fertilizer no matter on what type of the organic matter are mostly the same as it gives more growth rate and nutrients to the plants and soils.

Next, the compost bin that can be used as reference comes from the research by Toumi (2017) because of its simplicity and suitable size for the mini plant in this project. The compost bin for this machine can be made to a little bit smaller compared by the reviewed report so that it will achieve the objective where it stated that the machine must be portable. The tumbler also has some interesting and useful features that will affect the quality and time taken for the compost fertilizer to be made.

Finally, the shredder machine from the design by Ganesh U.L. et al. (2017) can be used as a reference because of its unique specifications. The shredder machine have two stages of shredding where after the second stage, the organic matter will be shredded into powder sized. This is actually suitable for the project mini plant because as mentioned in the objectives, the final product of the compost fertilizer must be in the smallest sized. The powdered organic matter also will help in shortening the decomposition time and will affect the final quality of the compost fertilizer.

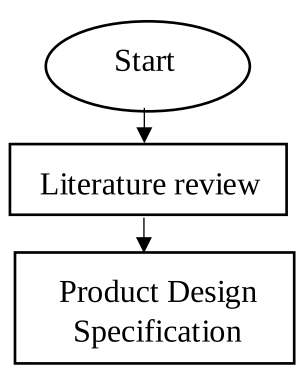
CHAPTER 3

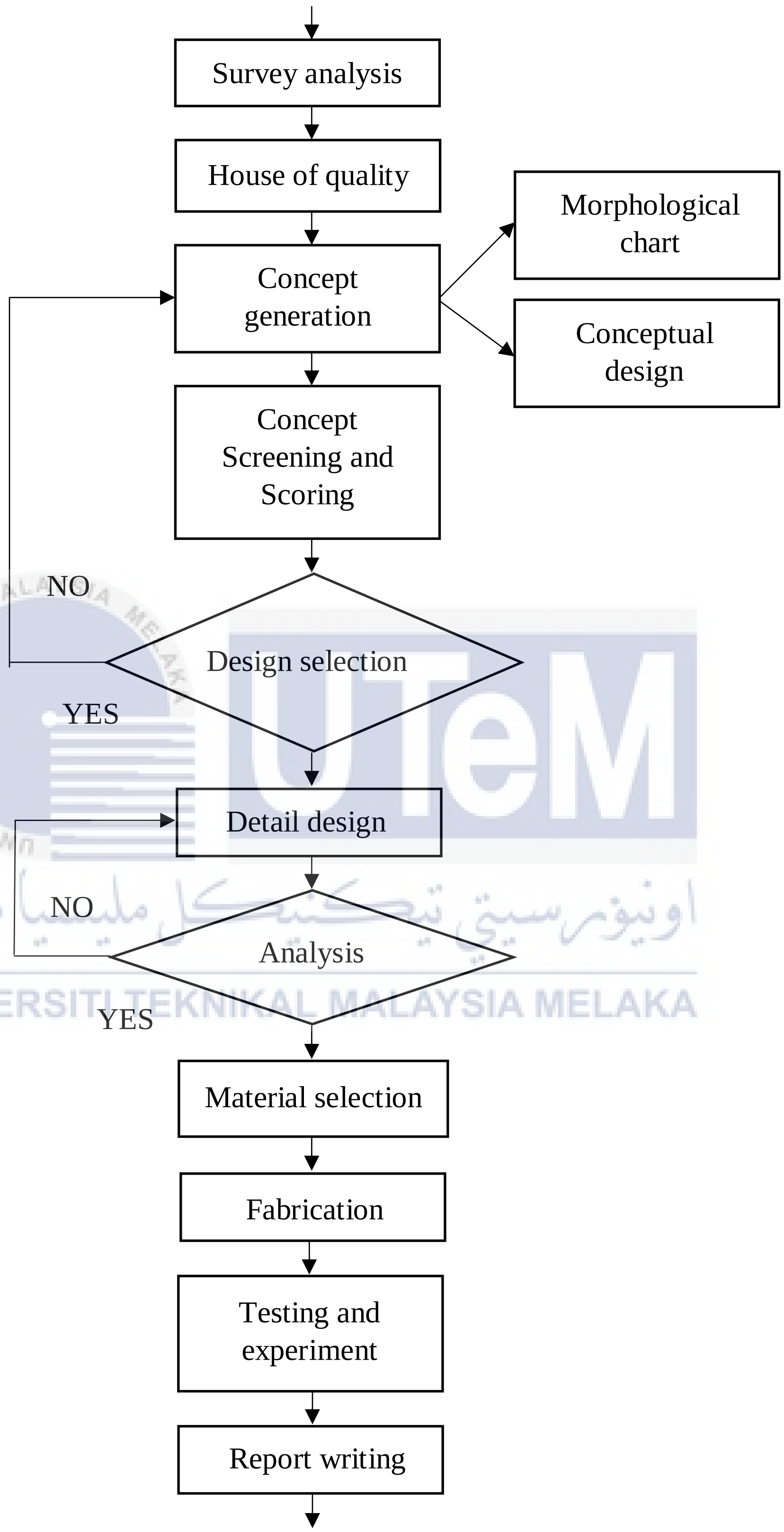
METHODOLOGY

This chapter describes about the methods that is used to achieve the objectives of the project. The methods include product design specification (PDS), survey analysis, quality function deployment (QFD) or house of quality (HOQ), concepts generation, concept scoring and screening, detail design, material selection and fabrication. All of these methods will be described in detailed. The data collection method is the typically determining for the data analysis from CAD software and testing on the prototype.

3.1 Flowchart of Project

Flowchart is one of the tools that being used to simplify the process of certain activities according to the sequence. From the flowchart, some problems can be detected by the person who conducts the process and easy for them to monitor the process. Figure 3.1 below shows the flowchart of the project.




Survey analysis
House of quality
Concept generation
Morphological chart
Conceptual design
Concept Screening and Scoring
NO
Design selection
YES
Detail design
NO
Analysis
YES
Material selection
Fabrication
Testing and experiment
Report writing

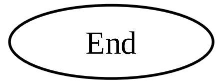


Figure 3.1: Flowchart of the project.

3.2 Product Design Specification (PDS)

Product design specification (PDS) is a process generated during the problem definition at the beginning of the design process. It shows the requirement that must be met in order to achieve the objectives of the project. Below are the list criteria that the mini plant must have:

1. Performance.
   - Shred organic matters like dried leaves into the smallest size as possible.
   - Produce compost fertilizer immediately.
   - Reduce the workforce in the making of compost fertilizer.
   - Produce a large amount of compost fertilizer at a time.
2. Size.

   - Small size that is suitable for the use of small farmers and gardeners.
   - Portable for the ease of facilitating the movement of the mini plant.
3. Material.
   - The mini plant is generally made of mild steel and covered with paint to prevent from corrosion for a longer life period.
   - The materials can withstand high stress, strain and torsional force to avoid from any damage.

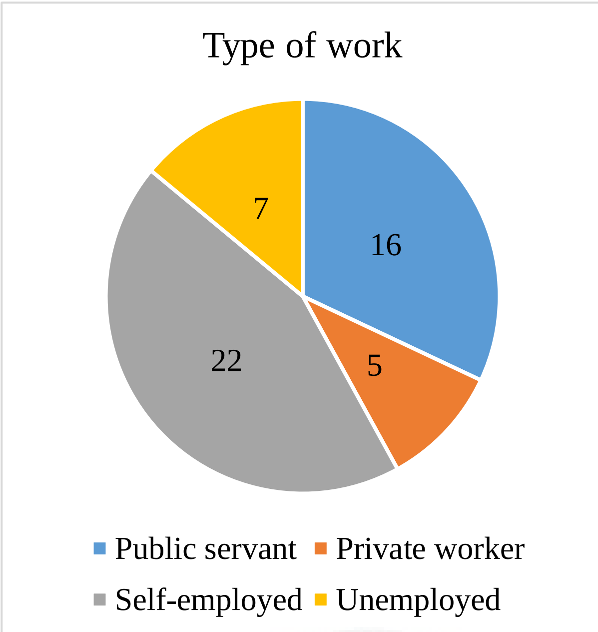
4. Safety.
    - The mini plant must have safety features like the top lid to prevent from any human parts to get inside the casing and keep the compost material within enclosure.
    - The mini plant will be provided with standard operation procedure (SOP) to easily operate the plant.

3.3 Survey Analysis

A survey was conducted to get the right information that will help in improving the design development of the mini plant for processing of compost fertilizer compared to the existing designs that can be found in markets today. From the results obtained, a house of quality (HOQ) can be constructed to analyze the best criteria that will be implemented in the design of the mini plant.

3.3.1 Survey Form Results

The survey contains about 22 questions including the two questions about the background information of the respondents. The survey was distributed to 50 respondents among the community via online access on Google Form to ask about the opinions on the project.



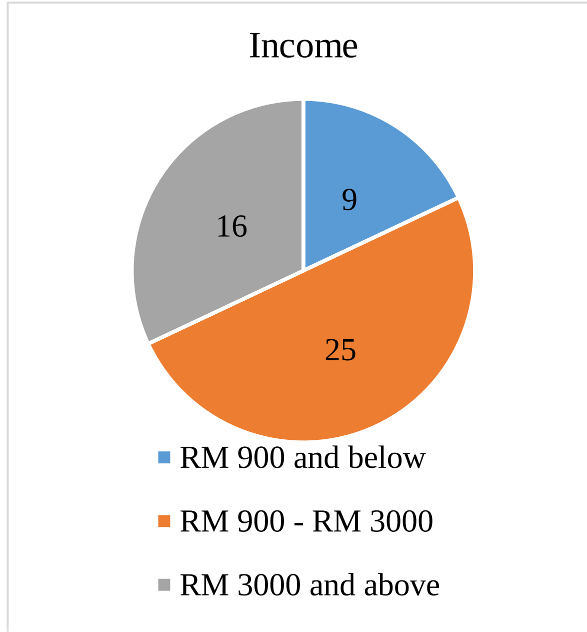


Figure 3.2: Pie chart showing the data of work type and income.

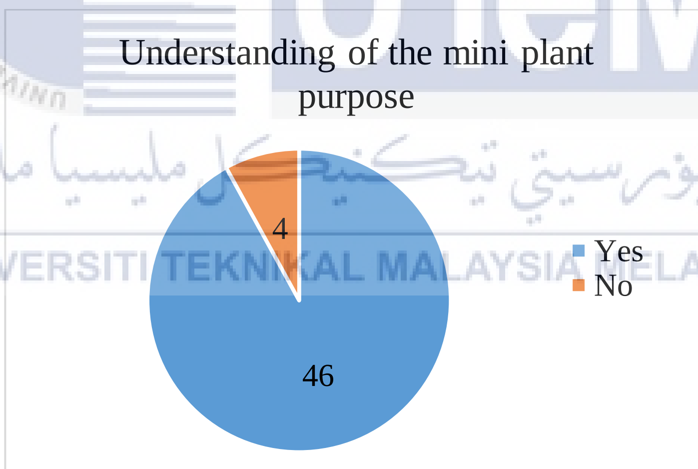


Figure 3.3: Pie chart showing the data of the understanding of the mini plant purpose.

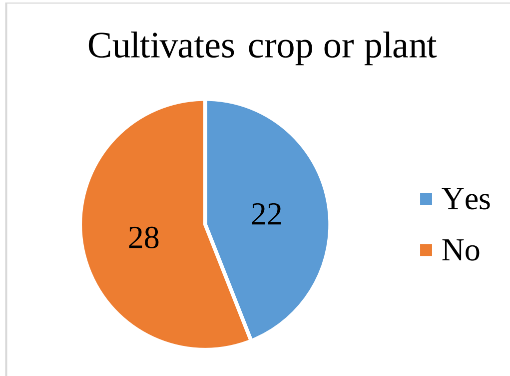


Figure 3.4: Pie chart showing the data of cultivation of crop or plant.

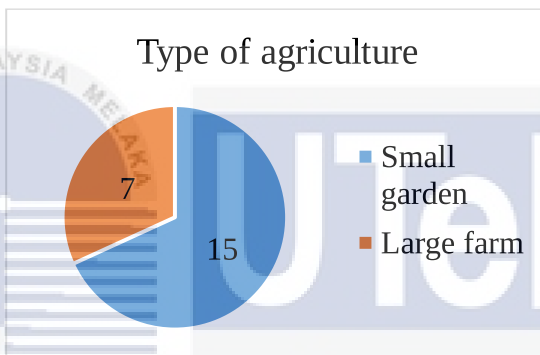


Figure 3.5: Pie chart showing the data of agriculture type.

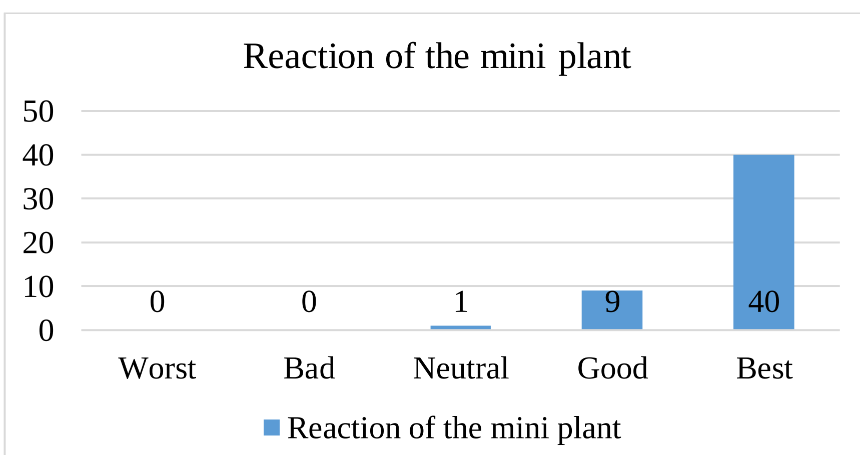


Figure 3.6: Bar chart showing the reaction of the mini plant.

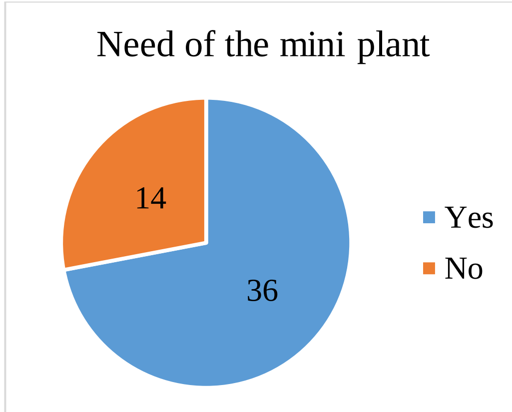


Figure 3.7: Pie chart showing the need of mini plant by respondents.

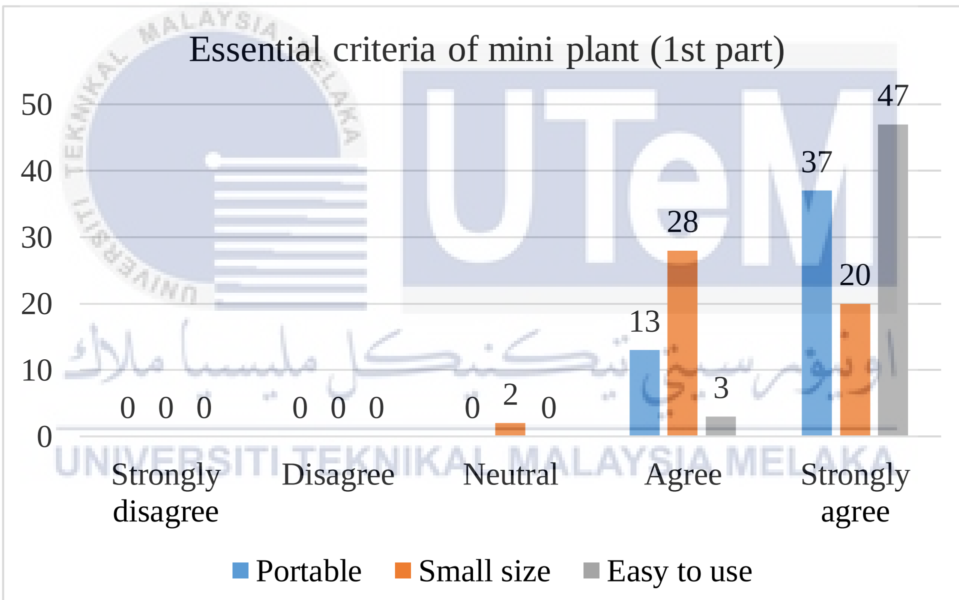


Figure 3.8: Bar chart showing the essential criteria of mini plant (1st part).

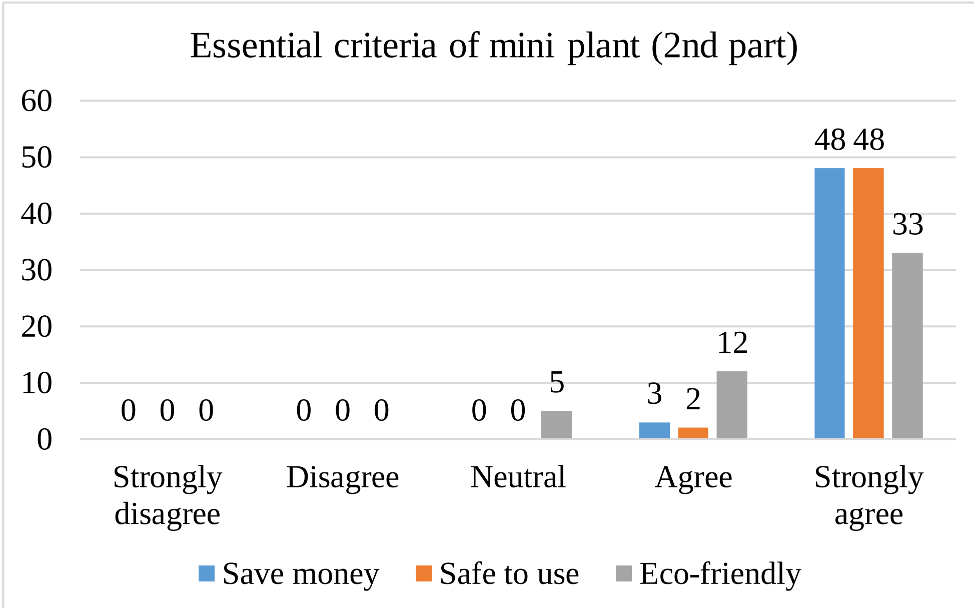


Figure 3.9: Bar chart showing the essential criteria of mini plant (2nd part).

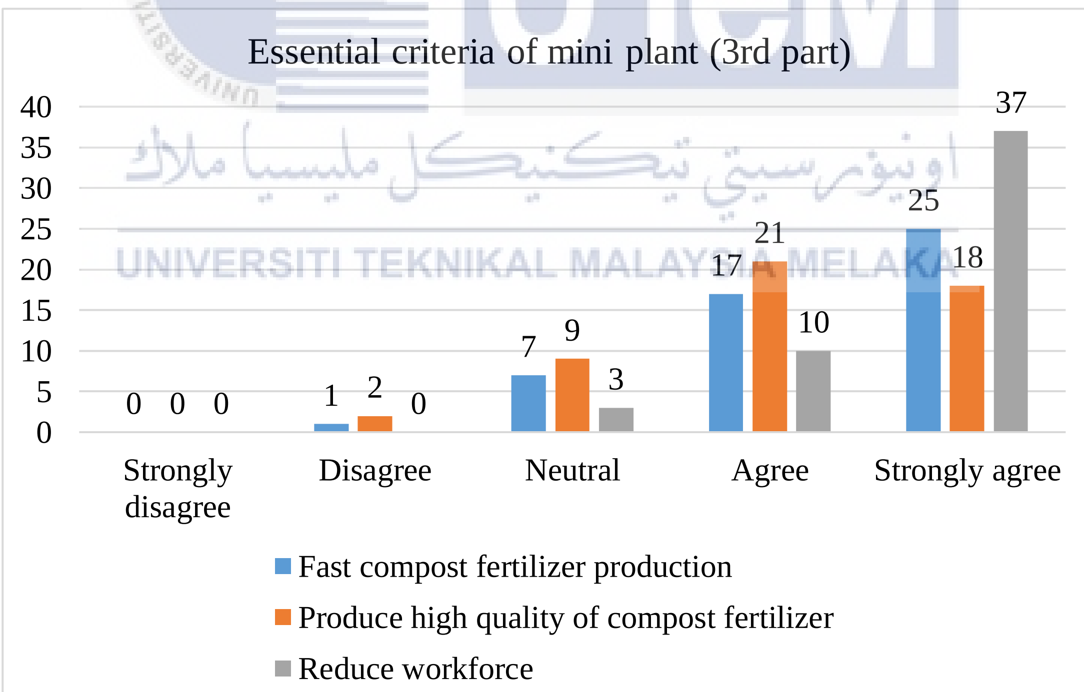


Figure 3.10: Bar chart showing the essential criteria of mini plant (3rd part).

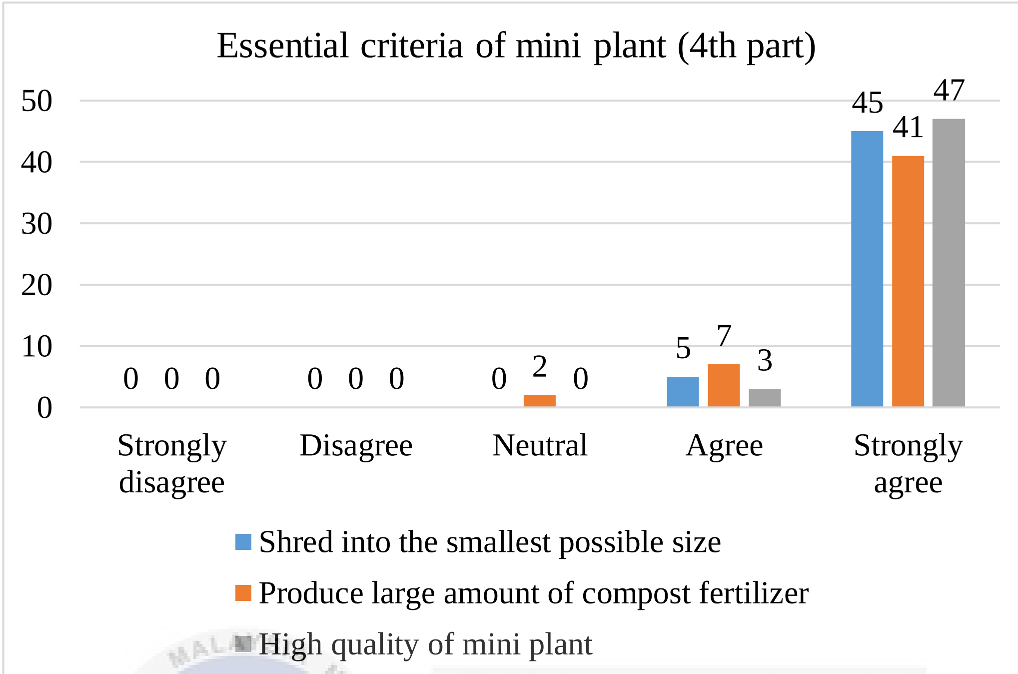


Figure 3.11: Bar chart showing the essential criteria of mini plant (4th part).

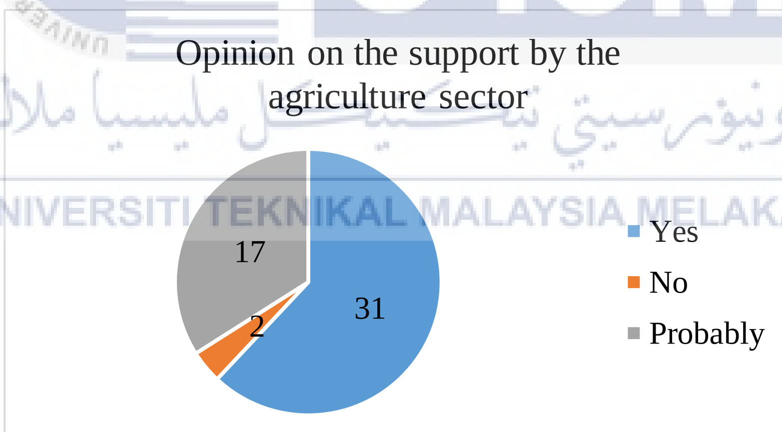


Figure 3.12: Pie chart showing on the opinion on the support by the agriculture sector.

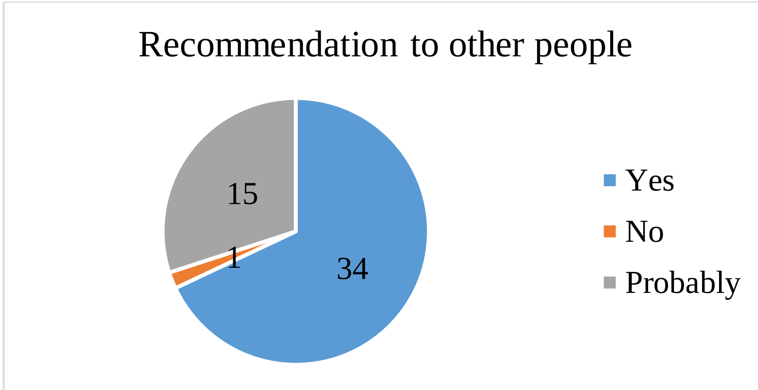


Figure 3.13: Pie chart showing the recommendation by respondents to other people.

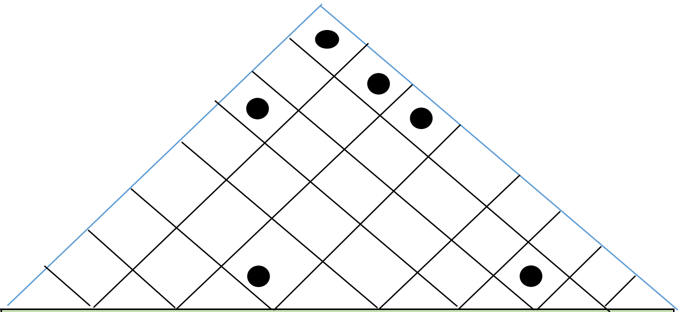
3.3.2 Conclusion

After conducting the survey, it is found that customers preferred the mini plant for processing of compost fertilizer that have a good quality of structure for doing heavy duties and for safety purpose. So the mini plant can be used for a longer period. Next, the respondents also preferred a very good performance of the mini plant in term of the easiness of use, low cost of maintenance, smallest shredding size of the dried leaves, and produce a large amount of compost fertilizer at once.

On the other hand, some respondents preferred the mini plant to be portable and small size to make it easier to facilitate the mini plant and keep the mini plant to be stored, so it can save some space in their farms or gardens. Besides, several respondents does not agree that the mini plant can produce compost fertilizer quickly and high in quality. This might because of the quality and the time taken for the production of compost fertilizer depends on the techniques or methods that are used individually.

3.4 House of Quality (HOQ)

The House of Quality (HOQ) is a central tool of Quality Function Deployment (QFD). The main function is to translate customer requirements, market research and benchmarking data into prioritized engineering targets to be met by a new product design. Customer requirements can be obtained from survey form analysis. There are 6 requirements for customers which are easy to used, stability, long lasting, portable, versatility, and safety. The HOQ has been generated, and the result is shown in Figure 3.14 below.



Direction of Improvements		Technical Details											
Engineering Characteristic / Customer Requirement	Customer Importance	Weight	Frame strength	Motor capability	Power source	No. of shredding blade	Compost bin volume	No. of mixing blade	Material	Improved Factor	Sale Points	Score	Percentage total (%)
Easy to use	5				9					1.1	1.1	6.1	9
Portable	4	9								1.2	1.4	6.7	10
Low maintenance cost	5				9	1		3	3	1.1	1.2	6.6	10
Safe to use	5	3	9	9	1					1.0	1.4	7.0	10
Eco-friendly	4				3		1			1.0	1.0	4.0	6
Reduce workforce	4			3			3	3		1.1	1.2	5.3	8
Smallest size shredding	5			9		9				1.2	1.4	8.4	13
Large production	5						9			1.0	1.0	5.0	8
High quality machine	5		9						9	1.0	1.4	7.0	10
Small size machine	3	9	1				3			1.4	1.0	4.2	6
Fast production	3			3		3	1			1.0	1.2	3.6	5
High quality of compost	3			3		3	1	1		1.0	1.1	3.3	5
Technical Priorities (Score)		119.1	130.2	176.1	133.3	102.9	84.4	39.0	82.8	Total		67.2	100
Percentage Total (%)		13.7	15.0	20.3	15.4	11.9	9.7	4.5	9.5	100%			
Design Target		30 kg	X	Petrol Engine	External	10	0.16 m^3	7	SS				

Figure 3.14: House of Quality (HOQ).

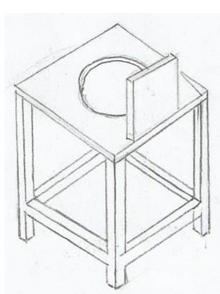
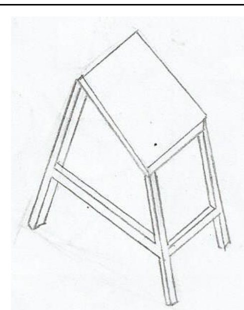
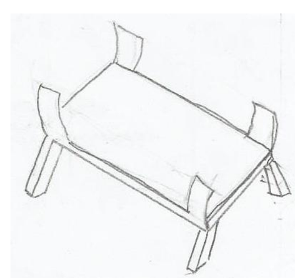
3.5 Concept Generation

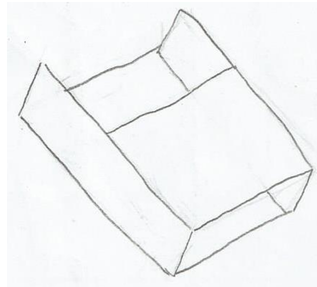
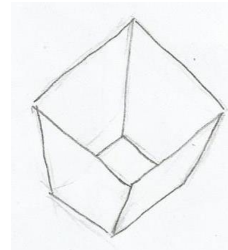
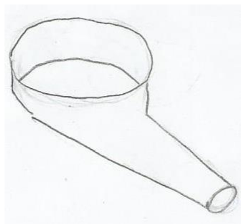
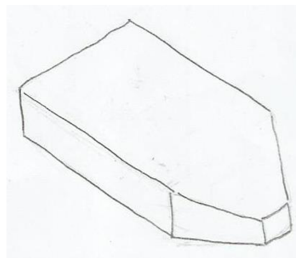
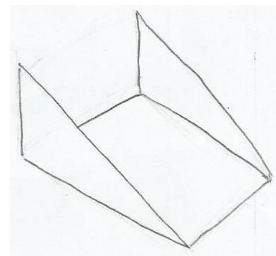
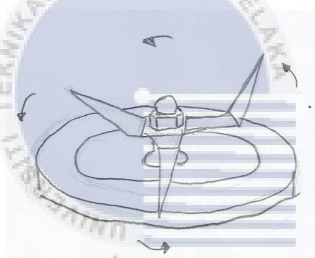
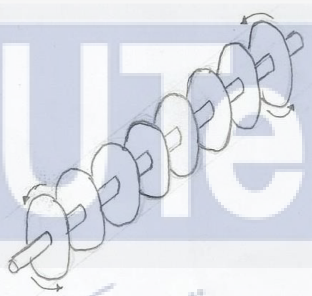
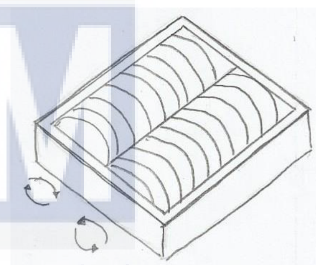
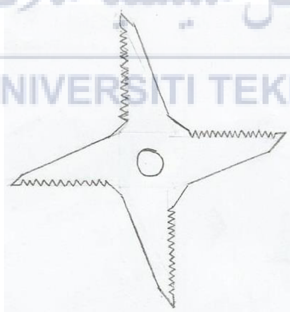
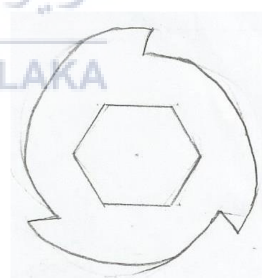
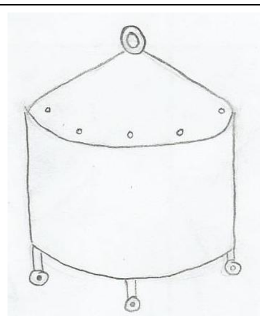
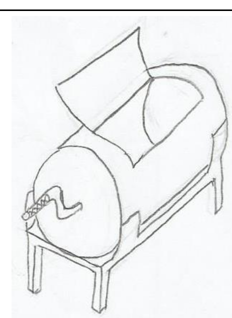
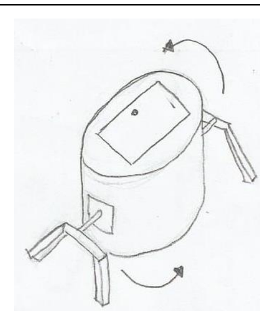
Concept generation, getting the thoughts, is the most basic step in the engineering design process. Beginning with an arrangement of customer needs and target specifications, the procedure closes with a variety of product options from which a final detail design is chosen. There are different steps engaged with the generic concept generation process, and in addition different approaches. In this project, two methods will be used in generating concept for the mini plant, which are the morphological chart and the conceptual design.

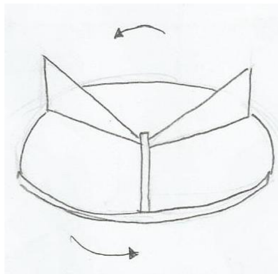
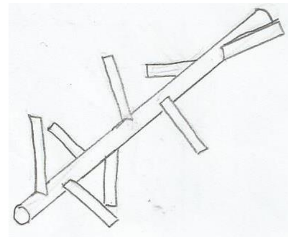
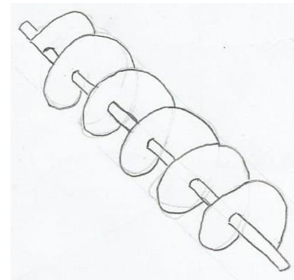
3.5.1 Morphological Chart

Several parts need to be designed for this mini plant based on the frame, hopper, shredder outlet, shredder blade, blade design, mixing blade and compost bin. This is the first step on how to adjust the perfect mechanism into the system for better performance. A few list of option or criteria design in morphological chart is sketched before the final detail design is created. Table 3.1 below shows the morphological chart for the project.

Table 3.1: Morphological chart.

PART	CONCEPT 1	CONCEPT 2	CONCEPT 3
Frame			

Hopper			
Shredder Outlet			
Shredder Blade			
Blade Design			
Compost Bin			

Mixing Blade			

3.5.2 Conceptual Design

For the concept generation of the mini plant for processing of compost fertilizer from dried leaves, conceptual designs need to be developed. The conceptual designs are generated by combining the criteria that have been configured in the morphological chart to develop a concept design of the mini plant, which contains all the criteria. Three conceptual designs have been generated by combining the criteria in the morphological chart. All the generated conceptual designs have their respective advantages and disadvantages that need to be determined in order to evaluate and compare before choosing the best conceptual design of the product. The three conceptual designs are shown in figures below.

3.5.2.1 Conceptual Design 1

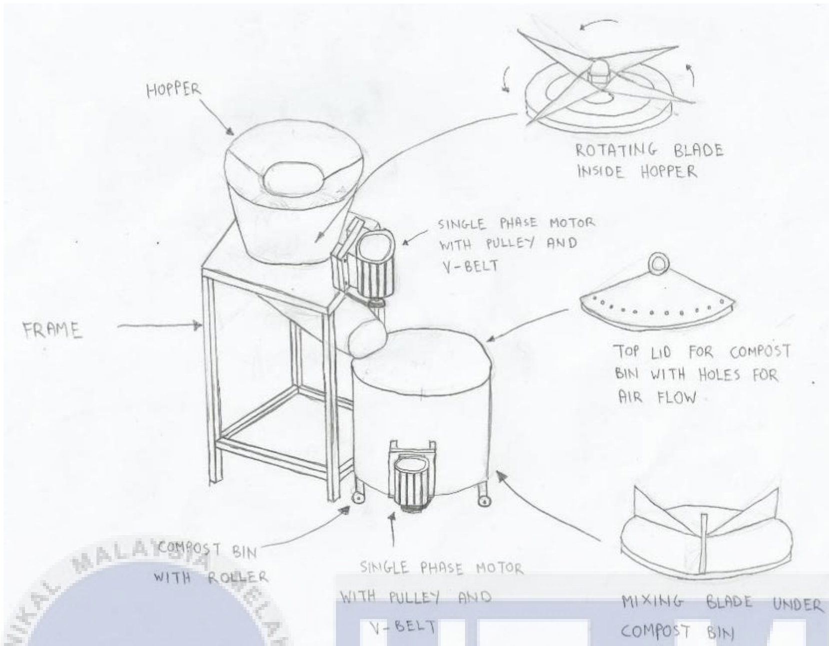


Figure 3.15: Conceptual design 1.

Conceptual design 1 has selected a square cuboid shape as the frame. This frame is less stable because of the cross sectional area of the frame and high center of gravity. The hopper is in a half cone shape located at the top of the frame and has a barrier around it for safety purposes. The shredder outlet is in a conical shape with inclined angle for the movement of the shredded leaves come from the shredding blade. Next, the shredding blade is inspired from the design of the kitchen blender, which has four blades that rotate in high speed. The compost bin is in cylindrical shape placed vertically with a mixing blade installed at the bottom of the bin for mixing the compost fertilizer. In addition, the compost bin is provided with the top lid with holes for air flow that is essential for the decomposition process. Lastly, the overall conceptual design needs at least two single phase DC motor to operate the shredding and mixing blade which might be a bit expensive.

3.5.2.2 Conceptual Design 2

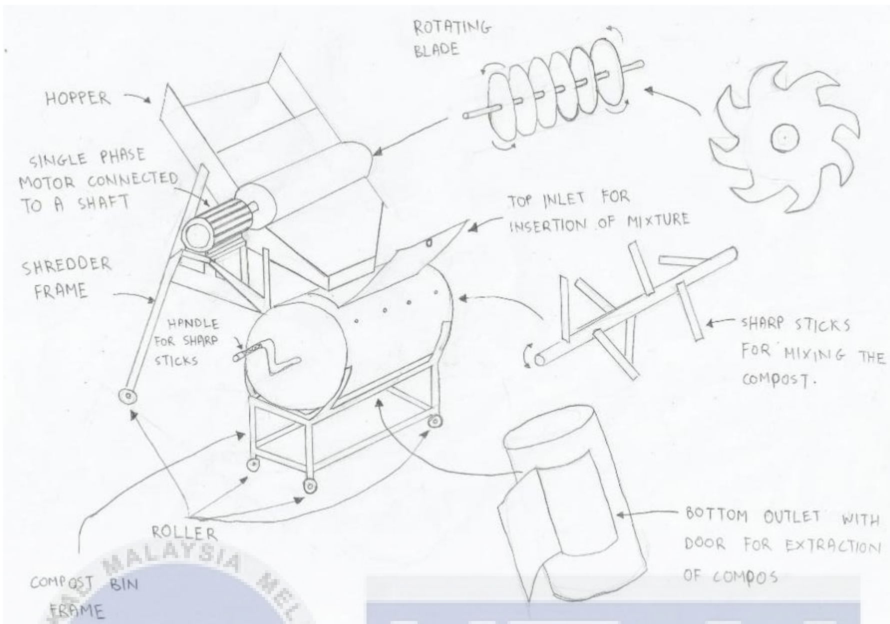


Figure 3.16: Conceptual design 2.

Conceptual design 2 has selected an inclined frame that has a larger cross sectional area compared to the first conceptual design, thus make it more stable, although the center of gravity is quite the same. The hopper is in rectangular shape placed in an inclined position on top of the frame and has a barrier after some distance for safety purposes. Next, the shredding blades are welded on a shaft connected to a 6.5 horsepower four-stroke petrol engine that will transfer the high-speed torsional force from the motor to cut the dried leaves into smaller pieces. The amount of the blades can be added to reduce the clearance between the blade and thus resulting a smaller size of the shredded dried leaves.

Moreover, the compost bin is in cylindrical shape with holes placed horizontally on a frame with installed rollers at the bottom for easy movement. The compost bin is also installed with two doors, one at the upper side and another at the bottom. This will help in the insertion of the compost mixture and the removal after it is completely developed. At the side of the bin, a handle is connected to a shaft located inside the bin. The shaft is attached with several sharp thin sticks. These sticks act like a mixing blade for the decomposition process. Furthermore, the mixing blade is controlled manually because the mixing process is not actually needed to be continuously. The mixing blade is only turn at a certain period of time to ensure the aeration in the compost bin to be even. Lastly, the design requires only one petrol engine motor to operate the shredding blade.

3.5.2.3 Conceptual Design 3

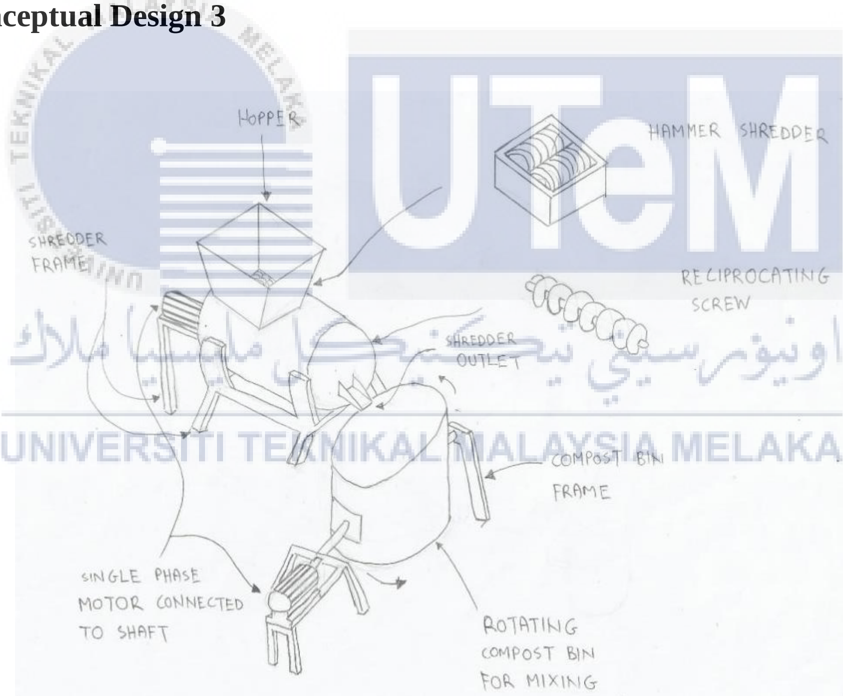


Figure 3.17: Conceptual design 3.

Conceptual design 3 has selected a cylindrical frame for the installment of the shredder container. This frame is stable because of low center of gravity. The hopper is in a half pyramid shape located at the top of the shredder container. Inside the container, there is reciprocating screw connected to a single-phase DC motor at the back. It will push the shredded dried leaves towards the shredder outlet located at the end of the container. Next, the shredding blade is inspired from the design of the hammer mill shredder, which has multiple blades installed closely on two shafts. The compost bin is in cylindrical shape placed vertically on a frame. The mixing process comes from the rotational movement of the compost bin driven by a single-phase DC motor. Lastly, the conceptual design needs at least three single phase DC motor to operate the shredding blade, reciprocating screw and the compost bin which might be a bit expensive.

3.6 Concept Screening and Concept Scoring

The concept screening and concept scoring techniques are used as the evaluation method to select the best conceptual design of the lifting device. In concept screening, a Pugh Concept Selection Method is used to reduce the conceptual design generated to a relative few that will get additional refinement and analysis. On the other hand, concept scoring used the Weighted Decision Matrix that is very useful in making complex decisions, especially in cases where there are many alternatives and many criteria of various priorities to be considered. The conceptual designs need to be evaluated according to the design criterion. Table 3.2 and Table 3.3 below shows the comparison of different conceptual design by using the Pugh Concept Selection Method and the Weighted Decision Matrix.

Table 3.2: Pugh Concept Selection Method.

CRITERIA	**CONCEPTUAL DESIGN**		
	1	2	3
Portable	=	+	-
Small size	=	-	+

Easy to use	+	-	+
Low maintenance cost	=	+	-
Eco-friendly	=	=	-
Fast production	-	+	-
High quality compost	-	+	-
Reduce workforce	=	-	+
Smallest shredding size	-	+	-
Large production	+	+	-
Safe to use	+	+	-
High quality machine	+	+	+
Sum of ‘+’	4	8	4
Sum of ‘-‘	3	2	8
Final score	1	6	-4

Table 3.3: Weighted Decision Matrix.

0	1	2	3	4
Unsatisfactory	Just tolerable	Adequate	Good	Very good

		CONCEPTUAL DESIGN					
		1		2		3	
CRITERIA	**WGT**	Rate	WGT Rate	Rate	WGT Rate	Rate	WGT Rate
Portable	0.10	3	0.30	4	0.40	2	0.20
Small size	0.06	2	0.12	2	0.12	4	0.24
Easy to use	0.09	3	0.27	3	0.27	4	0.36
Low maintenance cost	0.10	2	0.20	4	0.40	1	0.10
Eco-friendly	0.06	2	0.12	3	0.18	2	0.12
Fast production	0.05	3	0.15	4	0.20	2	0.10

High quality compost	0.05	3	0.15	4	0.20	2	0.10
Reduce workforce	0.08	4	0.32	3	0.24	4	0.32
Smallest shredding size	0.13	3	0.39	4	0.52	2	0.26
Large production	0.08	3	0.24	4	0.32	2	0.16
Safe to use	0.10	4	0.40	4	0.40	1	0.10
High quality machine	0.10	4	0.40	4	0.40	4	0.40
TOTAL	1.00		3.06		3.65		2.46
RANK			2ND		1ST		3RD

3.7 Design Selection

Based on the concept screening and scoring method, the best conceptual design for the mini plant is conceptual design 2 because both of its final scores shown from the tables is the highest compare to conceptual design 1 and 3. As a conclusion, conceptual design 2 is much promising and reliable to be fabricated and have more advantages. Therefore, concept design 2 is chosen as the final design for the further discussion in this project.

3.8 Detail Design

This method represents the final design of the mini plant for processing of compost fertilizer from dried leaves, which includes the detail design, and drawings of each part of the mini plant and full-assembled design. The detail design meets the main objectives of the project and focusing on these 4 items:

- Part design.
- Assembly design.
- Part drawing.
- Assembly drawing.

In order to create the design, a computer aided design (CAD) software, which is the Catia V5R21 software, will be used. All the detail designs and drawings will be represented in the Chapter 5: Results and Discussion.

3.9 Analysis

The analysis will be calculated by using ANSYS software in Static Structural Analysis. The analysis will focus on the results of stress, strain and torsional displacement under some action of load applied. This is to ensure the product can function properly without large deformation during the standard operating process along the whole body of the mini plant. All the analysis results will also be represented in Chapter 5.

3.10 Material Selection

This section will discuss about the materials and cost that involved in fabrication of the product. It consist of a Bill of Materials for the parts used in the mini plant. Furthermore, this section will briefly explain on the total amount and item description of this product.

3.10.1 Bill of Material

A bill of materials is a comprehensive list rundown of parts, items, assemblies and different materials required to make a product, and in addition guidelines required for gathering and utilizing the required materials. The bill of materials can be comprehended as the formula and shopping list for making a final product. The bill of material clarifies what, how, and where to purchase required materials, and incorporates instructions for how to assemble the product from the different parts requested. All manufacturers build items, regardless to their industry, start by making a bill of materials (BOM). Table 3.4 below shows the bill of materials for the mini plant.

Table 3.4: Bill of Materials.

NO.	PART NAME	QUANTITY	DESCRIPTION
1	Body frame	1	L-shaped mild steel bar
2	Blade casing	1	Mild steel sheet
3	Compost bin	1	Mild steel sheet
4	Compost bin door	2	Mild steel sheet
5	Shaft	3	Hollow mild steel rod
6	Mixing blade	1	Hollow mild steel rod and mild steel sheet
7	Shredding blade	14	High carbon steel
8	6.5 HP four stroke petrol engine	1	6.5 HP, 4.7 kW, 6.0 Liter
9	One way caster wheel	4	Polyurethane and alloy
10	Bearing	7	20mm inner diameter, Pillow block
11	Big sprocket	2	42 tooth
12	Small Sprocket	2	10 tooth
13	Chain	1	428 size specification
14	Hinge	8	Stainless steel

15	Cover net	1	Stainless steel
16	Bolt and nut	42	Stainless steel
17	Stopper caster wheel	2	Polyurethane and alloy

3.11 Fabrication Process

After the modelling of the mini plant by using the CAD software and the material selection is done, fabrication process will be proceeded in the workshop within the duration of one semester given. The processes involved in the fabrication are as followed:

- Marking process.
- Cutting process.
- Drilling process.
- Joining process.
- Assembly of parts.
- Installation of DC motor.
- Finishing process.

The fabrication process will be explained in detailed in the next chapter, Chapter 4: Fabrication Process.

3.12 Testing and Experiment

The next process after the prototype of the mini plant had completed some testing and experiment will be conducted on the prototype to ensure the strength, safety, and efficiency of the product. Based on the results obtained, we can make some discussion on whether the prototype really achieves the objectives of the project.

CHAPTER 4

FABRICATION PROCESS

This chapter will explained in detail about the fabrication process involved in the making the prototype for the compost fertilizer mini plant. The fabrication process took almost a full semester in order to complete the prototype. The fabrication process includes the marking, cutting, drilling, joining, assembly of parts, installation of motor, and finishing process.

4.1 Marking Process

The first process in the fabrication of the prototype is the marking process. After the raw materials had been obtained from the outside suppliers, some markings on the materials are made according to the detail design that had been provided with the exact dimensions and measurements. The process is carried out carefully in order to get the most precise dimensions of the prototype. Figure 4.1 below shows the marking process of the mini plant.

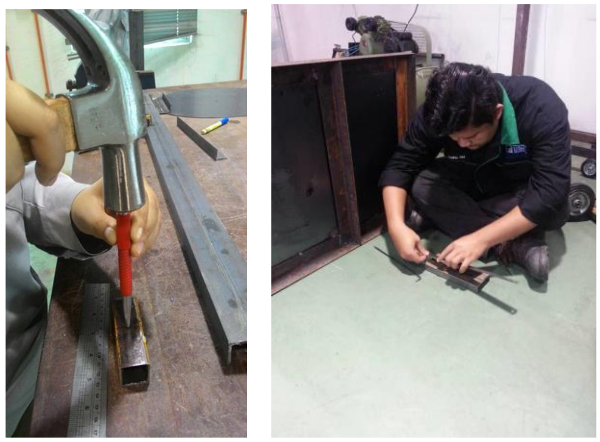


Figure 4.1: Marking process before cutting and drilling.

4.2 Cutting Process

After all the materials had been marked and measured, the cutting process will proceed. Most of the materials are cut manually by using the hand grinder and disc cutter machine. For a complicated shapes and dimensions, the materials are cut by using the computer numerical control (CNC) plasma cutting machine. The shapes and dimensions are sketched in the AutoCAD software before converted into the CNC plasma cutting software. Figure 4.2 and 4.3 below show the cutting process of the materials.

Figure 4.2: Cutting process by using the CNC plasma cutting machine for mild steel sheet with thickness of 0.8 mm.

Figure 4.3: Cutting process by using the disc cutter machine.

4.3 Drilling Process

Before the drilling process, the center of the holes are marked with center punch and hammer to ensure the drill bit is placed correctly. For a large hole, a smaller hole is drilled first so that the larger drill bit can drill easily. The drilling process is mostly been made by using the hand drill and bench drill machine. Figure 4.4 below shows the drilling process on the materials.

Figure 4.4: Drilling process by using the bench drill machine.

4.4 Joining Process

The joining process is made after all the materials had been cut and drilled according to their respective dimensions. There are two types of joining process involved in the fabrication of the mini plant, which are permanent joint and temporary joint. The permanent joint is done by using the arc welding and metal inert gas (MIG) welding while the temporary joint is mostly used fasteners like bolt and nut. Figure 4.5 below shows the joining process of the mini plant.

Figure 4.5: Joining process by using the arc welding machine.

4.5 Assembly of Parts

After all the parts are fabricated, the assembly process will be made to build the prototype of the compost fertilizer mini plant. The parts in the mini plant include the body frame, casing frame, upper and lower blade shafts, bearings, mixing blade, compost bin, caster wheels, sprockets, chain, and net. The parts are assembled by referring to the detail design that had been made earlier. Figure 4.6 below shows the assembly process of the prototype.

Figure 4.6: Assembly process of the upper and lower blade shafts on the casing blade.

4.6 Installation of motor

Next, the 6.5 horse power petrol engine motor will be installed on the platform located at the lower side of the body frame. At the end of the motor shaft, the big sprocket with 42 tooth is placed and tightened with a nut to prevent it from getting out. The motor is bind with four set of bolt and nut at the base and adjusted according to the position of the small sprockets located on the top of the motor. Figure 4.7 below shows the petrol engine motor already installed to the prototype.

Figure 4.7: Petrol engine motor located at the lower side of the body frame.

4.7 Finishing Process

Lastly, the prototype will undergo the finishing process to make it look good and safe from any sharp edges. The welded joint areas and the edges are grinded and polished by using the hand grinder to make the surface smooth and blunt. After that, all the parts are painted to prevent from any corrosion. Figure 4.8 below shows the finishing process on the mini plant.

Figure 4.8: Painting process on the parts.

4.8 Final Product

The final product will be tested whether it is safe to use and then, some adjustment will be made to ensure the efficiency and safety of the mini plant. Figure 4.9 below shows the final product.

Figure 4.9: Final product of the compost fertilizer mini plant.

CHAPTER 5

RESULT AND DISCUSSION

This chapter describes about the results that were obtained from the experiment and analysis that had been made on the design and prototype of the mini plant. The results of this project consists of the detail design, assembly design, finite element analysis (FEA), calculation on several parameters, and cost analysis. The designs, drawings, and finite element analysis are made on the ANSYS software. Based on the results, some discussions will be made to justify the results.

5.1 Detail Design

This section represents the design of the Mini Plant for Processing of Compost Fertilizer from Dried Leaves, which includes the detail design of each part and full-assembled design. This design has gone through enhancement process of final conceptual design based on the criteria selected during the discussion with the supervisor of the project. This section will include the following topics:

- Part Design
- Assembly Design

5.1.1 Part Design

5.1.1.1 Bearing

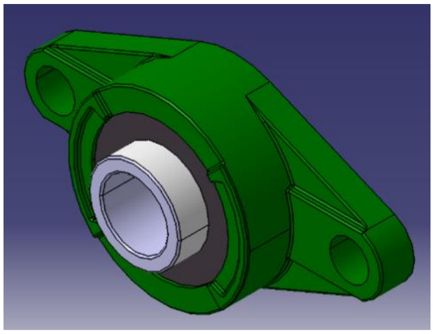


Figure 5.1: Bearing CATIA Part Model.

The bearing is installed at the end of the shaft to smoothen the rotational movement of the shaft. The inner diameter of the bearing is 20 mm that will fit with the diameter of the shaft. It has two holes at the side for the installation of the nut and bolt with diameter of 8 mm. The type of the bearing used in the prototype is UCFL204 pillow block deep-groove ball bearing manufactured by China FUDA F&D Bearing Corporation.

5.1.1.2 Big Sprocket

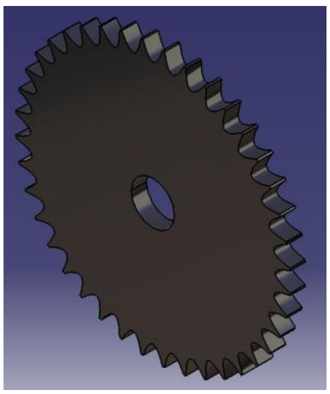


Figure 5.2: Big Sprocket CATIA Part Model.

In this prototype, two sizes of sprocket is used to transfer the rotational movement from the petrol engine to the shafts. There are two big sprockets included in the prototype, one is installed at the end of the petrol engine shaft that act as the driver sprocket and the other one is installed at the end of the mixing blade shaft that act as a driven sprocket. The mixing blade needs to move in a slow rotational movement, thus a bigger sprocket is suitable to transfer a larger torque needed during the mixing process of the compost fertilizer inside the compost bin. The inner hole diameter is 20 mm which will fit the diameter of the shaft. The sprocket has 42 teeth with a pitch of 12 mm, pitch diameter of 162 mm, and outside diameter of 187 mm.

5.1.1.3 Bin Door

Figure 5.3: Bin Door CATIA Part Model.

The bin door is installed at top and the bottom part of the compost bin. When the compost material is being shredded, the top bin door is opened for inserting the materials into the compost bin, while the bottom bin door is closed to prevent from the materials to spill out. After the shredding process is done, both of the door is closed for the mixing and composting process. Then after several weeks, the bottom door will be opened for the disposal of the compost fertilizer from the bin. The bin door is made of thin mild steel sheet with 0.8 mm thickness. At the top side of the bin door, a handle is welded together for the movement of the bin door.

5.1.1.4 Blade Casing

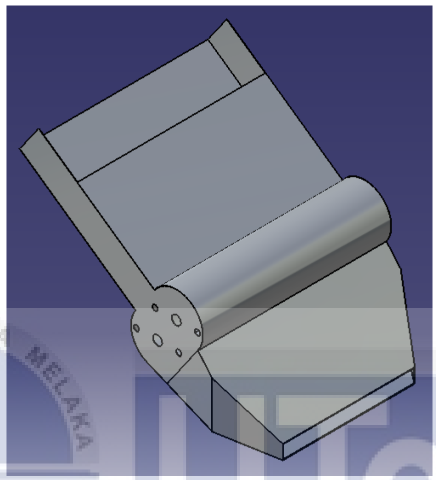


Figure 5.4: Blade Casing CATIA Part Model.

The blade casing is installed at the top side of the body frame part in an inclined position. This is because the gravity will help in moving the compost materials down from the inlet to the shredder blade and then to the outlet. Inside the blade casing, two shafts with shredder blades will be installed vertically and a thin barrier with small clearance is placed after the blades to ensure the large size compost materials is being shredded completely before going into the compost bin. While at the outside, four bearings will be placed according to the position of the shafts and some holes are drilled for the bolt to be fit in. The blade casing is fabricated by using 0.8 thin mild steel sheet.

5.1.1.5 Blade

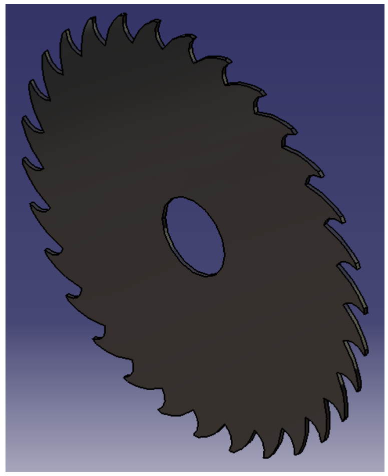


Figure 5.5: Blade CATIA Part Model.

The purpose of the blade is to shred the compost materials into smaller pieces. It is installed at the two shafts located inside the blade casing. Each shaft has seven blades welded in different dimension with different clearance with each other. Therefore, it will be fourteen blade inside the casing. The inside hole has a diameter of 20 mm which will fit with the diameter of the shaft. The outer diameter of the blade is 110 mm and has 30 teeth. The blade is made of high carbon steel and can withstand high round per minute (RPM) rotational movement.

5.1.1.6 Body Frame

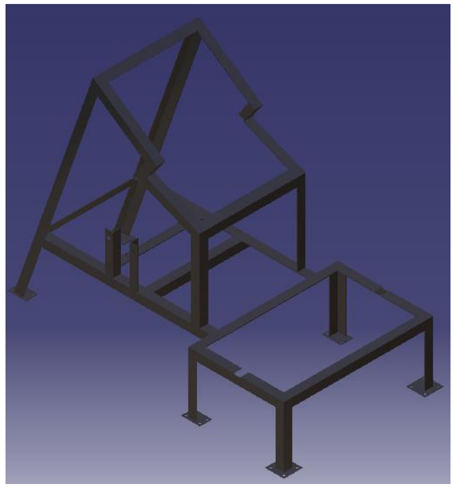


Figure 5.6: Body Frame CATIA Part Model.

The body frame is for putting and supporting most of the parts for the prototype such as blade casing, compost bin, and the petrol engine. At the top side, the blade casing will be placed in inclined position and under the casing is where the petrol engine placed. Meanwhile at the front side, the compost bin will be installed right underneath the outlet of the blade casing. Six thin plates will be welded together with the frame for the base of the caster wheel. The frame is fabricated with mild steel angle bar with dimension of 32 X 32 X 2.8 mm.

5.1.1.7 Compost Bin

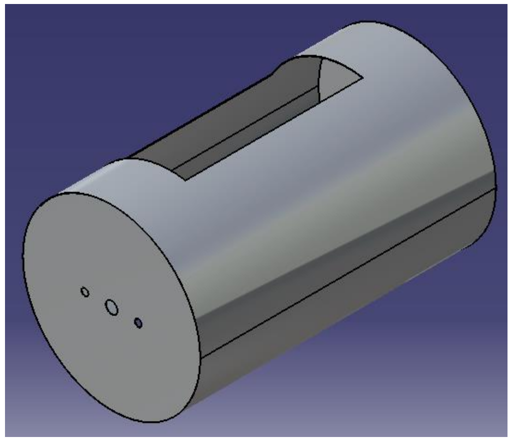


Figure 5.7: Compost Bin CATIA Part Model.

The compost bin acts as a storage for the compost materials during the composting process. It has an inlet at the top side for the insertion of the compost materials and an outlet at the bottom side for the disposal of the compost fertilizer. Both of the inlet and outlet will be closed by the bin door. Inside, a mixing blade is placed at the center of the bin and will connect to two bearing at the outside of the bearing. The compost bin is fabricated with 0.8 mm thin mild steel sheet welded all over the part.

5.1.1.8 6.5 HP Petrol Engine

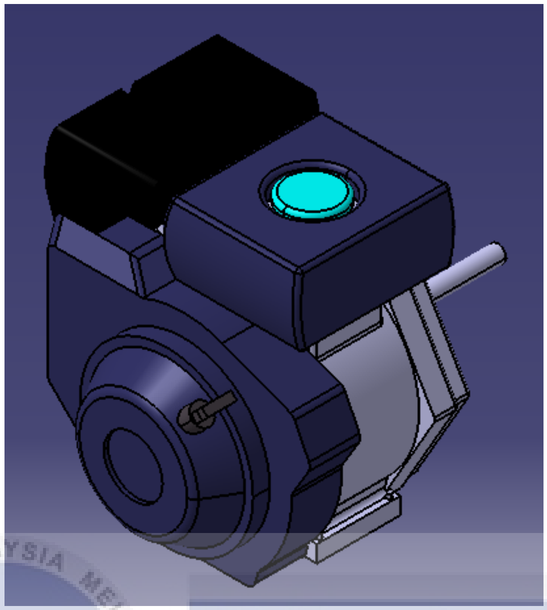


Figure 5.8: 6.5 HP Petrol Engine CATIA Part Model.

The petrol engine is used to transfer the rotational movement to the shaft with blades and to the mixing blade by sprocket and chain. The specifications for this particular petrol engine used for the prototype is:

- Air-cooled, 4-stroke, OHV, horizontal shaft
- Displacement: 196 cm^3
- Ignition mode: Transistor Magneto
- Compression ratio: 8:1
- Maximum output: 4.7 kW / 6.5 HP / 3600 RPM
- Fuel tank capacity: 6.0 Litre
- Weight: 18 kg.

5.1.1.9 Hinge

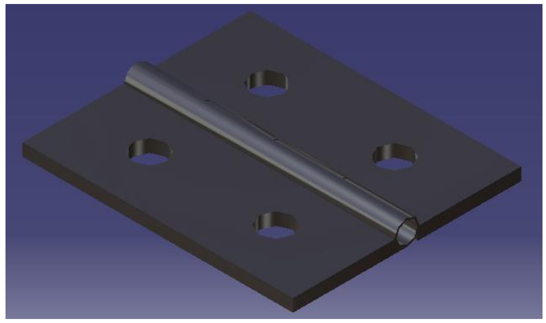


Figure 5.9: Hinge CATIA Part Model.

The hinge is used to connect the bin door and the net to the compost bin and the blade casing. It acts as a joint for both of the parts so that they can be close and open during the shredding and mixing process. The hinge is made of stainless steel plate to prevent it from any corrosion.

5.1.1.10 Lower Shaft Blade

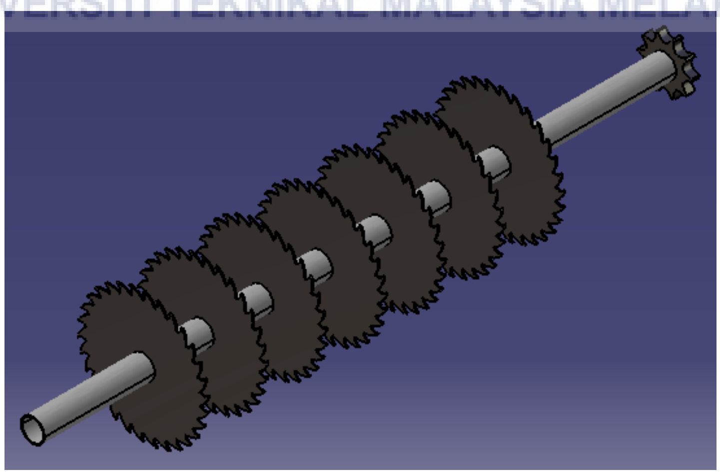


Figure 5.10: Lower Shaft Blade CATIA Part Model.

The lower shaft blade contains the shaft and seven blades. The blades are welded on the hollow shaft to make it stay on position and prevent it from being dismiss from the shaft. This part is located inside the blade casing at the lower side and the rotational movement comes from the petrol engine, which is transmitted, via sprocket and chain. At one end of the shaft, a small sprocket is installed where it is located at the outside of the blade casing. The dimension between the blades is about 49 mm and the thickness of the blade is about 1 mm. The material of the blade is high carbon steel while for the shaft is made of mild steel.

5.1.1.11 Mixing Blade

Figure 5.11: Mixing Blade CATIA Part Model.

The mixing blade is located inside the compost bin at the center for mixing the compost materials that had been shredded. It consists of a hollow shaft and eight thin mild steel sheet welded on the shaft. The length of the thin sheet has a length of 130 mm, which are lower than the radius of the compost bin. Therefore, the metal sheet will not collide with the inner wall of the compost bin. At both end of the shaft, two bearings will be installed to make the rotational movement as smooth as possible.

5.1.1.12 Net

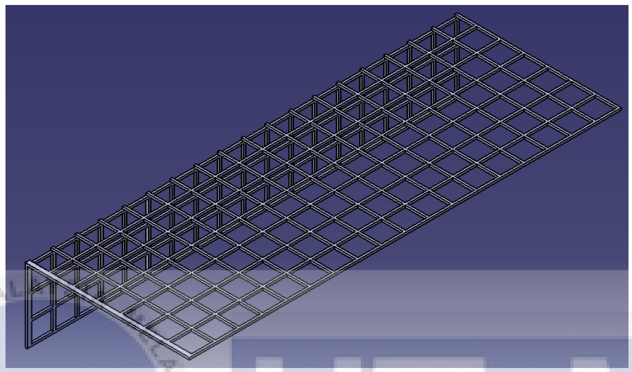


Figure 5.12: Net CATIA Part Model.

The net is installed at the top end side of the blade casing connected with two hinges. It is used as a protection during the shredding process to prevent from any human body parts to get intact with the blades inside the blade casing. Besides, it prevents from the compost materials to be thrown out due to the force from the high rotational speed of the shafts and blades. It is made of stainless steel to prevent from any corrosion.

5.1.1.13 One Way Wheel

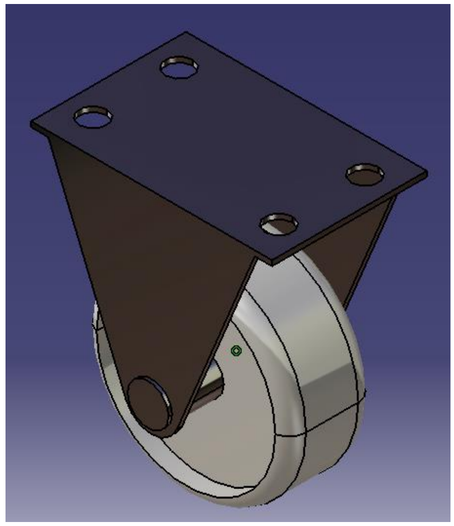


Figure 5.13: One Way Wheel CATIA Part Model.

The one way wheel is located at the bottom side of the prototype. It is to ease the movement of the prototype so it can be used anywhere as the user want to. The wheel can only go in forward and backward direction. So, only two of them are placed at the rear side and the other two will be placed at the middle side of the prototype. It consists of an alloy casing and a polyurethane wheel with dimension of 60 mm in diameter. At the top of the casing, four holes with diameter of 8 mm is drilled for the placement of the bolt. The bolt will connect with the thin plate below the body frame and tighten with nut and washer.

5.1.1.14 Small Sprocket

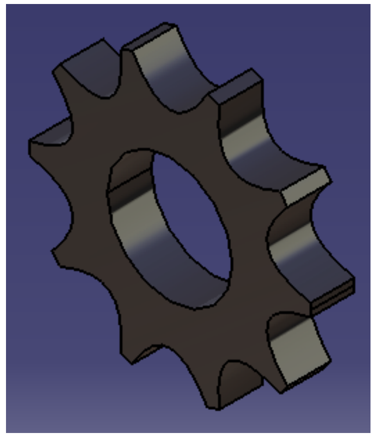


Figure 5.14: Small Sprocket CATIA Part Model.

There are two small sprockets included in the prototype, one is installed at the end of the lower shaft blade and the other one is installed at the end of the upper shaft blade that act as a driven sprocket. The shredder blades need to move in a high-speed rotational movement, thus a smaller sprocket is suitable to transfer the speed from the petrol engine during the shredding process. The inner hole diameter is 20 mm which will fit the diameter of the shaft. The sprocket has 10 teeth with a pitch of 12 mm, pitch diameter of 33 mm, and outside diameter of 45 mm.

5.1.1.15 Stopper Wheel

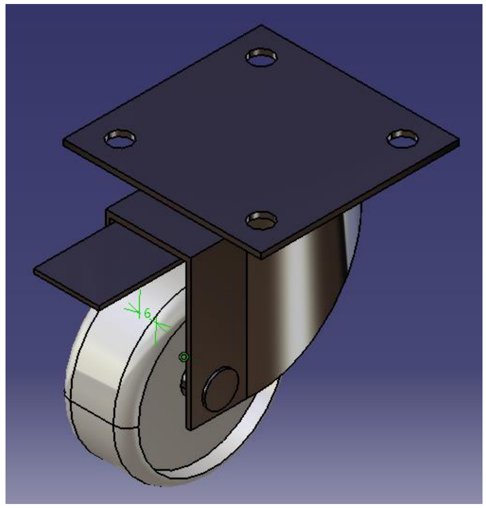


Figure 5.15: Stopper Wheel CATIA Part Model.

The wheel with brake is located at the bottom side of the prototype. It is to ease the movement of the prototype so it can be used anywhere as the user want to. The wheel is flexible, thus it can go in any direction. Two of them are placed at the front side of the prototype. It consists of an alloy casing, a polyurethane wheel with dimension of 60 mm in diameter, and a stopper to lock the wheel from moving around during the mini plant process. At the top of the casing, four holes with diameter of 8 mm is drilled for the placement of the bolt. The bolt will connect with the thin plate below the body frame and tighten with nut and washer.

5.1.1.16 Upper Shaft Blade

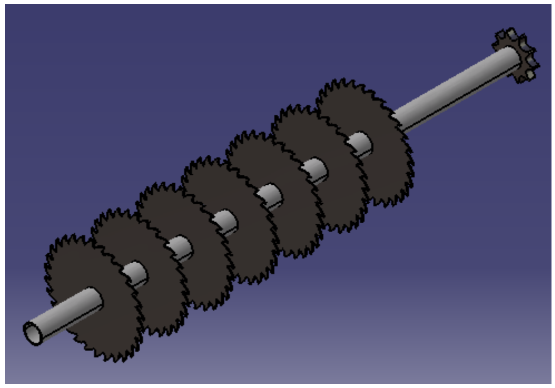


Figure 5.16: Upper Shaft Blade CATIA Part Model.

The upper shaft blade contains the shaft and seven blades. The blades are welded on the hollow shaft to make it stay on position and prevent it from being dismiss from the shaft. This part is located inside the blade casing at the upper side and the rotational movement comes from the petrol engine, which is transmitted via sprocket and chain. At one end of the shaft, a small sprocket is installed where it is located at the outside of the blade casing. The dimension between the blades is about 49 mm and the thickness of the blade is about 1 mm. The material of the blade is high carbon steel while for the shaft is made of mild steel.

5.1.2 Assembly Design

5.1.2.1 Compost Fertilizer Mini Plant

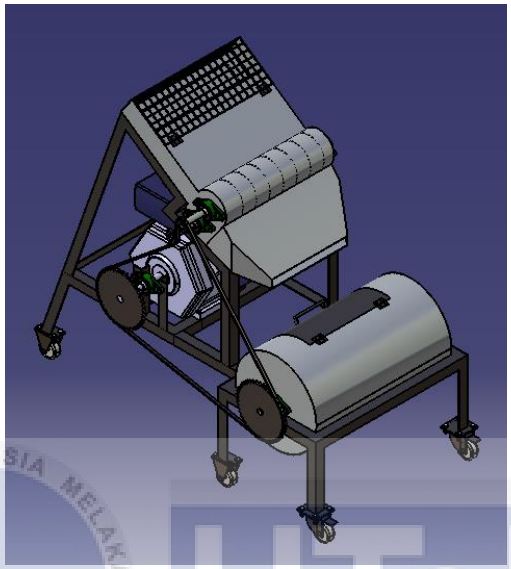


Figure 5.17: Compost Fertilizer Mini Plant CATIA Assembly Model.

All the parts involving in the mini plant are then assembled to get the full assembly model. At the left side of the mini plant, a chain will be installed to the four sprockets. The sprocket at the engine will transmit the rotational movement to the other three sprockets at the compost bin and the casing blade. Sprockets at the engine, compost bin and the upper blade shaft will rotate in anti-clockwise direction while the lower blade shaft will rotate in clockwise direction. This is because the two blade shafts need to rotate in inward direction from the hopper to the outlet so that the compost materials will automatically pushed inside the shredding area.

5.2 Finite Element Analysis

The finite element model is generated using ANSYS software for the lower blade shaft, upper blade shaft, mixing blade and the platform of the engine. The finite element models are shown in the figures below. One of the advantages in ANSYS software is that the mesh can be separated into three categories, which are fine, medium and course meshing. ANSYS software has the functionality for recalculating the loads after the mesh is refined. The part design file from CATIA V5R21 must be converted first to Standard for the Exchange of Product (STP) file type in order for the ANSYS software to read the existing file. The analysis had been made is the bending analysis.

5.2.1. Body Frame

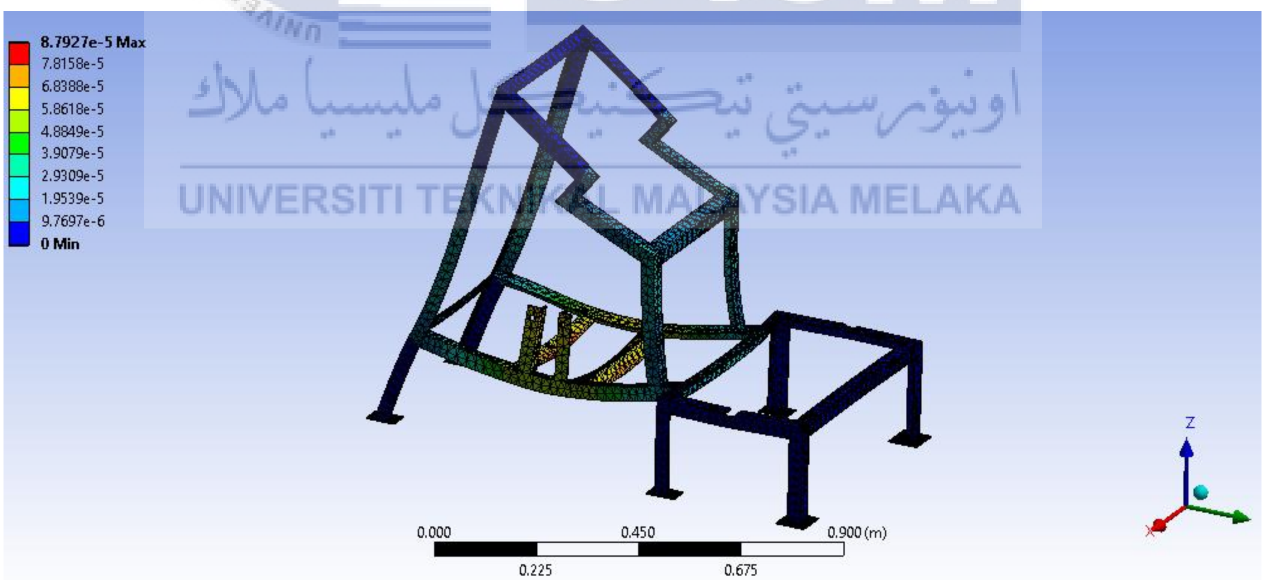


Figure 5.18: FEA Bending Total Deformation Analysis for the Body Frame part.

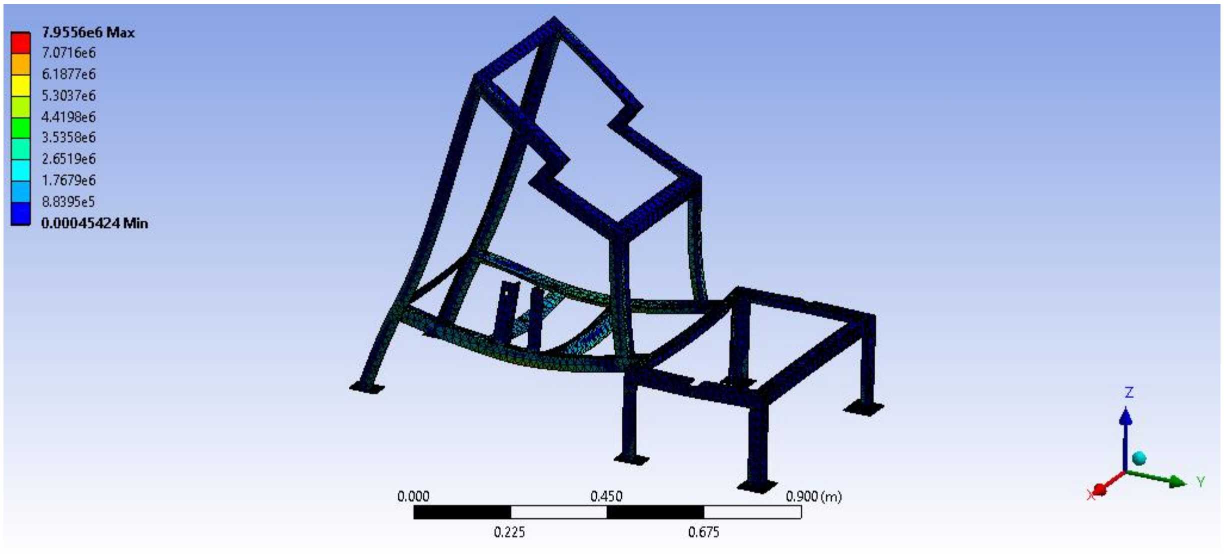


Figure 5.19: FEA Bending Equivalent Stress Analysis for the Body Frame part.

Table 5.1: Results for FEA Bending Analysis for the Body Frame part.

Object Name	*Total Deformation*	*Equivalent Stress*
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Total Deformation	Equivalent (von-Mises) Stress
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	0. m	4.5424e-004 Pa
Maximum	8.7927e-005 m	7.9556e+006 Pa
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

From Figure 5.36, the analysis shows that the deformation occurs most at the engine platform when the force of 176.58 N from the engine weight is place on top. Although the deformation look significant, the maximum total deformation is about 8.7927 X 10^-5 m, which is very little. The ultimate stress for mild steel is 250 MPa. The factor of safety of the body frame part is:

$$\text{F.O.S} = \frac{\text{Ultimate stress}}{\text{Actual stress}} = \frac{250\ MPa}{7.9556\ MPa} = 31.424$$

5.2.2 Lower Shaft Blade

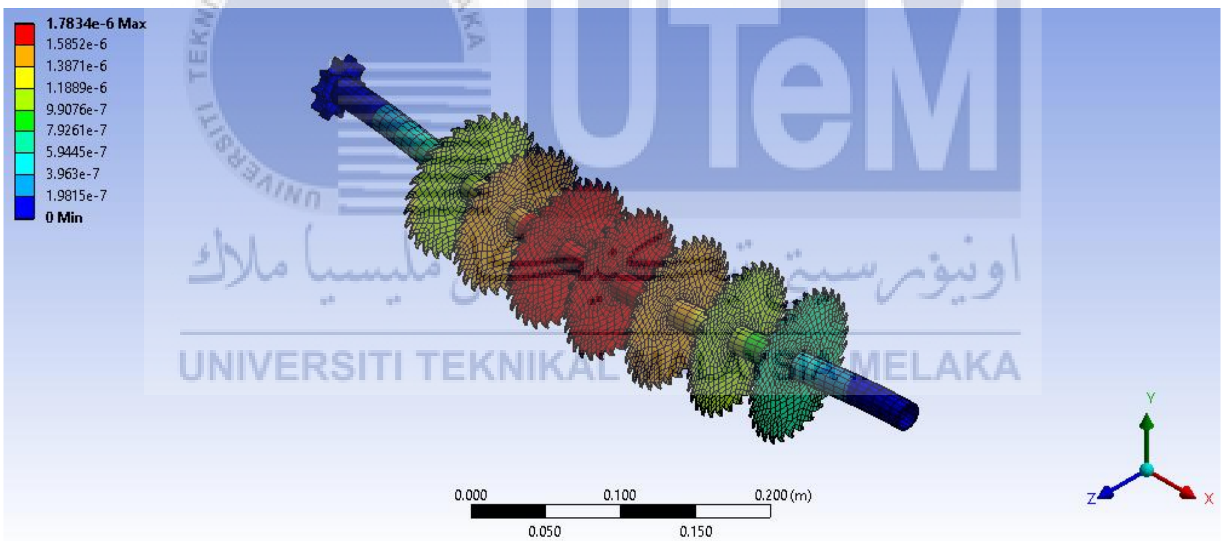


Figure 5.20: FEA Bending Total Deformation Analysis for the Lower Shaft Blade part.

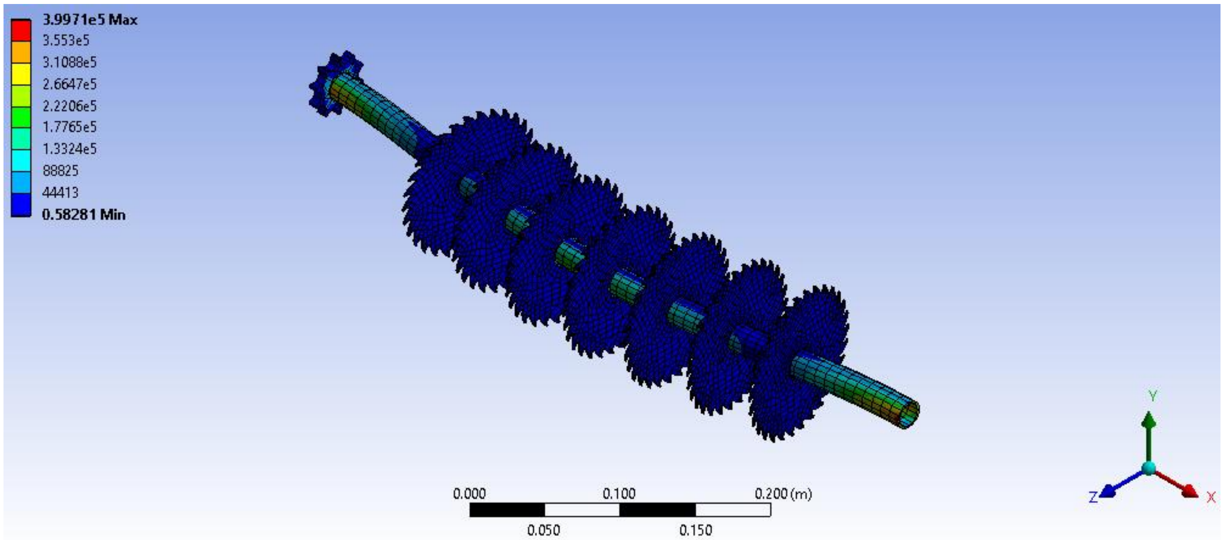


Figure 5.21: FEA Bending Equivalent Stress Analysis for the Lower Shaft Blade part.

Table 5.2: Results for FEA Bending Analysis for the Lower Shaft Blade part.

Object Name	Total Deformation	Equivalent Stress
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Total Deformation	Equivalent (von-Mises) Stress
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	0. m	0.58281 Pa
Maximum	1.7834e-006 m	3.9971e+005 Pa
Minimum Occurs On	s. sprocket shaft	blade
Maximum Occurs On	s. sprocket shaft	
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

From Figure 5.38, the analysis shows that the deformation occurs most at the middle area of the shaft when the force of 3.4 N from the blades weight is place on the shaft. Although the deformation look significant, the maximum total deformation is about 1.7834 X 10^-6 m, which is very little. The ultimate stress for mild steel is 250 MPa. The factor of safety of the body frame part is:

$$\text{F.O.S} = \frac{\text{Ultimate stress}}{\text{Actual stress}} = \frac{250\ MPa}{0.39971\ MPa} = 625.453$$

5.2.3 Upper Shaft Blade

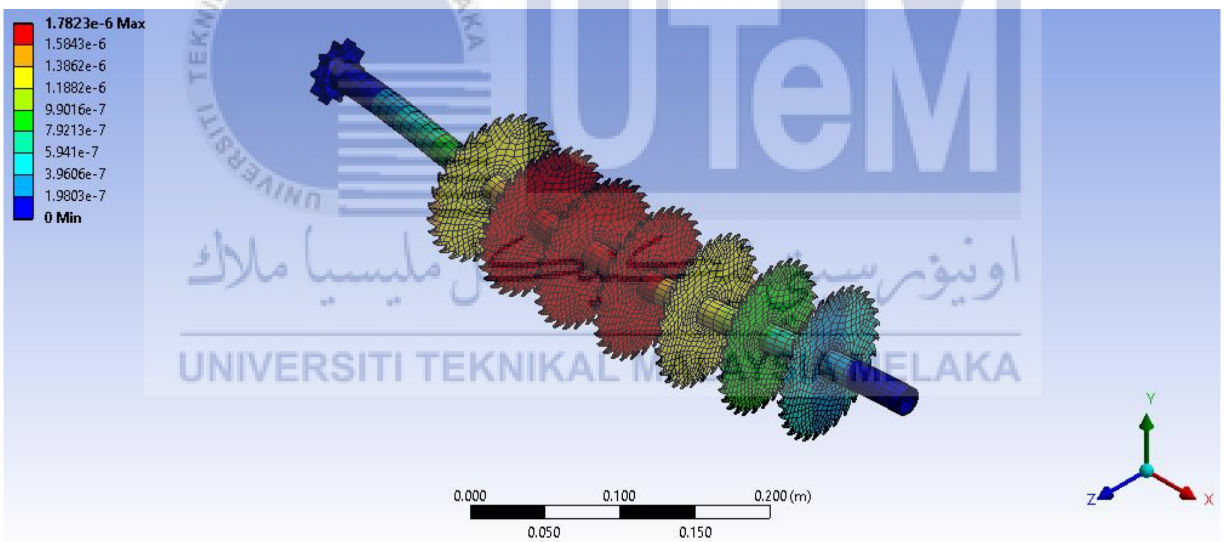


Figure 5.22: FEA Bending Total Deformation Analysis for the Upper Shaft Blade part.

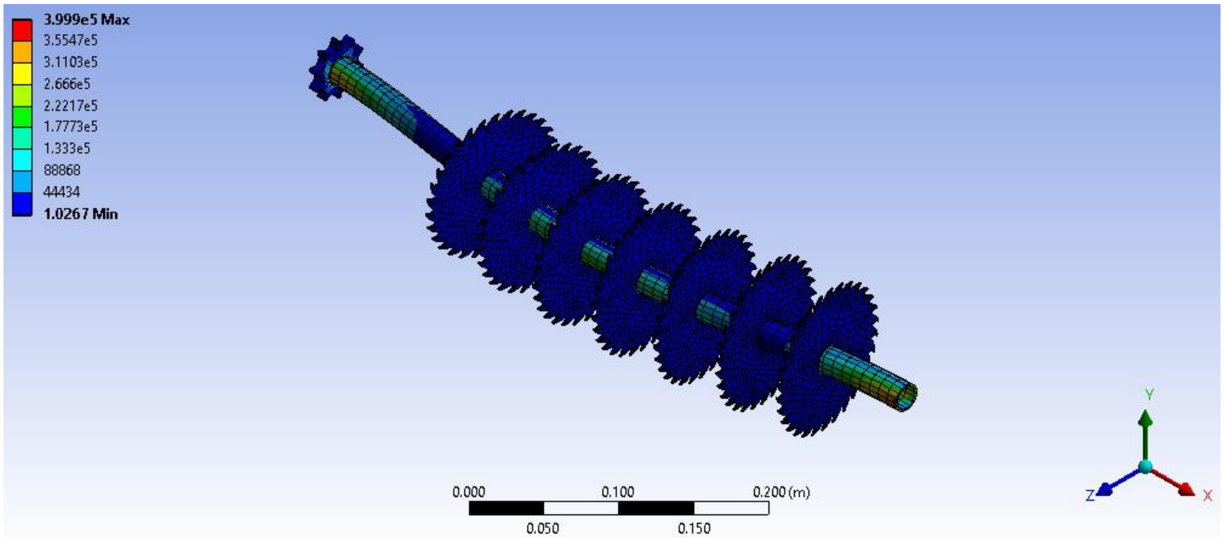


Figure 5.23: FEA Bending Equivalent Stress Analysis for the Upper Shaft Blade part.

Table 5.3: Results for FEA Bending Analysis for the Upper Shaft Blade part.

Object Name	*Total Deformation*	*Equivalent Stress*
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Total Deformation	Equivalent (von-Mises) Stress
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	0. m	1.0267 Pa
Maximum	1.7823e-006 m	3.999e+005 Pa
Minimum Occurs On	s. sprocket shaft	blade
Maximum Occurs On	blade	s. sprocket shaft
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

From Figure 5.40, the analysis shows that the deformation occurs most at the middle area of the shaft when the force of 3.4 N from the blades weight is place on the shaft. Although the deformation look significant, the maximum total deformation is about 1.7823 X 10^-6 m, which is very little. The ultimate stress for mild steel is 250 MPa. The factor of safety of the body frame part is:

$$\text{F.O.S} = \frac{\text{Ultimate stress}}{\text{Actual stress}} = \frac{250\ MPa}{0.4\ MPa} = 625$$

5.2.4 Mixing Blade

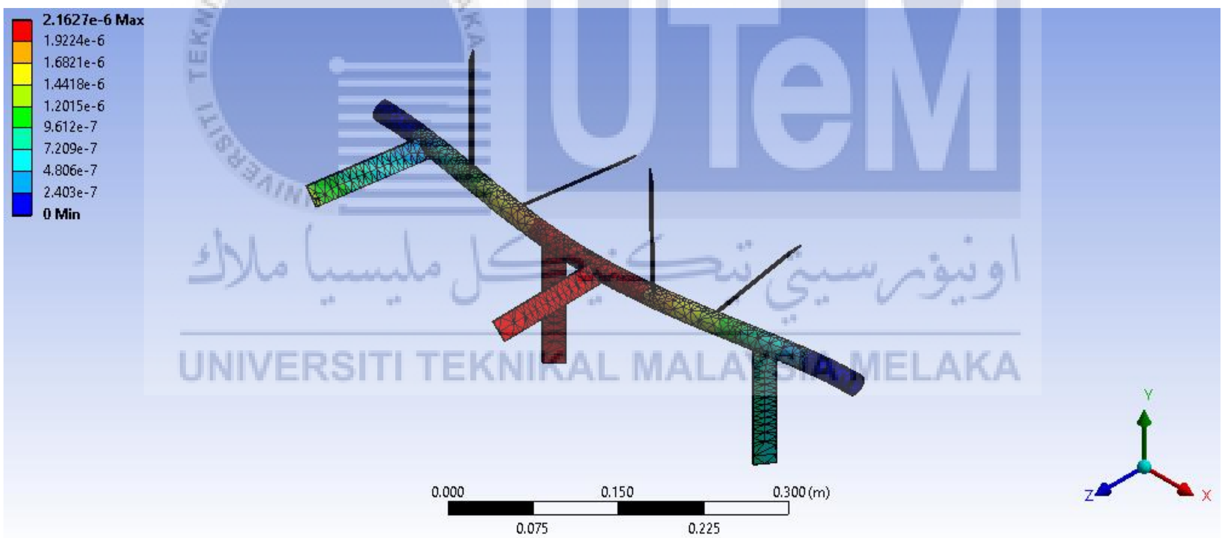


Figure 5.24: FEA Bending Total Deformation Analysis for the Mixing Blade part.

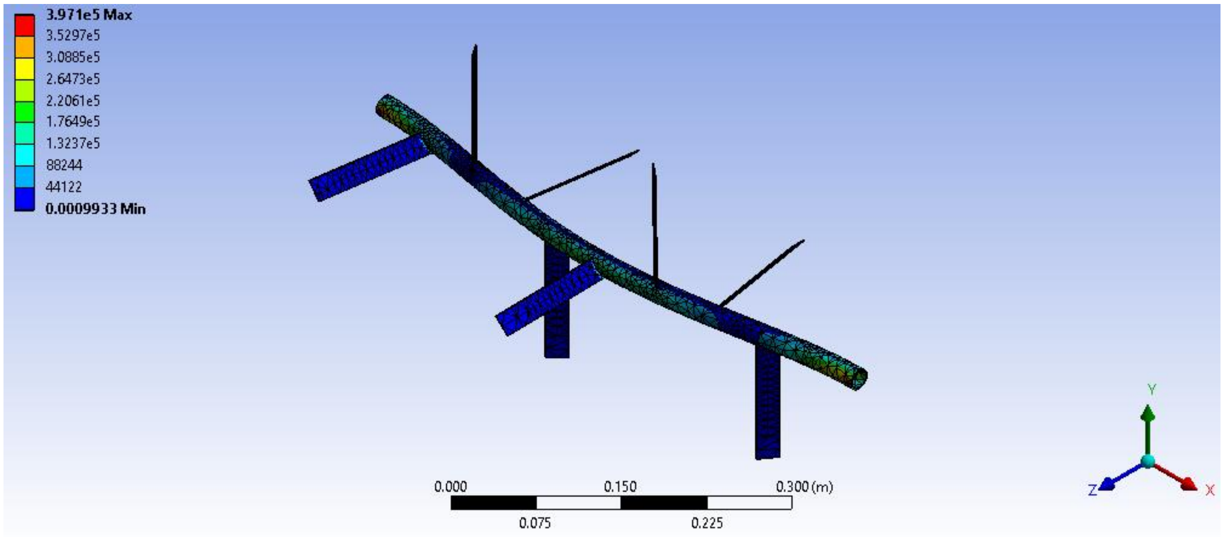


Figure 5.25: FEA Bending Equivalent Stress Analysis for the Mixing Blade part.

Table 5.4: Results for FEA Bending Analysis for the Mixing Blade part.

Object Name	*Total Deformation*	*Equivalent Stress*
State	Solved	
Scope		
Scoping Method	Geometry Selection	
Geometry	All Bodies	
Definition		
Type	Total Deformation	Equivalent (von-Mises) Stress
By	Time	
Display Time	Last	
Calculate Time History	Yes	
Identifier		
Suppressed	No	
Results		
Minimum	0. m	9.933e-004 Pa
Maximum	2.1627e-006 m	3.971e+005 Pa
Information		
Time	1. s	
Load Step	1	
Substep	1	
Iteration Number	1	
Integration Point Results		
Display Option		Averaged
Average Across Bodies		No

From Figure 5.40, the analysis shows that the deformation occurs most at the middle area of the shaft when the force of 3.14 N from the blades weight is place on the shaft. Although the deformation look significant, the maximum total deformation is about 2.1627 X 10^-6 m, which is very little. The ultimate stress for mild steel is 250 MPa. The factor of safety of the body frame part is:

$$\text{F.O.S} = \frac{\text{Ultimate stress}}{\text{Actual stress}} = \frac{250\ MPa}{0.3971\ MPa} = 629.564$$

The values obtained for the Factor of Safety are very high which indicates that the parts will fail at a higher design load. In order to justify the answers, some calculation will be made below to compare which values of FOS.

5.3 Calculation

5.3.1 Lower Shaft Blade Bending

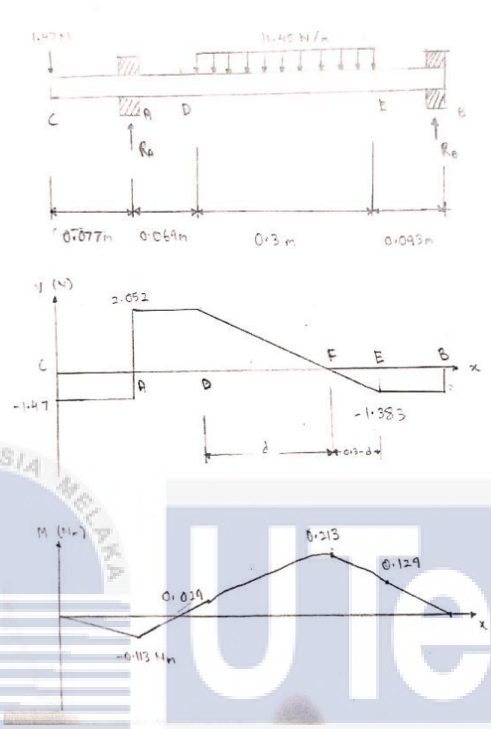


Figure 5.26: Lower shaft blade bending diagram.

$\Sigma M_A = 0$: $1.47(0.077) - 11.45(0.3)(0.219) + 0.462R_B = 0$

$R_B = 1.383$ N

$\Sigma M_B = 0$: $1.47(0.539) + 11.45(0.3)(0.243) - 0.462R_A = 0$

$R_A = 3.522$ N

Shear: C to A: $V = -1.47$ N

A: $V = -1.47 + 3.522 = 2.052$ N

D to E: $V = 2.052 - (11.45)(0.3) = -1.383$ N

Locate point F: $\frac{d}{2.052} = \frac{0.3-d}{1.383}$

d = 0.179 m

Areas for shear diagram: C to A: (-1.47)(0.077) = -0.113 Nm

A to D: (2.052)(0.069) = 0.142 Nm

D to F: $\frac{(2.052)(0.179)}{2}$ = 0.184 Nm

F to E: $\frac{(-1.383)(0.121)}{2}$ = -0.084 Nm

E to B: (-1.383)(0.093) = -0.129 Nm

Bending moments: $M_c = 0$

$M_A = 0 - 0.113 = -0.113$ Nm

$M_D = -0.113 + 0.184 = 0.029$ Nm

$M_F = 0.029 + 0.184 = 0.213$ Nm

$M_E = 0.213 - 0.084 = 0.129$ Nm

$M_B = 0.129 - 0.129 = 0$

$|M|_{max} = 0.213$ Nm

For hollow shaft: $C_o = \frac{(0.02)}{2} = 0.01$ m

$C_i = \frac{(0.0168)}{2} = 0.0084$ m

$$I = \frac{\pi}{4}(C_o^4 - C_i^4) = \frac{\pi}{4}(0.001^4 - 0.0084^4) = 3.944 \text{ X } 10^{-9} \text{ m}^4$$

$$S = \frac{I}{C_o} = \frac{3.944 \text{ X } 10^{-9}}{0.01} = 3.944 \text{ X } 10^{-7} \text{ m}^3$$

Normal stress: $\sigma = \frac{M}{S} = \frac{0.213}{3.944 \text{ X } 10^{-7}} = 0.54 \text{ MPa}$

Therefore, the Factor of Safety is: $\text{FOS} = \frac{250}{0.54} = 463$

The values obtained for the Factor of Safety are very high which indicates that the parts will fail at a higher design load.

5.3.2 Upper Shaft Blade Bending

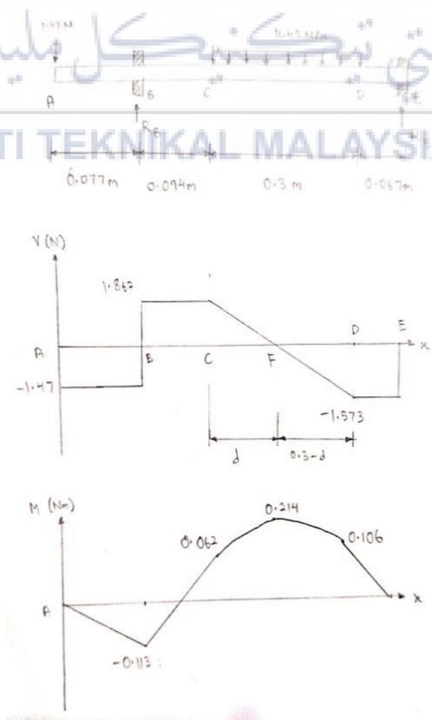


Figure 5.27: Upper shaft blade bending diagram.

$\Sigma M_B = 0$: $1.47(0.077) - 11.45(0.3)(0.244) + 0.461R_B = 0$

$R_B = 1.573$ N

$\Sigma M_B = 0$: $1.47(0.538) + 11.45(0.3)(0.217) - 0.461R_A = 0$

$R_A = 3.332$ N

Shear: A to B: $V = -1.47$ N

A: $V = -1.47 + 3.332 = 1.862$ N

C to D: $1.862 - (11.45)(0.3) = -1.573$ N

E: $-1.573 + 1.573 = 0$

Locate point F: $\frac{d}{1.862} = \frac{0.3-d}{1.573}$

$d = 0.163$ m

Areas for shear diagram: A to B: $(-1.47)(0.077) = -0.113$ Nm

B to C: $(1.862)(0.094) = 0.175$ Nm

C to F: $\frac{(1.862)(0.163)}{2} = 0.152$ Nm

F to D: $\frac{(-1.573)(0.137)}{2} = -0.108$ Nm

D to E: $(-1.573)(0.067) = -0.106$ Nm

Bending moments: $M_A = 0$

$M_B = 0 - 0.113 = -0.113$ Nm

M_C = -0.113 + 0.175 = 0.062 Nm

M_F = 0.062 + 0.152 = 0.214 Nm

M_D = 0.214 – 0.108 = 0.106 Nm

M_E = 0.106 – 0.106 = 0

$|M|_{max}$ = 0.214 Nm

For hollow shaft: $C_o = \frac{(0.02)}{2}$ = 0.01 m

$C_i = \frac{(0.0168)}{2}$ = 0.0084 m

$I = \frac{\pi}{4}(C_o^4 - C_i^4) = \frac{\pi}{4}(0.001^4 - 0.0084^4) = 3.944 \text{ X } 10^{-9}$ m^4

$S = \frac{I}{C_o} = \frac{3.944\ X\ 10^{-9}}{0.01} = 3.944 \text{ X } 10^{-7}$ m^3

Normal stress: $\sigma = \frac{M}{S} = \frac{0.214}{3.944\ X\ 10^{-7}}$ = 0.543 MPa

Therefore, the Factor of Safety is: FOS = $\frac{250}{0.543}$ = 460

The values obtained for the Factor of Safety are very high which indicates that the parts will fail at a higher design load.

5.3.3 Sprocket Ratio

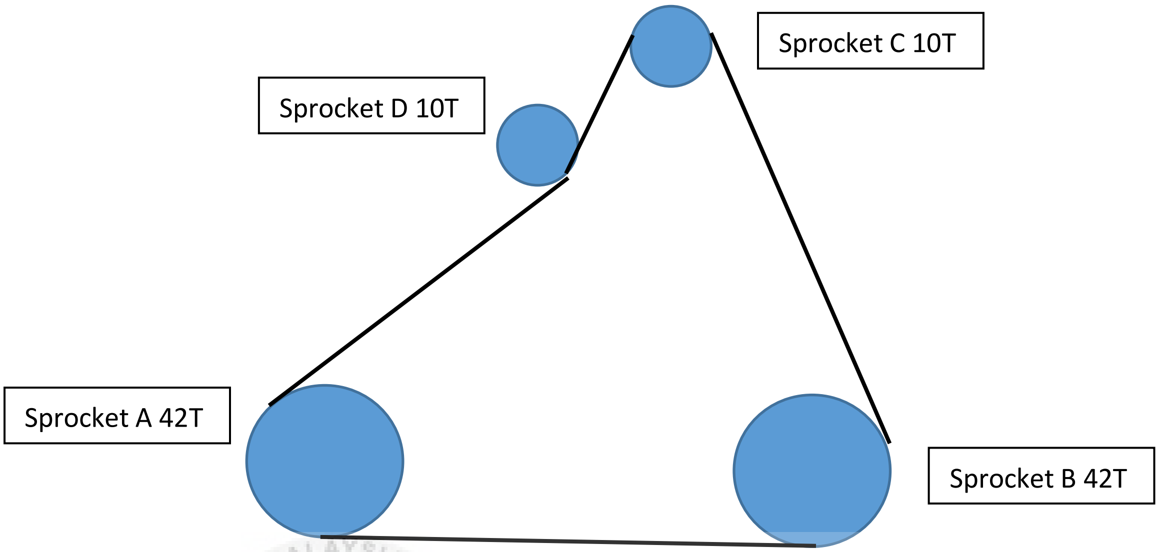


Figure 5.28: Free body diagram for the sprockets and chain.

Sprocket ratio, R = $\dfrac{Number\ of\ tooth\ of\ driven\ sprocket}{Number\ of\ tooth\ of\ driver\ sprocket}$

R_1 at mixing blade = 42/42 = 1

R_2 at upper shaft blade = 10 / 42 = 0.238

R_3 at lower shaft blade = 10 / 42 = 0.238

5.3.4 Shaft Torque

Engine torque = $\dfrac{P}{2\pi f} = \dfrac{4700}{2\pi(60)}$ = 12.467 Nm

Torque at mixing blade = R_1 X Engine torque = 1 X 12.467 Nm = 12.467 Nm

Torque at upper shaft blade = R_2 X Engine torque = 0.238 X 12.467 Nm = 2.967 Nm

Torque at lower shaft blade = R_3 X Engine torque = 0.238 X 12.467 Nm = 2.967 Nm

5.3.5 Shaft Speed

Speed at engine = 3600 RPM

Speed at mixing blade = Engine speed / R_1 = 36000 / 1 = 3600 RPM

Speed at upper shaft blade = Engine speed / R_2 = 3600 / 0.238 = 15126.05 RPM

Speed at lower shaft blade = Engine speed / R_3 = 3600 / 0.238 = 15126.05 RPM

5.4 Cost Analysis

In this section, some detail discussions concerning the cost that associated with manufacturing the prototype will be explained. The discussion comprises of Material Cost, Labour Cost, Manufacturing Overhead Cost and Total Manufacturing Cost per Unit. Furthermore, this segment will fully clarify on the calculation of expense for a unit of prototype.

5.4.1 Material Cost

This topic will explain about the part cost to produce the compost fertilizer mini plant in details as shown below:

Table 5.5: Material cost for each part used in the mini plant.

NO.	**PART NAME**	**QUANTITY**	**PRICE PER UNIT (RM)**	**TOTAL PRICE (RM)**
1	Body frame	1	43.60	43.60
2	Blade casing	1	30.00	30.00
3	Compost bin	1	12.00	12.00
4	Compost bin door	2	5.00	10.00
5	Shaft	3	4.50	13.50
6	Mixing blade	1	20.00	20.00
7	Shredding blade	14	2.00	28.00
8	6.5 HP four stroke petrol engine	1	295.00	295.00
9	One way caster wheel	4	4.00	16.00
10	Bearing	7	15.00	105.00
11	Big sprocket	2	7.60	15.20
12	Small Sprocket	2	7.00	14.00
13	Chain	1	25.00	25.00
14	Hinge	8	0.50	4.00
15	Cover net	1	2.00	2.00
16	Bolt and nut	42	1.20	50.40
17	Stopper caster wheel	2	4.30	8.60
			Total	692.30

5.4.2 Labour Cost

The labour cost is included for the labor wages for fabricating the prototype. For this project, only one labour is involved. So, the minimum wages for a labour in this country is about RM 1000.00 per labour.

5.4.3 Manufacturing Overhead Costs

This part shows the other external expenses that is not include the material cost and the labour cost. The details can be seen in Table 5.6 below.

Table 5.6: Manufacturing overhead cost.

MANUFACTURING OVERHEAD	COST (RM)
Electricity	300.00
Water supplies	90.00
Material handling equipment	100.00
Maintenance service	150.00
Personal protection equipment	80.00
Total	720.00

5.4.4 Total Manufacturing Cost Per Unit

The total manufacturing cost per unit must include all the material cost, labour cost, and the manufacturing overhead cost. Below is the calculation for the total expense for the prototype.

Total manufacturing cost:

$$= \frac{Material\ Cost + Labour\ Cost + Overhead\ Cost}{Unit\ produced} = \frac{692.30 + 1000.00 + 720}{1} = \text{RM } 2412.30$$

The selling price can be charged up to 30 percent from the total manufacturing cost to gain some profit. Below is the selling price for the compost fertilizer mini plant.

$$\text{Selling price} = \text{RM } 2412.30 \text{ X } \frac{130}{100} = \text{RM } 3135.99$$

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

` This chapter concludes all of the process involving in the compost fertilizer. Besides, some recommendation are provided for future improvement on the mini plant for processing of compost fertilizer from dried leaves.

6.1 Conclusion

In this project, the new mini plant for processing the compost fertilizer from dried leaves is successfully designed and analyzed. Two types of software have been used throughout this project, which are CATIA V5R21 and ANSYS software. The process was started with generating three conceptual designs. Then from the three conceptual design, they were filtered to the most high ranked by using Pugh Selection Method and Weighted Decision Matrix. After that, the conceptual design was generated into the detailed design by using CATIA V5R21 software. Then, some parts were analyzed in the Finite Element Analysis (FEA) by using ANSYS software for their performance based on the objective of the study. From the results, the factor of safety for the parts are very high indicating that the parts will fail at a higher design load. Other parameters were also calculated to show the specifications of the prototype.

The project of designing and developing the compost fertilizer mini plant is a complex project that need earlier research on the existing products in markets. The design should fulfil all the objectives that has been generated where the product must be designed and fabricated in a small size that is portable for use and ease the storage purposes. Besides, the prototype must be tested whether it can shorten the time and reduce the workforce in producing the compost fertilizer. Within the whole semester period, the prototype is fabricated and finished but the finished product do not function as there are some problems faced during the testing. Some of the objectives are achieved while the others need to be investigated in the future research.

6.2 Recommendation

For further improvement of this project, some recommendations have been suggested to enhance the design and sustainability of this product in the future works. One of the recommendations is to reduce the size of the blade casing while increasing the size of the compost bin for a larger production of compost fertilizer. The compost bin can also be separated from the whole prototype so that the users can use many compost bins to store the composted materials. The existing prototype uses a high power four-stroke petrol engine, which have very high vibration. This will affect the alignment of the sprockets and chain installed at the shafts thus generating a loud noise. For further improvement, it is suggested that the prototype can use single-phase electric motor, which have a lower vibration and use pulley and belt to transmit the rotational movement so that the prototype will run smoothly, and less noise will be generated. The mini plant can also be built with a control system for it to be easily moved without the need of labor to push or pull the whole plant to change its position. Stronger material can be applied to make the product last longer with regular use.

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APPENDIX A1

GANTT CHART PSM I

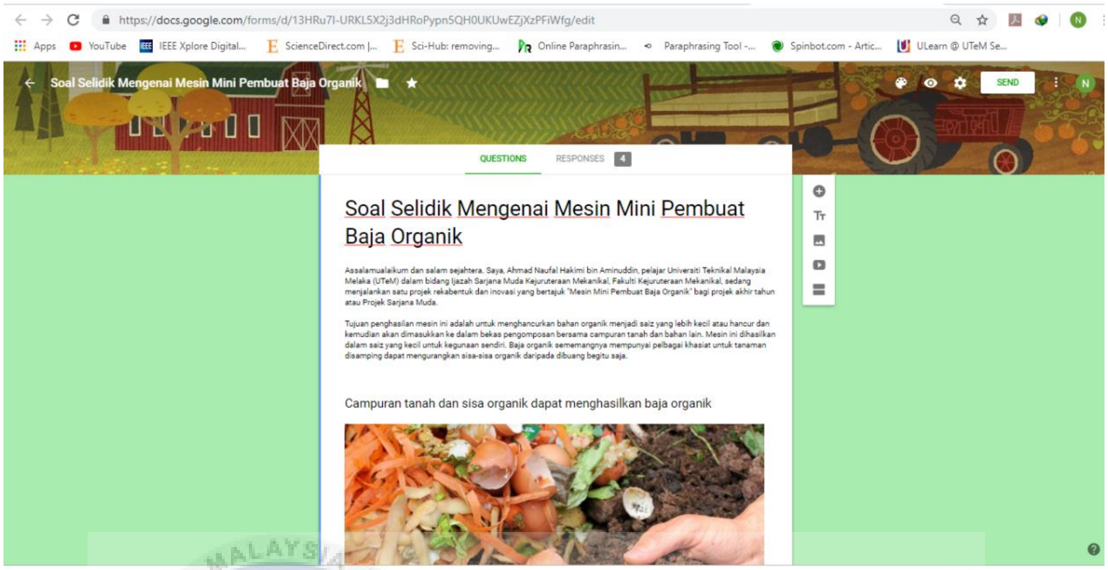
Activities	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Brainstorming and select the title															
Meeting with supervisor															
Chapter 1:Identify Introduction, Problem statement, Objectives and Scope															
Chapter 2: Literature Review															
Chapter 3: Methodology															
Reference and formatting															
Submission of general conduct form and logbook to supervisor															
Presentation PSM I															
Submission of PSM 1 reports to supervisor and examiners															

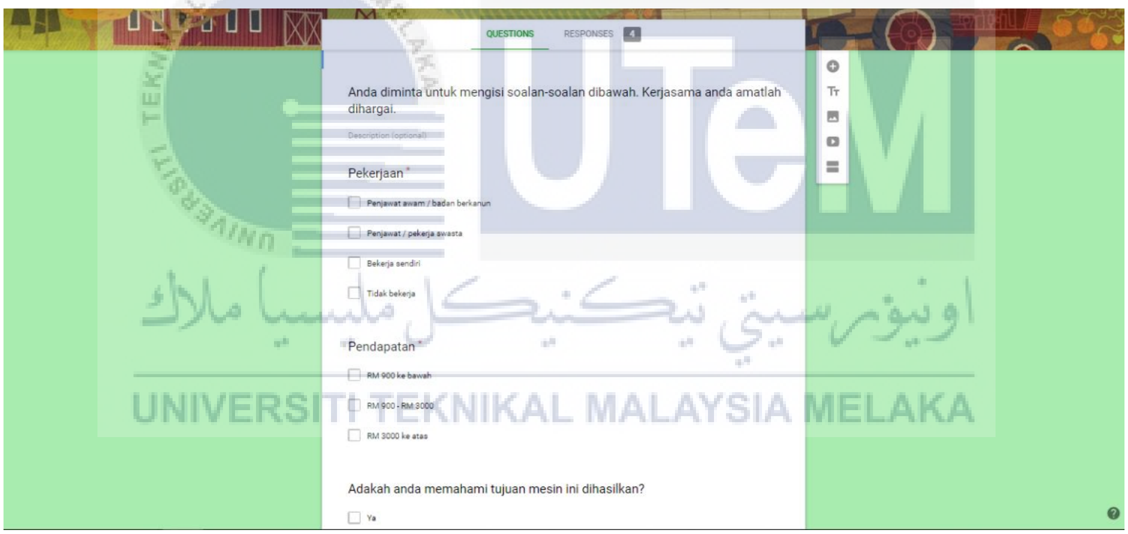
APPENDIX A2

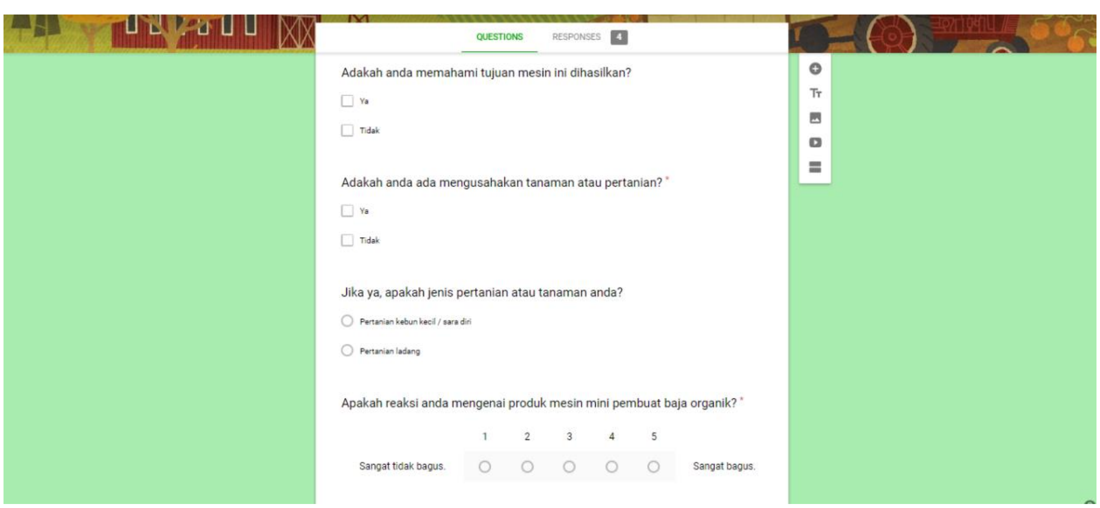
GANTT CHART PSM II

Activities	Week														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Briefing about PSM II															
Meeting with supervisor															
Material selection															
Fabrication process															
Experiment and testing															
Chapter 4: Fabrication Process															
Chapter 4: Result and Discussion															
Chapter 5: Conclusions and Recommendations															
Reference and formatting															
Submission of general conduct form and logbook to supervisor															
Presentation PSM II															
Submission of reports to supervisor and examiners															

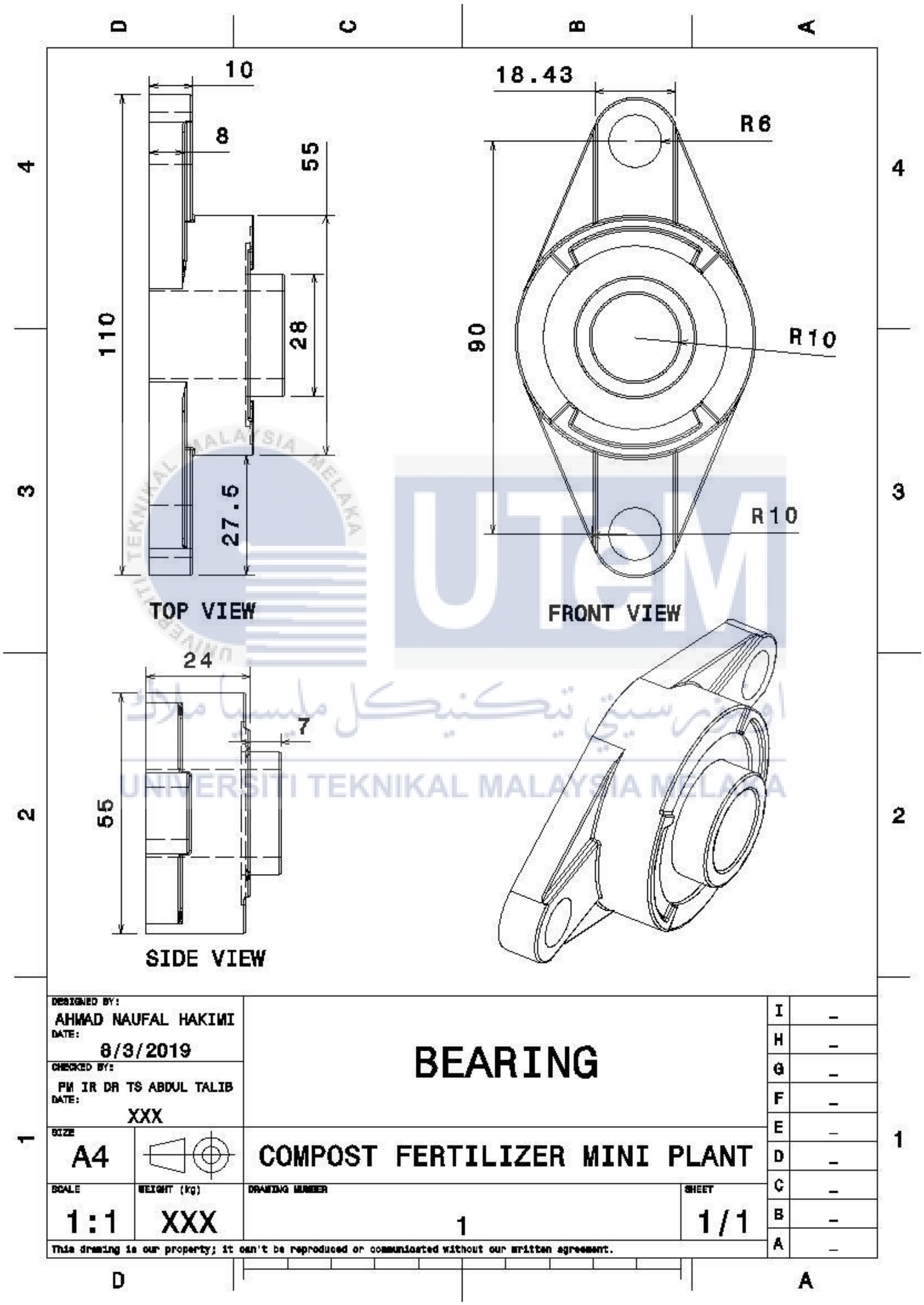
APPENDIX B


https://docs.google.com/forms/d/13HRu7I-URKL5X2j3dHRoPypn5QH0UKUwEZjXzPFiWfg/edit
Soal Selidik Mengenai Mesin Mini Pembuat Baja Organik
SEND
QUESTIONS
RESPONSES 4
Soal Selidik Mengenai Mesin Mini Pembuat Baja Organik
Assalamualaikum dan salam sejahtera. Saya, Ahmad Naufal Hakimi bin Aminuddin, pelajar Universiti Teknikal Malaysia Melaka (UTeM) dalam bidang Ijazah Sarjana Muda Kejuruteraan Mekanikal, Fakulti Kejuruteraan Mekanikal, sedang menjalankan satu projek rekabentuk dan inovasi yang bertajuk "Mesin Mini Pembuat Baja Organik" bagi projek akhir tahun atau Projek Sarjana Muda.
Tujuan penghasilan mesin ini adalah untuk menghancurkan bahan organik menjadi saiz yang lebih kecil atau hancur dan kemudian akan dimasukkan ke dalam bekas pengomposan bersama campuran tanah dan bahan lain. Mesin ini dihasilkan dalam saiz yang kecil untuk kegunaan sendiri. Baja organik sememangnya mempunyai pelbagai khasiat untuk tanaman disamping dapat mengurangkan sisa-sisa organik daripada dibuang begitu saja.
Campuran tanah dan sisa organik dapat menghasilkan baja organik


QUESTIONS
RESPONSES 4
Anda diminta untuk mengisi soalan-soalan dibawah. Kerjasama anda amatlah dihargai.
Description (optional)
Pekerjaan *
Penjawat awam / badan berkanun
Penjawat / pekerja swasta
Bekerja sendiri
Tidak bekerja
Pendapatan *
RM 900 ke bawah
RM 900 - RM 3000
RM 3000 ke atas
Adakah anda memahami tujuan mesin ini dihasilkan?
Ya

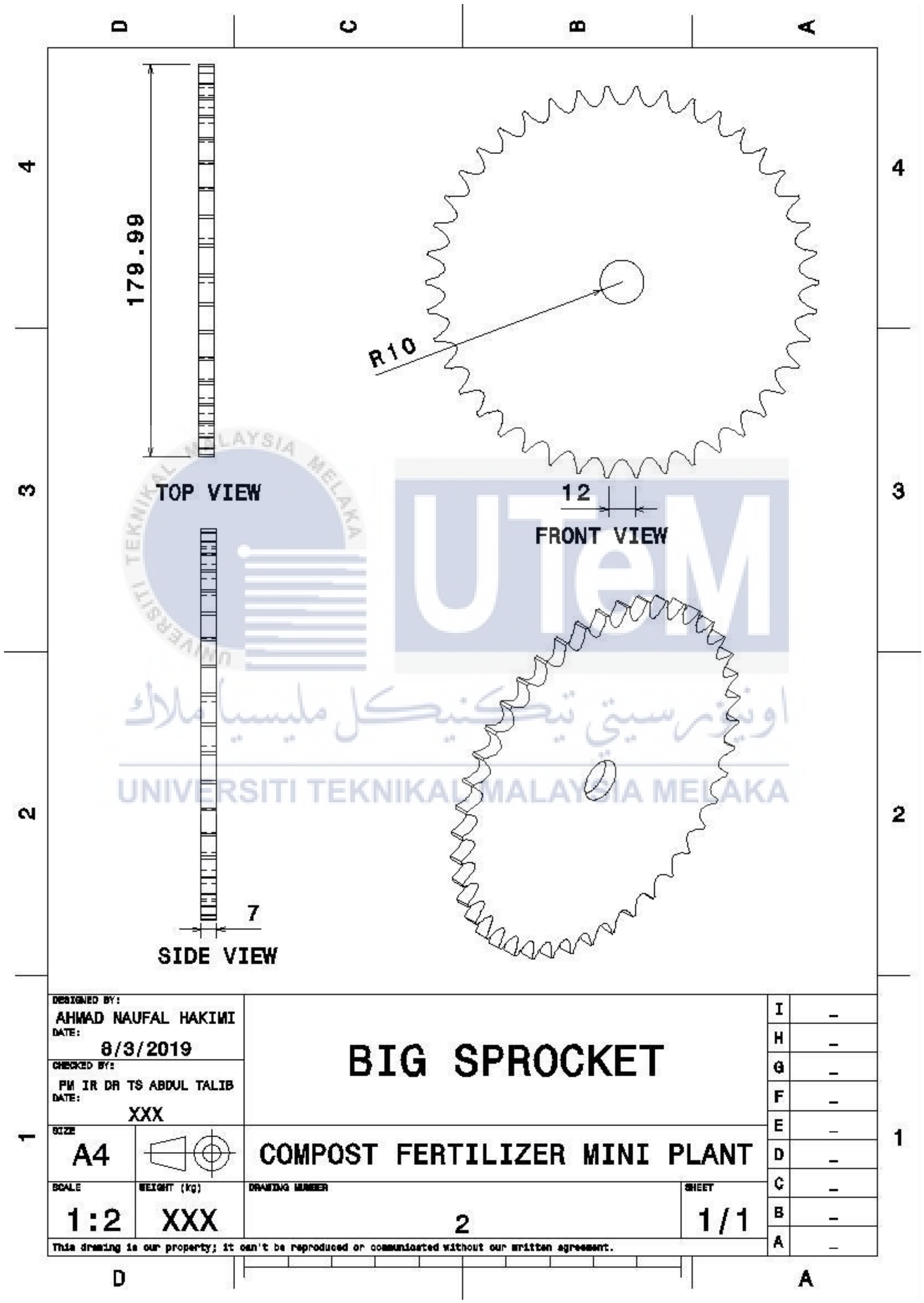

QUESTIONS
RESPONSES 4
Adakah anda memahami tujuan mesin ini dihasilkan?
Ya
Tidak
Adakah anda ada mengusahakan tanaman atau pertanian? *
Ya
Tidak
Jika ya, apakah jenis pertanian atau tanaman anda?
Pertanian kebun kecil / sara diri
Pertanian ladang
Apakah reaksi anda mengenai produk mesin mini pembuat baja organik? *
1 2 3 4 5
Sangat tidak bagus.
Sangat bagus.

APPENDIX C1



TOP VIEW
FRONT VIEW
SIDE VIEW
10
8
55
110
28
27.5
18.43
R6
90
R10
R10
24
7
55
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
SIZE
A4
BEARING
COMPOST FERTILIZER MINI PLANT
SCALE
1:1
WEIGHT (kg)
XXX
DRAWING NUMBER
1
SHEET
1/1
This drawing is our property; it can't be reproduced or communicated without our written agreement.

APPENDIX C2



D
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B
A
4
3
2
1
179.99
TOP VIEW
R10
12
FRONT VIEW
7
SIDE VIEW
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
BIG SPROCKET
SIZE
A4
COMPOST FERTILIZER MINI PLANT
SCALE
1:2
WEIGHT (kg)
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DRAWING NUMBER
2
SHEET
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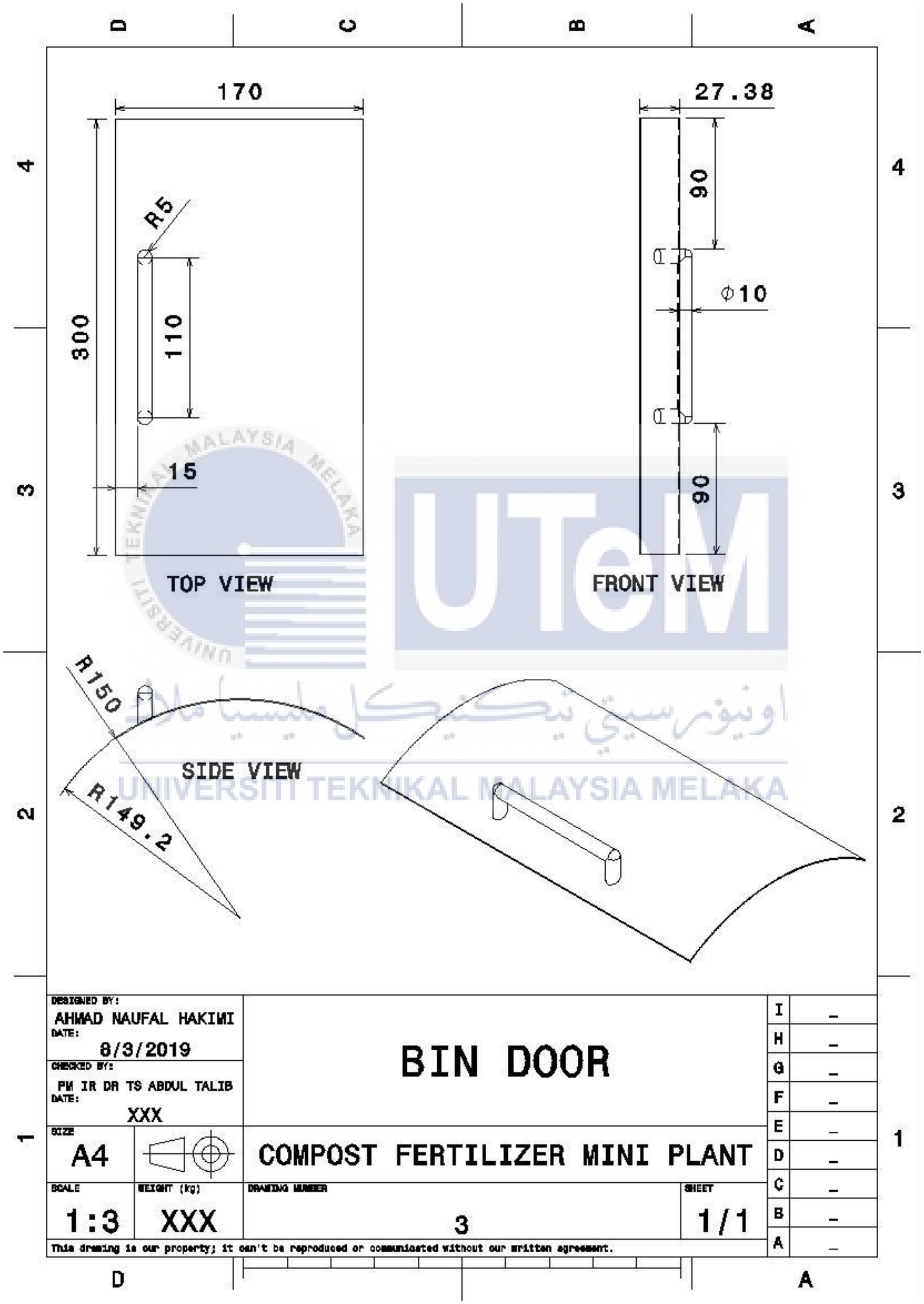
APPENDIX C3



170
300
R5
110
15
TOP VIEW
27.38
90
Φ10
90
FRONT VIEW
R150
R149.2
SIDE VIEW
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
BIN DOOR
SIZE
A4
COMPOST FERTILIZER MINI PLANT
SCALE
1:3
WEIGHT (kg)
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DRAWING NUMBER
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SHEET
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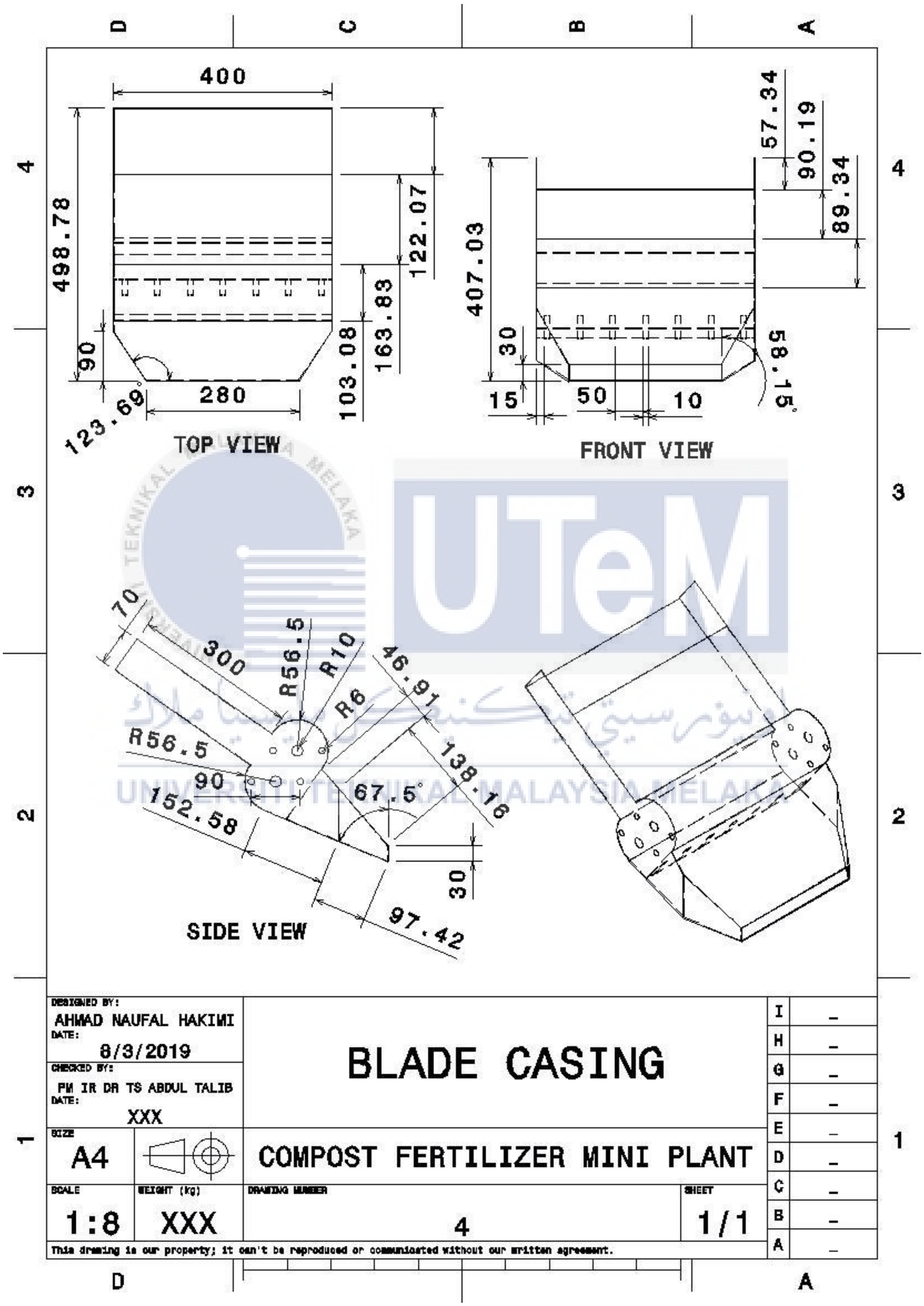
APPENDIX C4



D
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4
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1
400
498.78
90
123.69°
280
103.08
163.83
122.07
TOP VIEW
407.03
30
15
50
10
57.34
90.19
89.34
58.15°
FRONT VIEW
70
300
R56.5
R10
R6
46.91
R56.5
90
152.58
67.5°
138.16
30
97.42
SIDE VIEW
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
BLADE CASING
SIZE
A4
COMPOST FERTILIZER MINI PLANT
SCALE
1:8
WEIGHT (kg)
XXX
DRAWING NUMBER
4
SHEET
1/1
This drawing is our property; it can't be reproduced or communicated without our written agreement.
I
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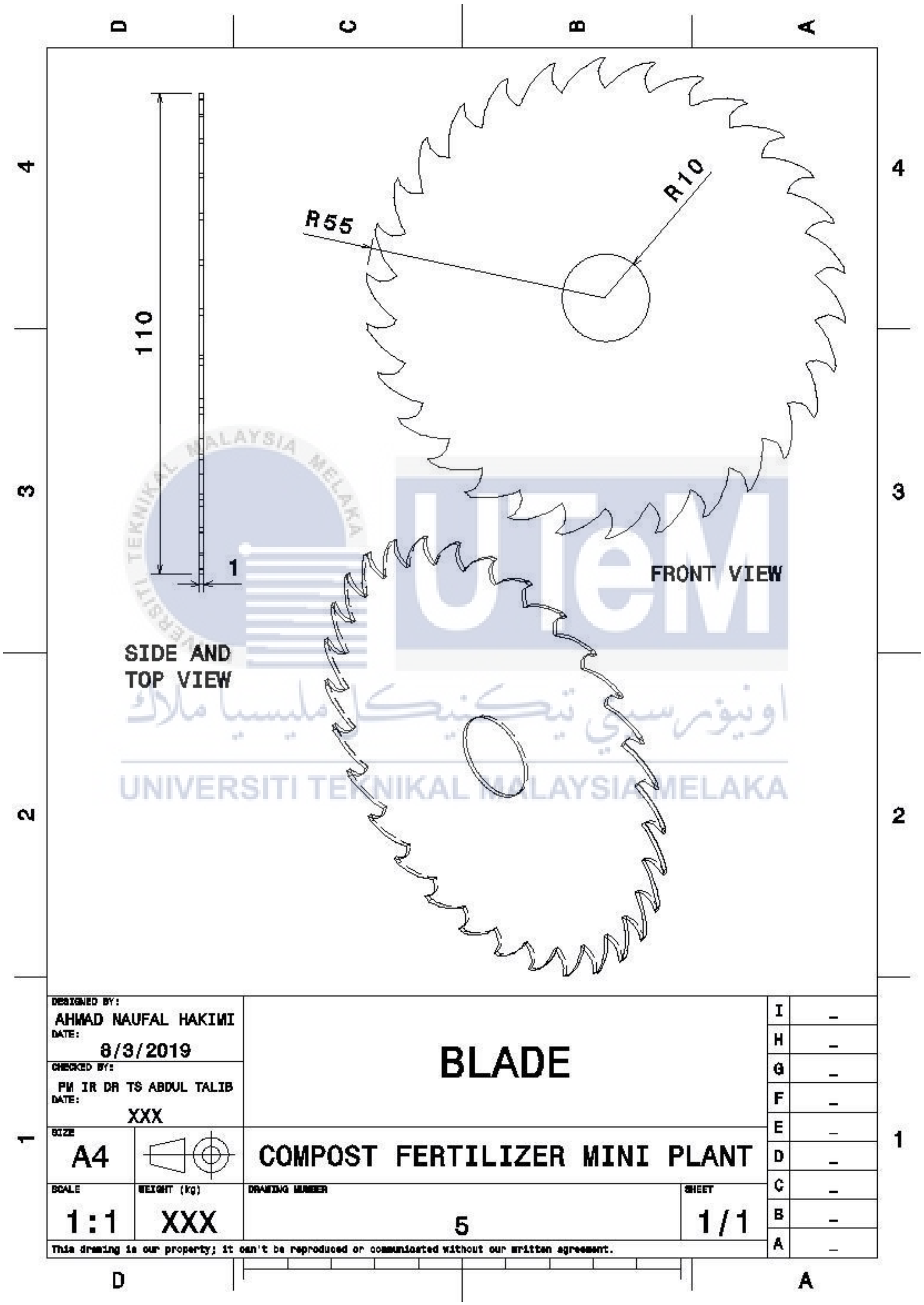
APPENDIX C5



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C
B
A
4
3
2
1
110
1
R55
R10
SIDE AND
TOP VIEW
FRONT VIEW
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
BLADE
SIZE
A4
COMPOST FERTILIZER MINI PLANT
SCALE
1:1
WEIGHT (kg)
XXX
DRAWING NUMBER
5
SHEET
1/1
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A
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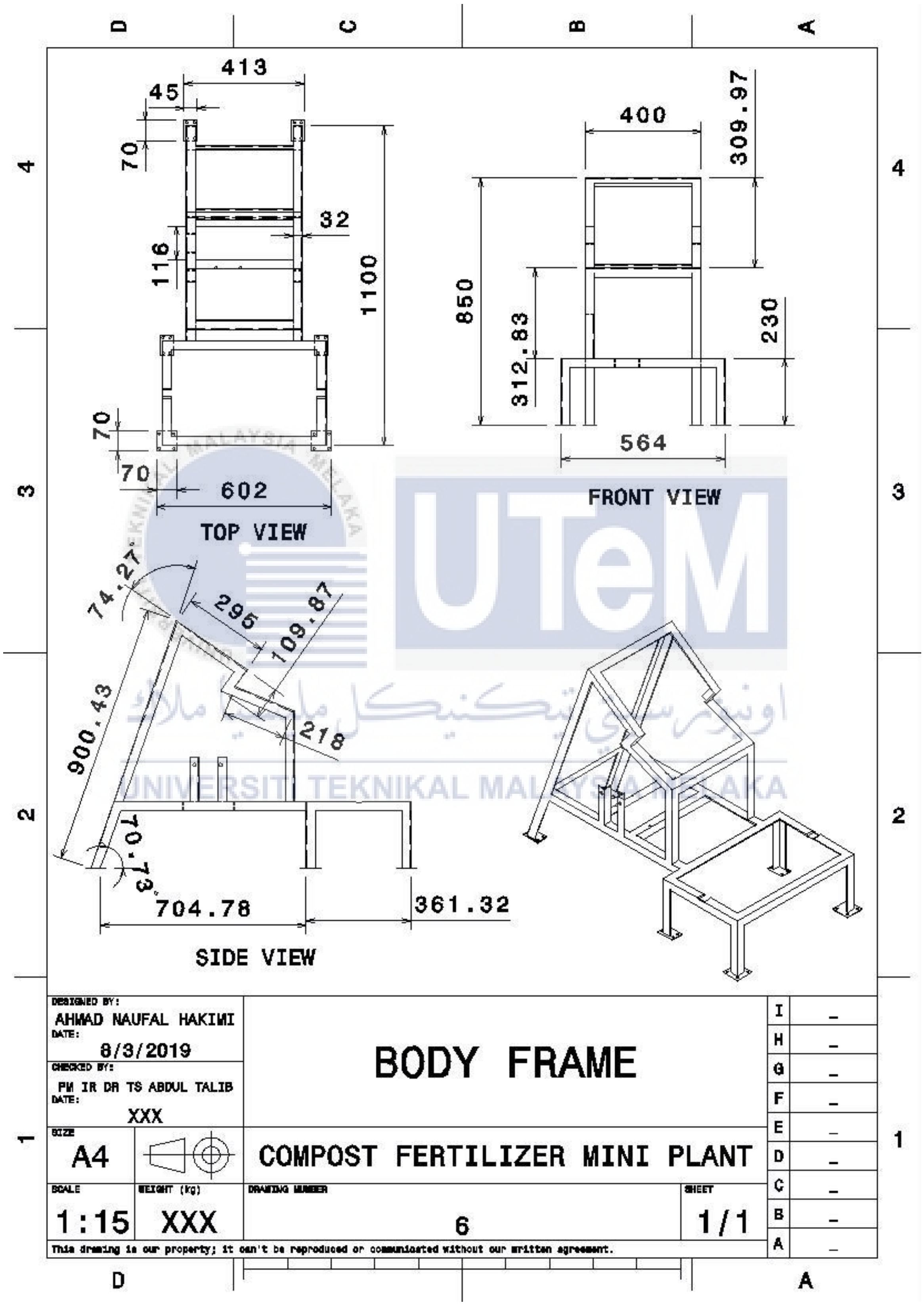
APPENDIX C6


D
C
B
A
4
3
2
1
413
45
70
32
116
1100
70
70
602
TOP VIEW
400
309.97
850
312.83
230
564
FRONT VIEW
74.27°
295
109.87
900.43
218
70.73°
704.78
361.32
SIDE VIEW
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
BODY FRAME
SIZE
A4
COMPOST FERTILIZER MINI PLANT
SCALE
1:15
WEIGHT (kg)
XXX
DRAWING NUMBER
6
SHEET
1/1
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D
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B
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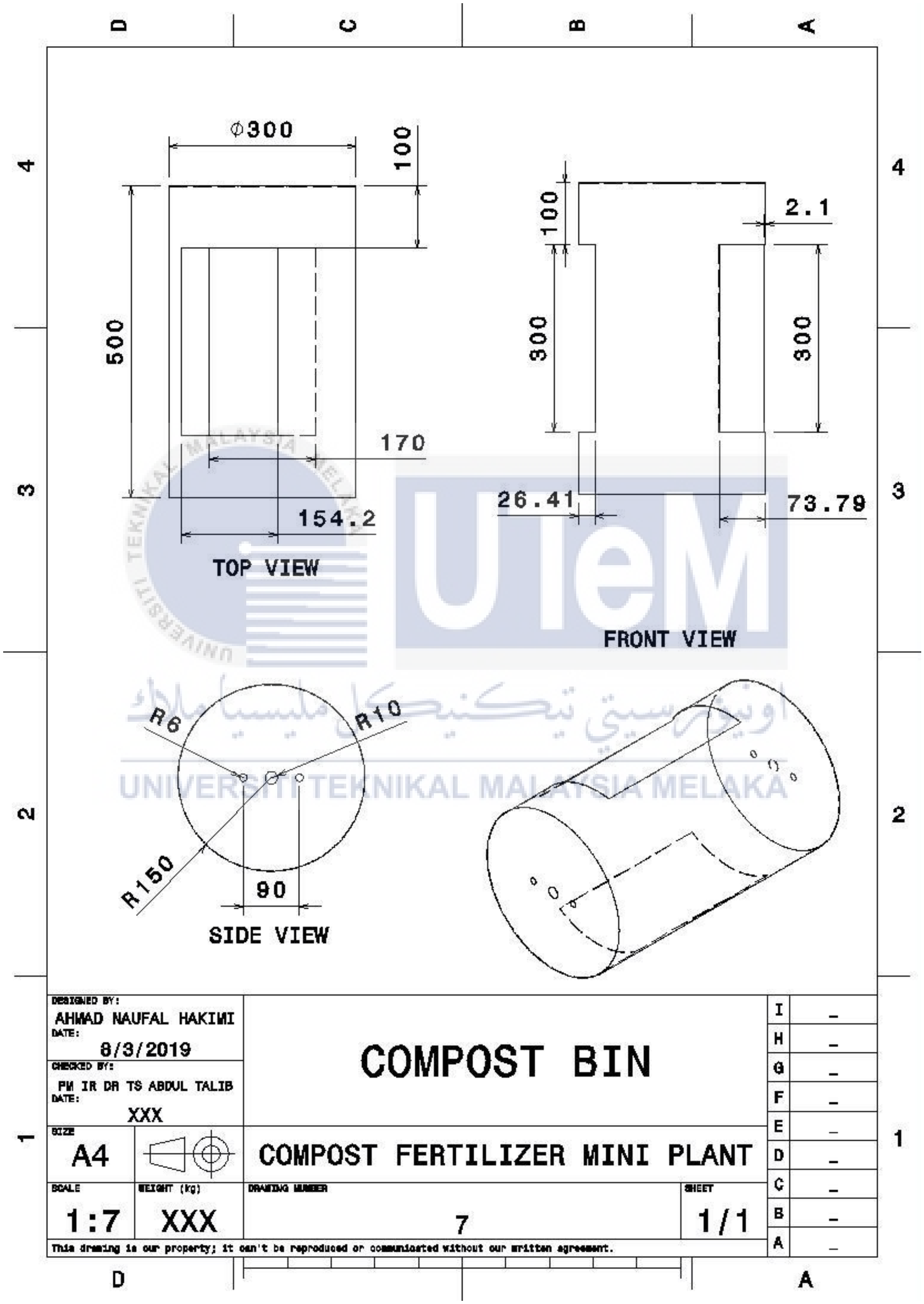
APPENDIX C7



Ø300
100
500
170
154.2
TOP VIEW
100
2.1
300
300
26.41
73.79
FRONT VIEW
R6
R10
R150
90
SIDE VIEW
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
COMPOST BIN
SIZE
A4
COMPOST FERTILIZER MINI PLANT
SCALE
1:7
WEIGHT (kg)
XXX
DRAWING NUMBER
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SHEET
1/1
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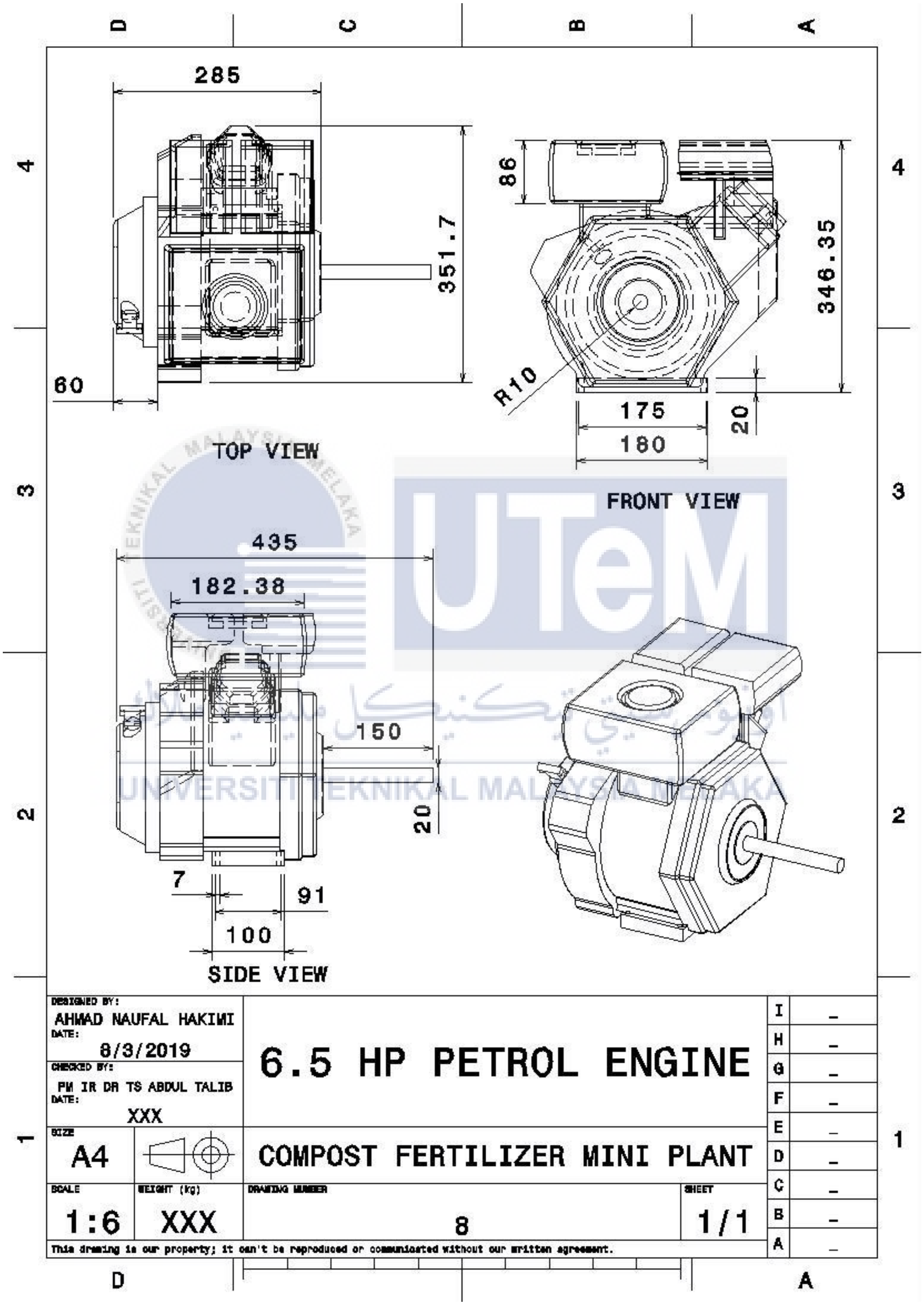
APPENDIX C8



285
351.7
60
TOP VIEW
86
346.35
R10
175
180
20
FRONT VIEW
435
182.38
150
20
7
91
100
SIDE VIEW
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
6.5 HP PETROL ENGINE
SIZE
A4
COMPOST FERTILIZER MINI PLANT
SCALE
1:6
WEIGHT (kg)
XXX
DRAWING NUMBER
8
SHEET
1/1
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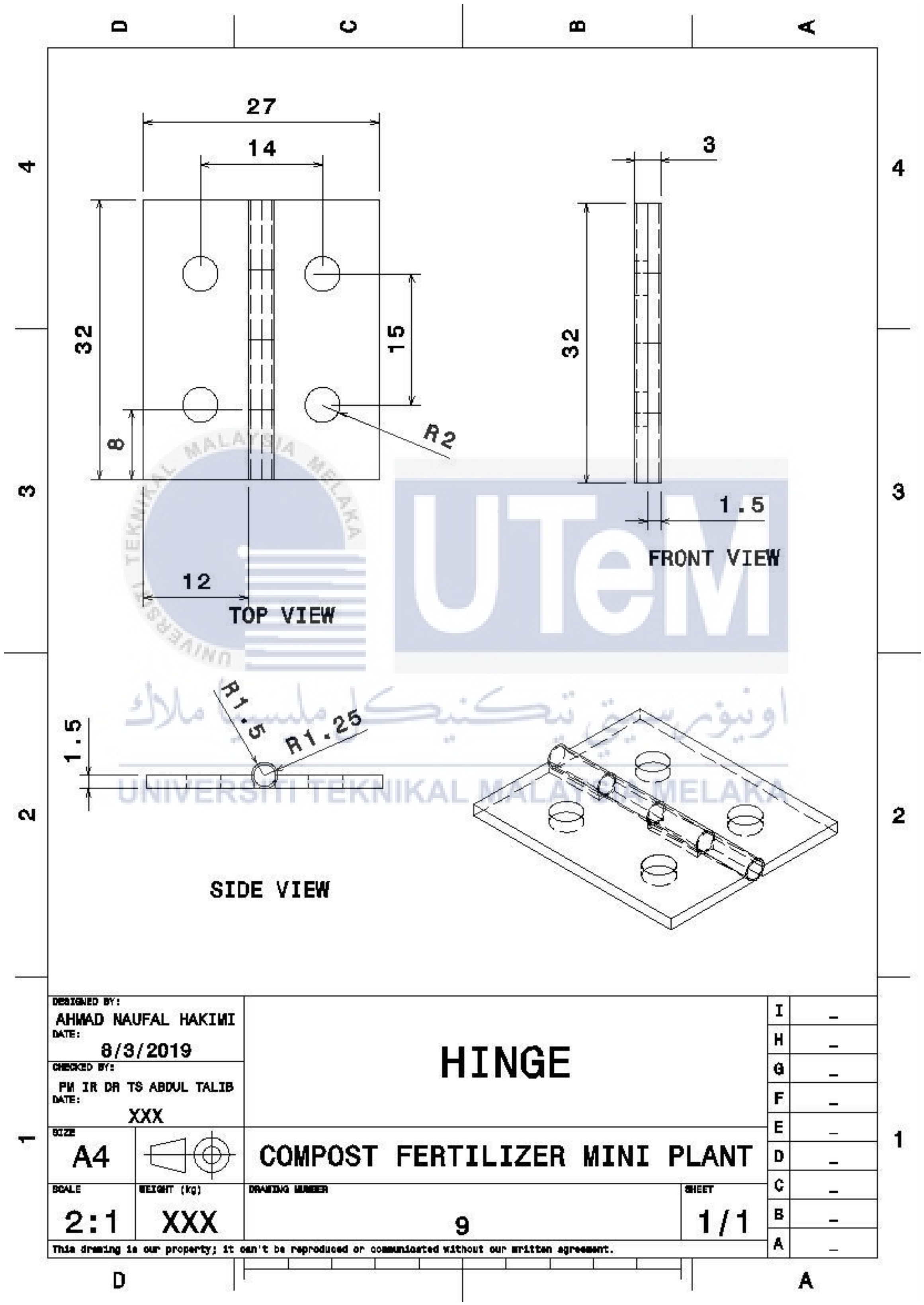
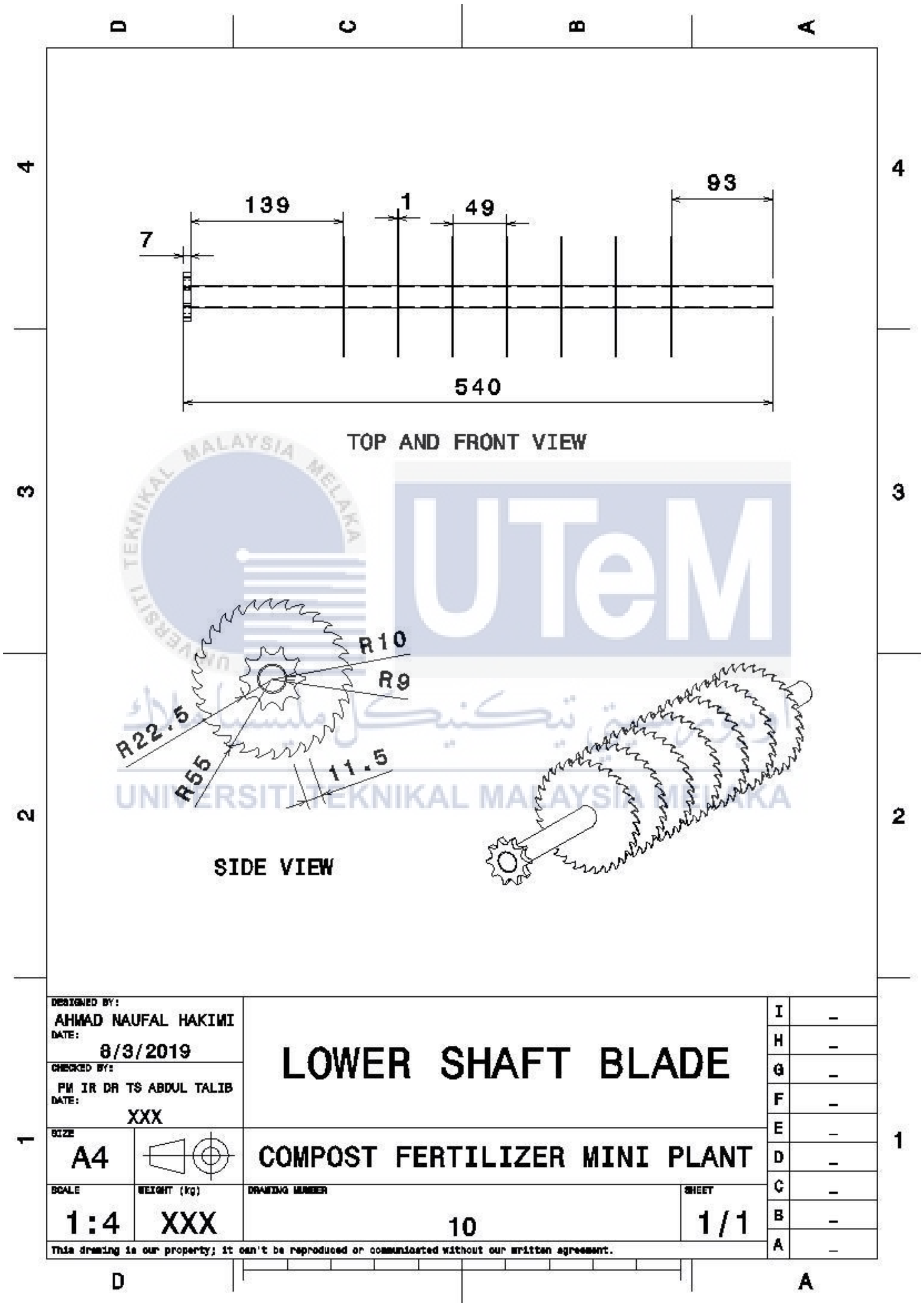
APPENDIX C9

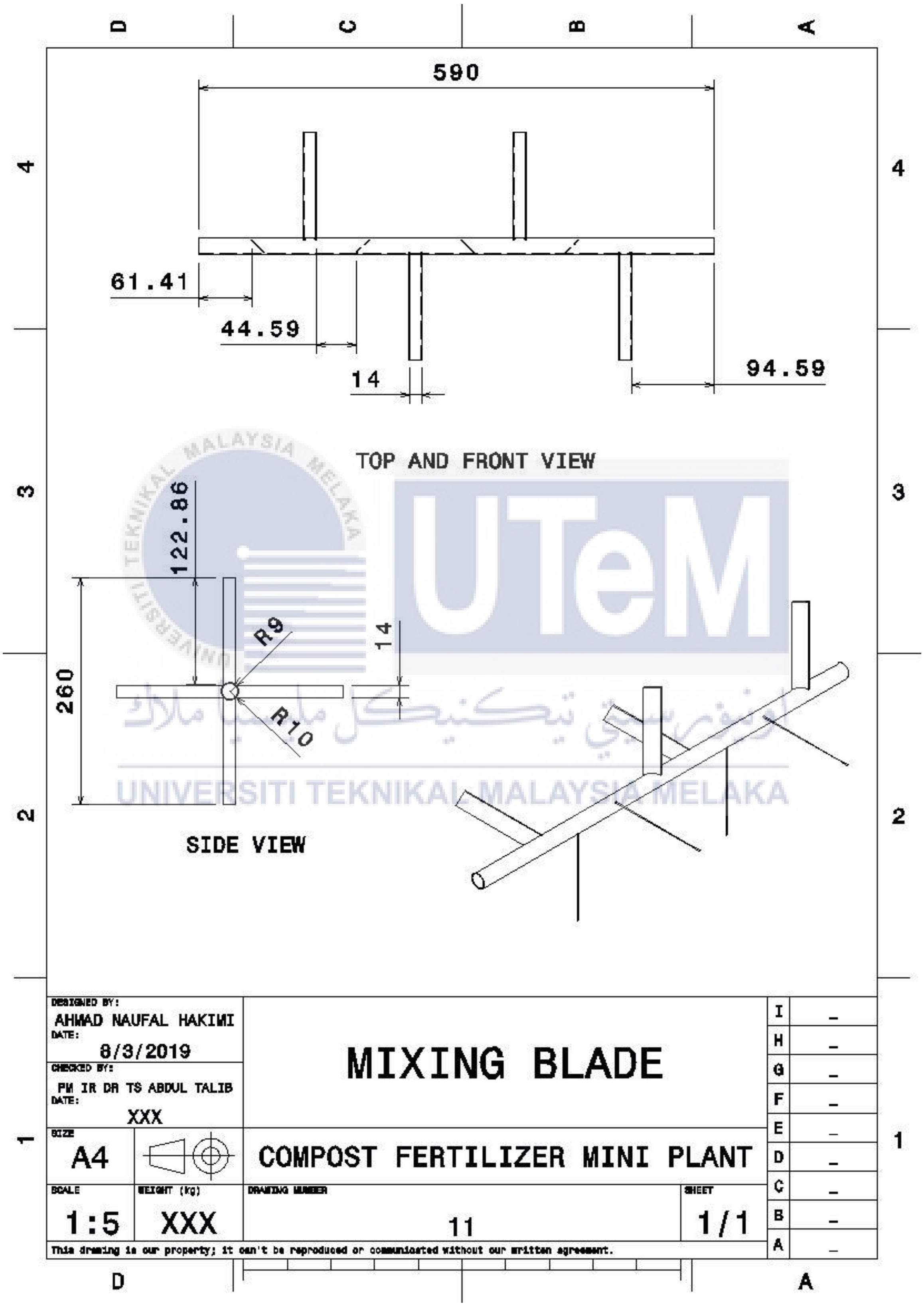


27
14
3
32
15
32
R2
8
1.5
12
TOP VIEW
FRONT VIEW
R1.5
R1.25
1.5
SIDE VIEW
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
HINGE
SIZE
A4
COMPOST FERTILIZER MINI PLANT
SCALE
2:1
WEIGHT (kg)
XXX
DRAWING NUMBER
9
SHEET
1/1
This drawing is our property; it can't be reproduced or communicated without our written agreement.

APPENDIX C10



APPENDIX C11



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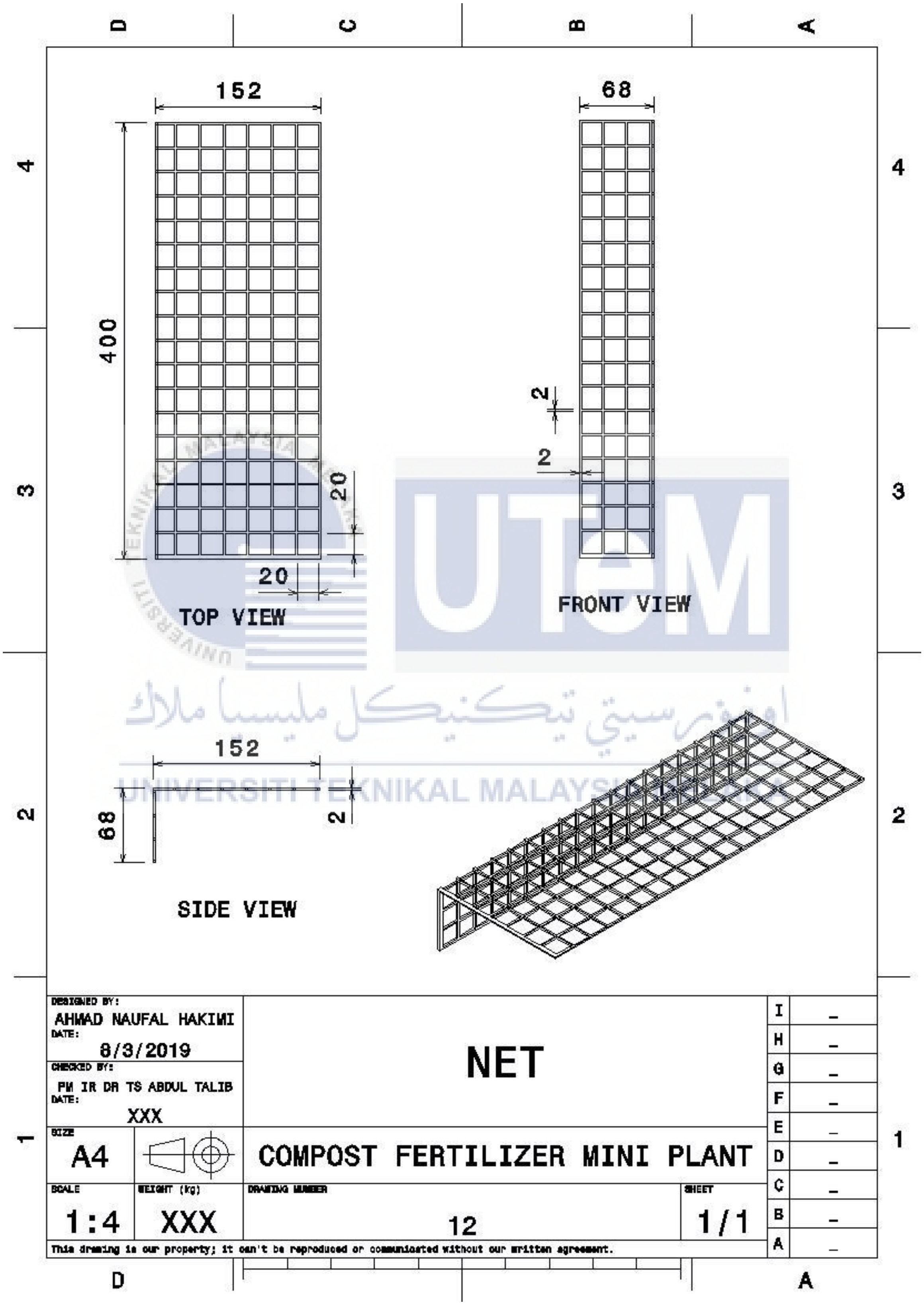

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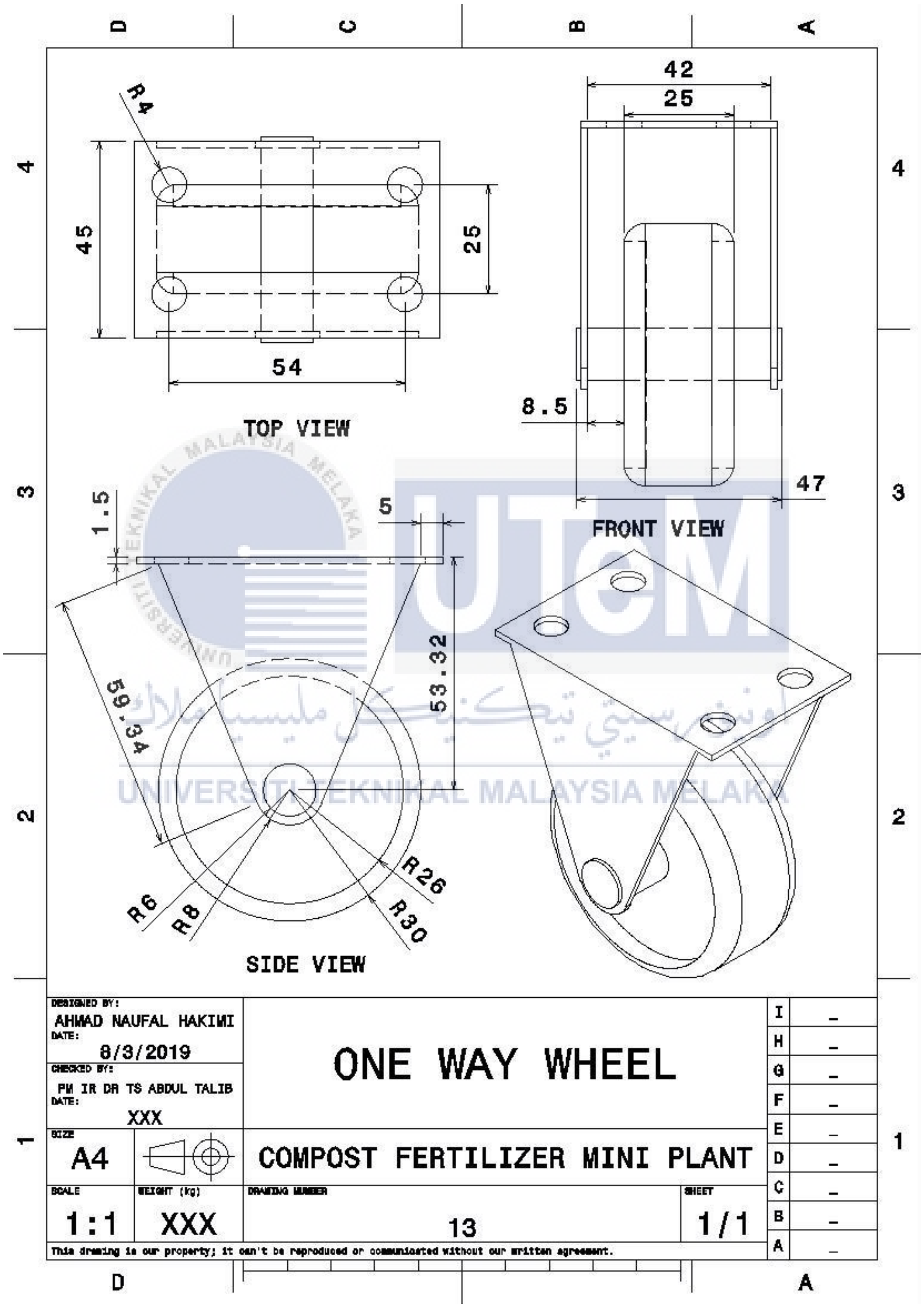
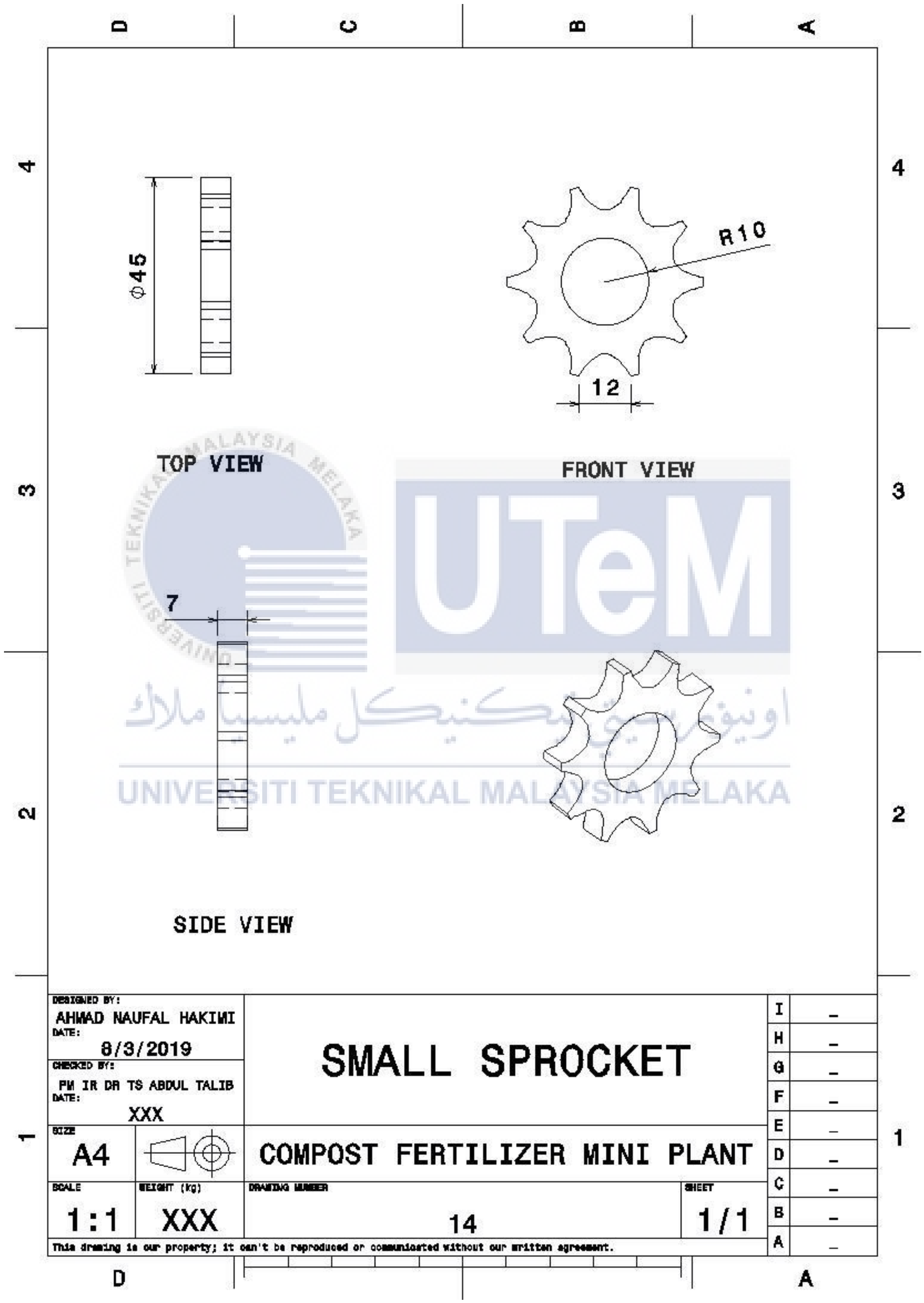
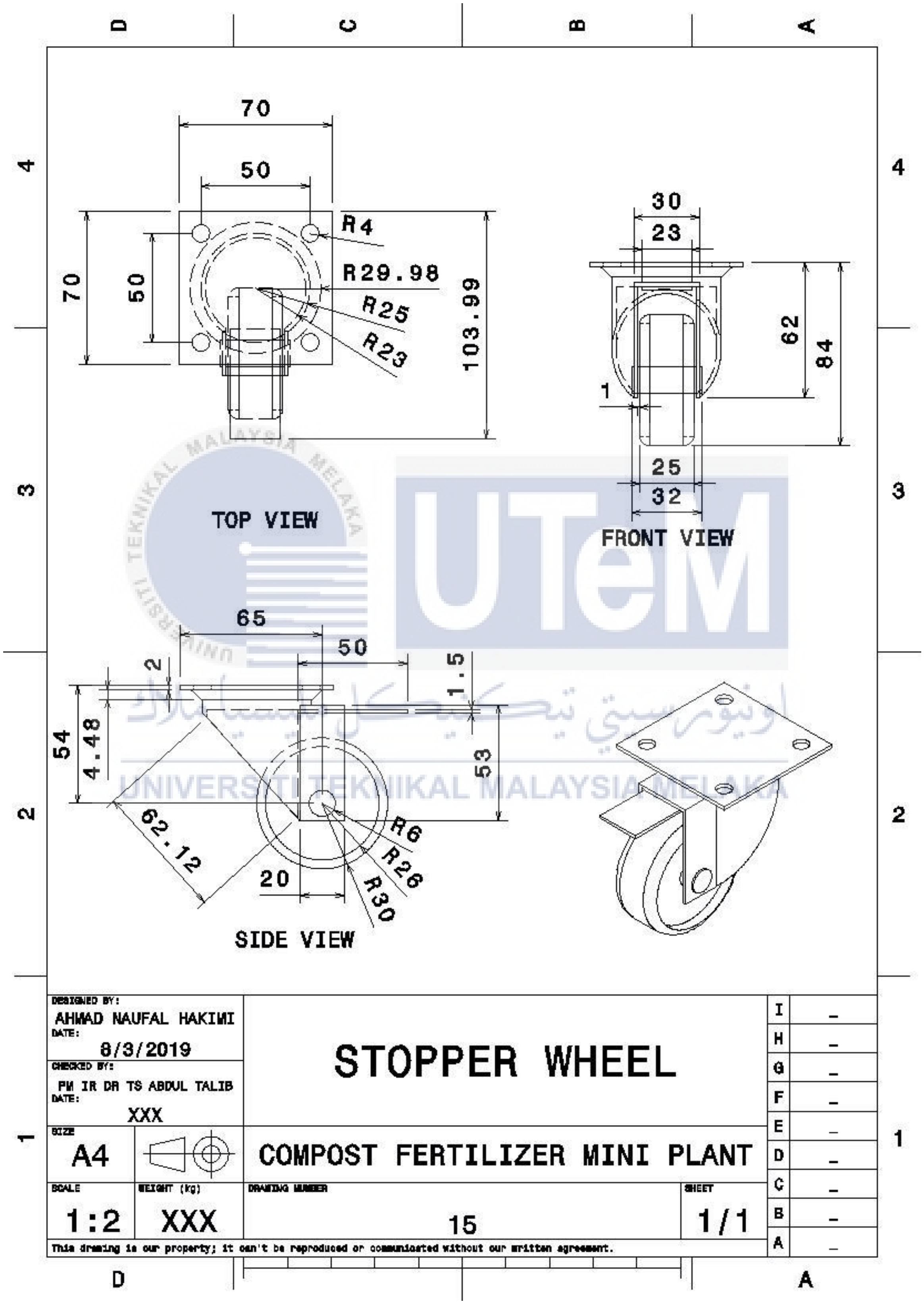


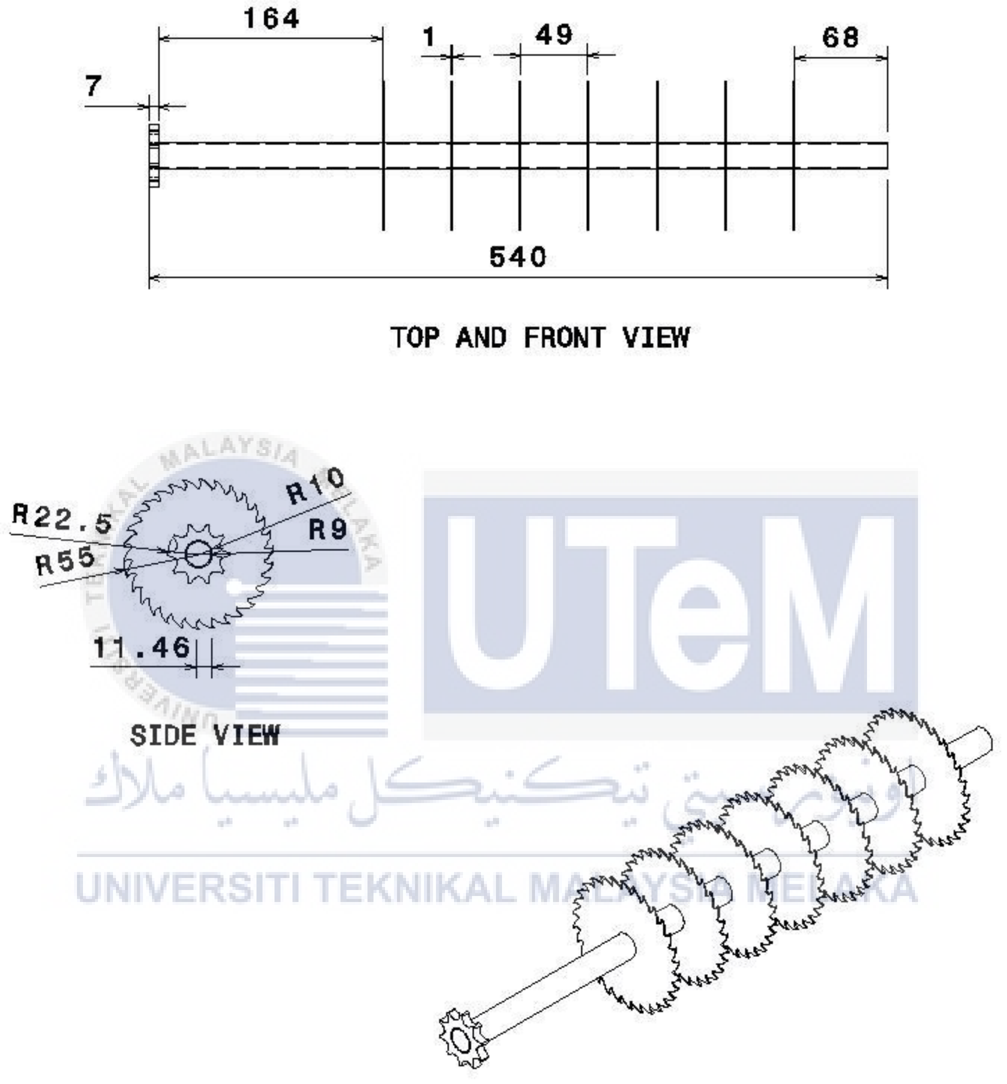
APPENDIX C14



APPENDIX C15



APPENDIX C16



DESIGNED BY: AHMAD NAUFAL HAKIMI DATE: 8/3/2019	UPPER SHAFT BLADE		
CHECKED BY: PM IR DR TS ABDUL TALIB DATE: XXX			
SIZE: A4	COMPOST FERTILIZER MINI PLANT		
SCALE: 1:4	WEIGHT (kg): XXX	DRAWING NUMBER: 16	SHEET: 1/1

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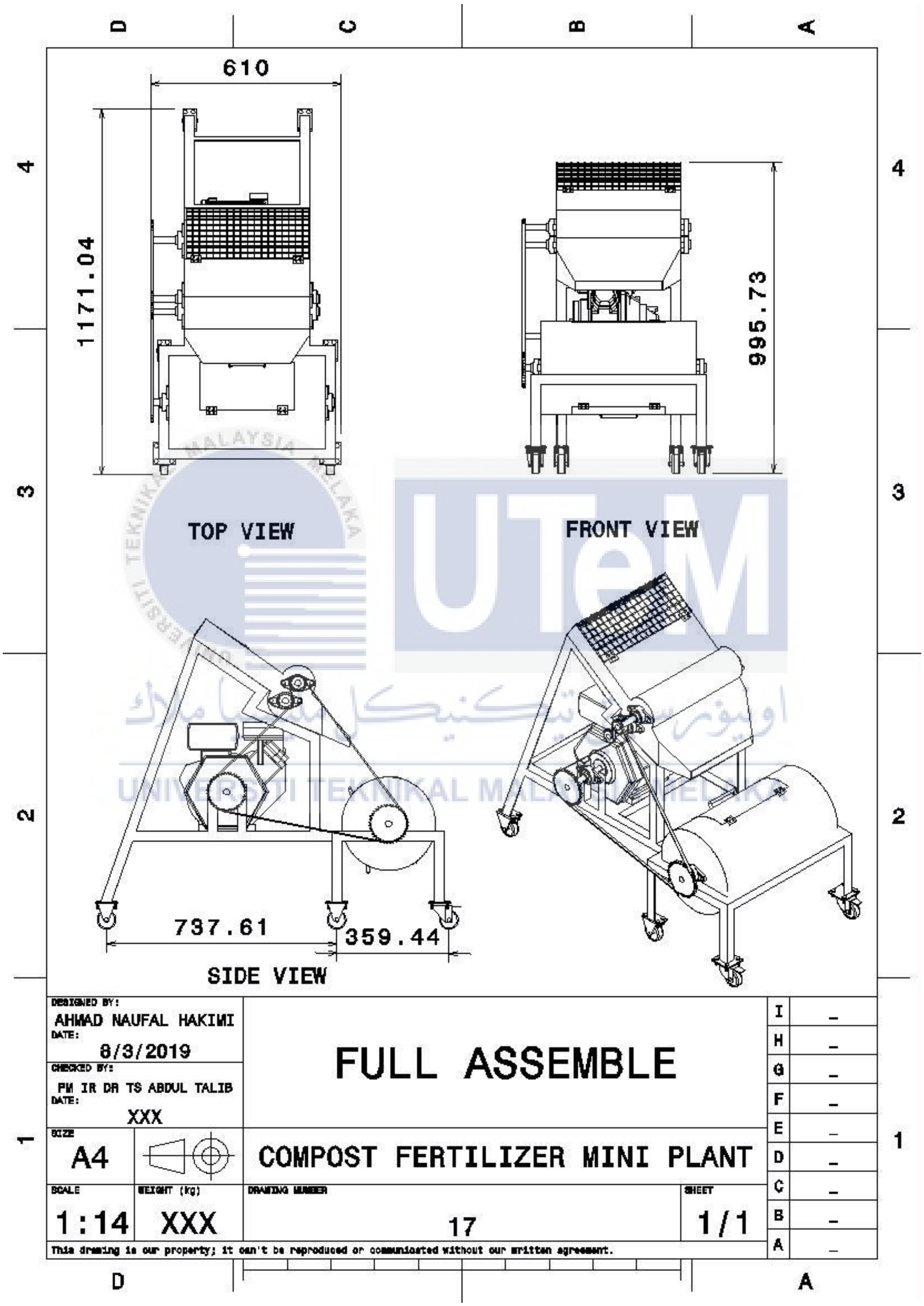
APPENDIX D



D
C
B
A
4
3
2
1
610
1171.04
995.73
TOP VIEW
FRONT VIEW
737.61
359.44
SIDE VIEW
DESIGNED BY:
AHMAD NAUFAL HAKIMI
DATE:
8/3/2019
CHECKED BY:
PM IR DR TS ABDUL TALIB
DATE:
XXX
FULL ASSEMBLE
SIZE
A4
COMPOST FERTILIZER MINI PLANT
SCALE
1:14
WEIGHT (kg)
XXX
DRAWING NUMBER
17
SHEET
1/1
I
H
G
F
E
D
C
B
A
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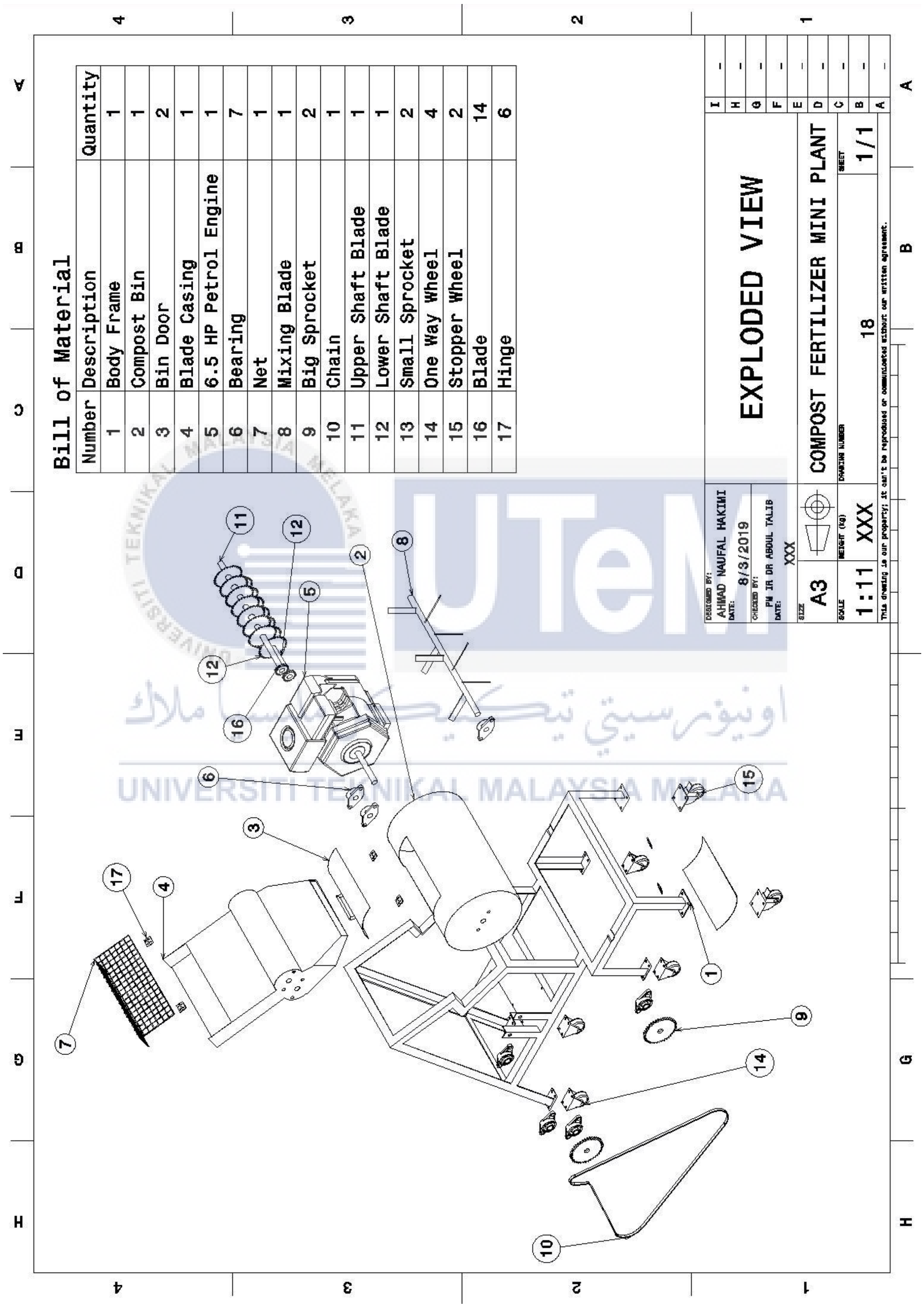
APPENDIX E


Bill of Material
Number | Description | Quantity
1 | Body Frame | 1
2 | Compost Bin | 1
3 | Bin Door | 2
4 | Blade Casing | 1
5 | 6.5 HP Petrol Engine | 1
6 | Bearing | 7
7 | Net | 1
8 | Mixing Blade | 1
9 | Big Sprocket | 2
10 | Chain | 1
11 | Upper Shaft Blade | 1
12 | Lower Shaft Blade | 1
13 | Small Sprocket | 2
14 | One Way Wheel | 4
15 | Stopper Wheel | 2
16 | Blade | 14
17 | Hinge | 6
DESIGNED BY: AHMAD NAUFAL HAKIMI
DATE: 8/3/2019
CHECKED BY: PM IR DR ABDUL TALIB
DATE: XXX
EXPLODED VIEW
SIZE A3
COMPOST FERTILIZER MINI PLANT
SCALE 1:11
WEIGHT (kg) XXX
DRAWING NUMBER 18
SHEET 1/1
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