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Design of Banana Pringles Shaping Machine for Small Industry

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Abstract: Banana is a common food that has been consume by the people especially Malaysia. The aims of the study are to design a banana pringles shaping machine especially for small and medium enterprise (SME). The machine will help in production of a new snack and reduce the manpower in order to produce the banana pringles. The step on design a machine that suit the SME specification need a lot of phase like planning, concept generation, conceptual design, embodiment design phase and details design. The mechanism that be used on the machine is same like stamping machine and moulding machine but it more convenient, small and less cost. Compared to manual stamping or moulding, the machine can produce more pieces.

Keywords: Banana 1, Design 2, Pringles

1. Introduction

Malaysia's agriculture business is expected to generate 7.4 percent of the country's gross domestic product in 2020 (GDP). Malaysia is one of the nations that produces a large amount of tropical fruit, which is consumed by the general public on a regular basis. The fruits are very varied, with both local and imported varieties acting as popular between-meal snacks in addition to their nutritional value. In most stores, most of the tropical fruits on this list are available all year round. Malaysians consume more bananas than any other fruit.

Malaysia has more than 16 banana varieties documented in it, which is a significant number. The banana can be used in many ways such as eaten raw, snack, fresh or cooked. Small and medium-sized enterprises (SMEs) lack economies of scale and may incur significant expenditures in the acquisition and usage of technology, as well as in the upgrading of the skills of their personnel. A major emphasis of the Muda Agriculture Development Authority (MADA) for Industry Development Program is the development of processing industry entrepreneurs with the goal of enhancing product quality in order to enter a larger market. Conducting research on creative and high-impact new goods is one of the responsibilities of this program, which also includes other responsibilities. So, it is important to develop the pringles shaping machine to achieve MADA Industry Development Program scope.

According to the findings of the research, two machines have been developed that can be used, however they are not exclusively for the production of bananas. It is used for the manufacturing of

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potato pringle, and it has a number of functions that may be used to the production of banana pringle. The present machine is employed in large industries and cannot be transported and relocated to another location. Following then, it required a significant investment in terms of maintenance and operation.

2. Methodology

2.1 Engineering Design Specification (EDS)

A Product Design Specification (PDS) is a document developed as a compilation of engineering design activities from the design planning phase. This is because it serves as a reference document for the product's design and construction. As a result, to successfully finish the Banana Pringle Shaping Machine, all client requirements must be collated and documented in EDS. These requirements will be included alongside the companies' requirements.

Table 2.1 Engineering Design Specification.

Dimension	Description
Operation	This banana pringles machine is designed to ease the small business especially banana small industries to produce banana pringles straight from home. As a result, the process is a little bit simple than the industries machine.
Aesthetics / Design	Has simple design that as long as it can be used.
Features	The banana pringles machine must a light in weight machine to help the worker easy to change the place and the machine must be able to use in a long term to enable the company to produce based on their target
Cost	The product offered in reasonable cost as well as has a low-cost maintenance

2.2 Conceptual Design

According to the hierarchical structure of parts and sub-assemblies depicted, it is obvious that the banana pringle forming machine is constructed from the combination of five main component.

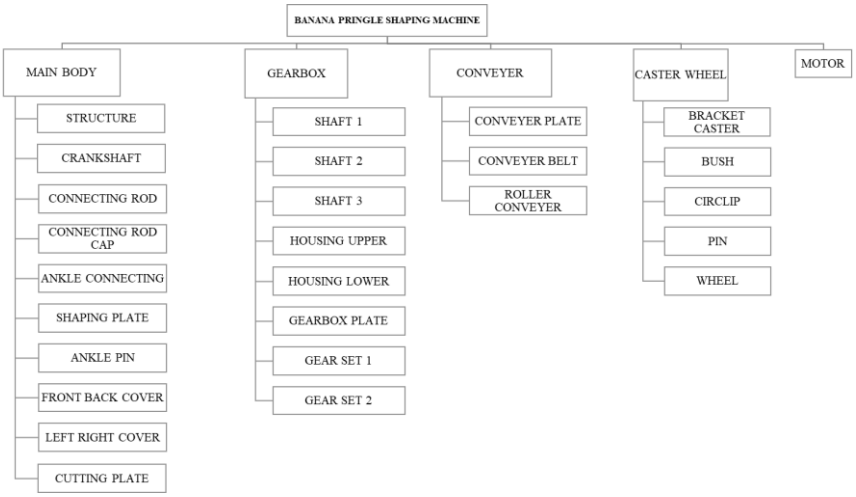


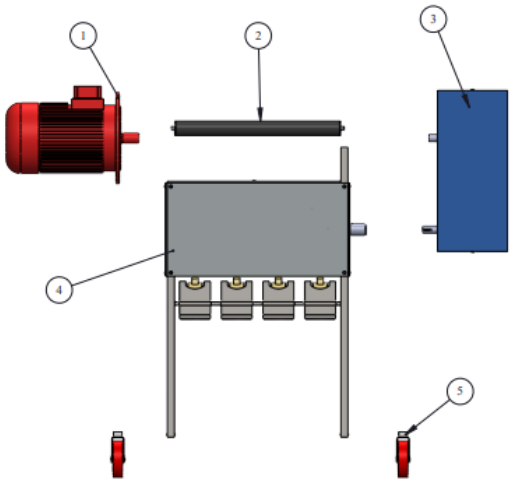
Figure 2.1 Conceptual Design Tree

2.3 Details Design

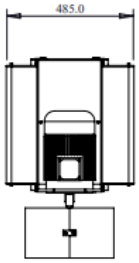
The last level of design is called detail design. It is important that any changes to product design

standards be adequately documented for future reference and decision-making. The following tasks are necessary to be completed at this stage: make a choice, complete engineering drawings, and a comprehensive bill of materials were prepared using SolidWorks software, among others. The report included a detailed product specification that was finalized in preparation for the product manufacturing process.

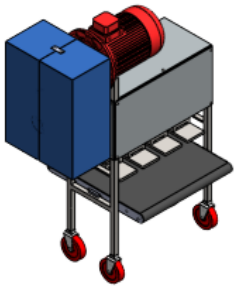
ITEM NO.	PART NUMBER	DRAWING NO.	QTY.
1	MOTOR	-	1
2	CONVEYER	BPSM 01.03.00(A)	1
3	GEARBOX	BPSM 01.2.00(A)	1
4	MAIN BODY	BPSM 01.01.00(A)	1
5	CASTER WHEEL	BPSM 01.04.00(A)	1



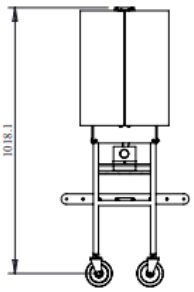
FRONT VIEW



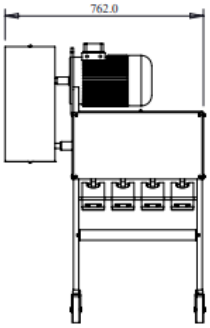
TOP VIEW



ISOMETRIC VIEW



FRONT VIEW



SIDE VIEW

3. Results and Discussion

3.1 Calculation Analysis

Table 3.1 The calculation of the motor and gearbox.

No	Parameter	Value
1	Angular velocity, ω	$\omega = \frac{2\pi N}{60}$ $\omega = \frac{2\pi(50)}{60}$ $\omega = 5.236\ rad/s$
2	Power required, P_{req}	$P_{req} = \tau\omega$ $P_{req} = (500)(5.236)$ $P_{req} = 2618\ W = 2.6\ kW$
3	Speed, n	$n_{req} = \frac{60\omega}{2\pi}$ $n_{req} = \frac{60(5.236)}{2\pi}$ $= 50.00\ rpm$
4	Teeth Gear Set 1 & 2	$N_p = \frac{2k}{(1+2M_G)sin^2\emptyset}\left(M_G + \sqrt{{M_G}^2(1+2M_G)sin^2\emptyset}\right)$ $N_{p,1} = 15.74\ \approx 16\ teeth$ $N_{p,2} = 15.44\ \approx 16\ teeth$ $\frac{N_G}{N_P} = M_G$ $N_{G,1} = 80\ teeth$ $N_{G,2} = 64\ teeth$
5	Torque and rpm Gear Set 1 &2	$T_{P,1} = 40.87\ N.m$ *(same shaft with motor)* $T_{G,1} = \frac{N_{G,1}}{N_{P,1}}T_{P,1}$ $= \frac{80}{16}\ (40.87)$ $= 204.35\ N.m$ $T_{P,2} = 204.35\ N.m$ *(same shaft with gear 1)* $T_{G,2} = \frac{N_{G,2}}{N_{P,2}}T_{P,2}$ $= \frac{64}{16}\ (204.35)$ $= 817.4\ N.m$
6	Speed	$n_{p,1} = 700\ rpm$ *(Same shaft with motor)* $n_{G,1} = \frac{N_{P,1}}{N_{G,1}}n_{p,1}$ $= \frac{16}{80}(700)$ $= 140\ rpm$ $n_{p,2} = 140\ rpm$ *(Same shaft with gear 1)* $n_{G,2} = \frac{N_{P,2}}{N_{G,2}}n_{p,2}$ $= \frac{16}{64}(140)$ $= 30\ rpm$

3.2 Analysis of Solidwork on Structure

The body of the construction for the whole mechanism is employed in this step to perform the simulation process using Solidwork software. There are four analysis which are stress (Von Mises) analysis, displacement (Res Dis) and factor of safety (FOS) analysis.

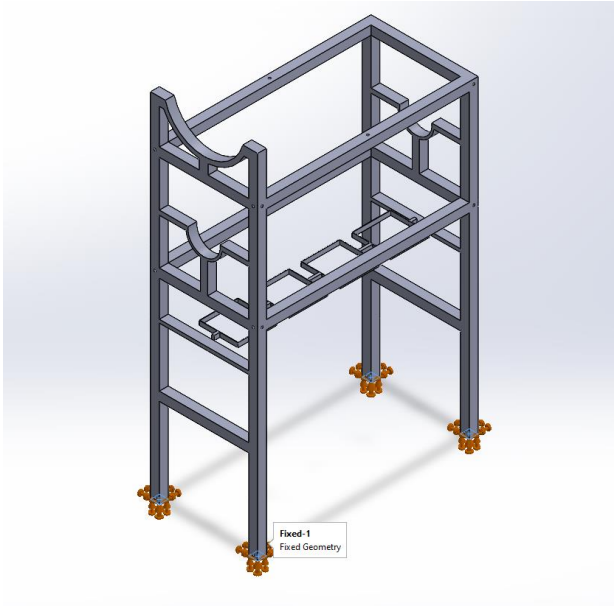


Figure 3.1 Fixed Geometry Applied.

Figure 3.1 shows the fixed geometry that has been applied on the bottom of the structure.

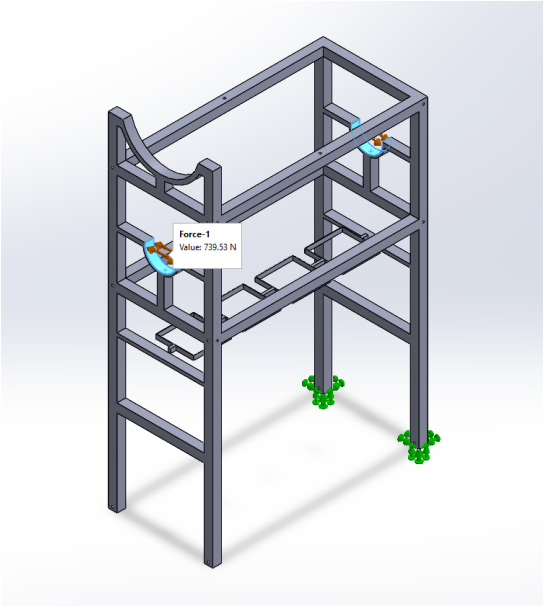


Figure 3.2 Force 1 Applied.

Figures 3.2 shows the force of the total crankshaft, ankle plate, shaping plate that has been applied on the structure. The total force is 739.53 N.

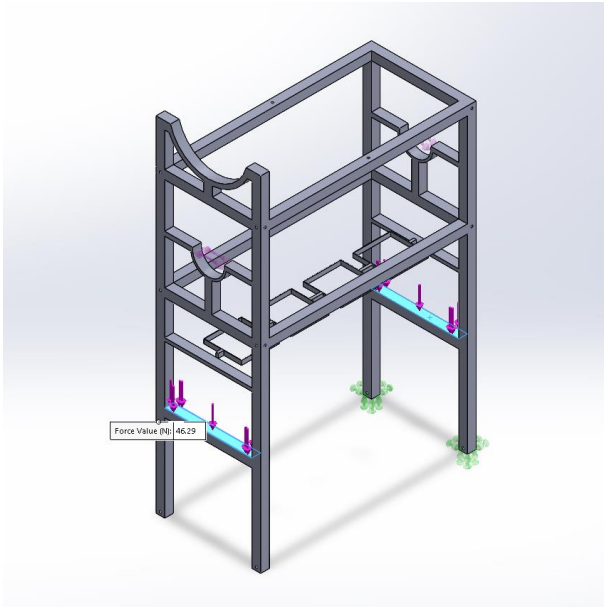


Figure 3.3 Force 2 Applied.

Figure 3.3 shows the force 2 that has been made my conveyer belt on the structure. The value of the force 2 is 46.29 N.

3.2.1 Stress Analysis

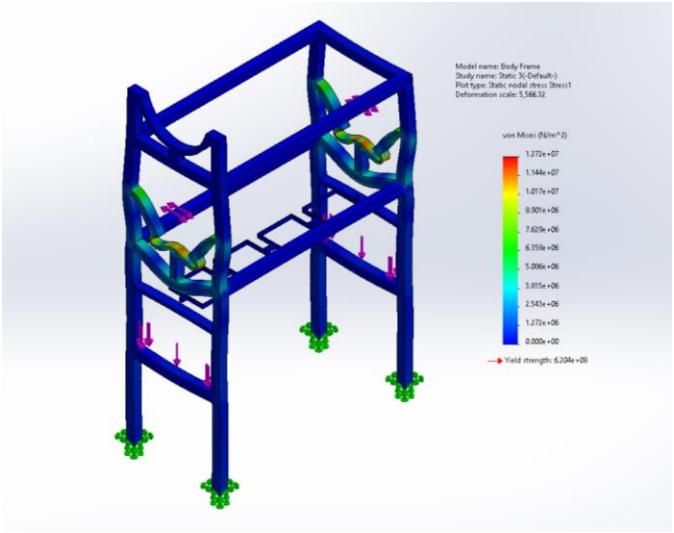


Figure 3.4 Analysis Stress from Solidwork Study Simulation.

3.2.2 Displacement Analysis

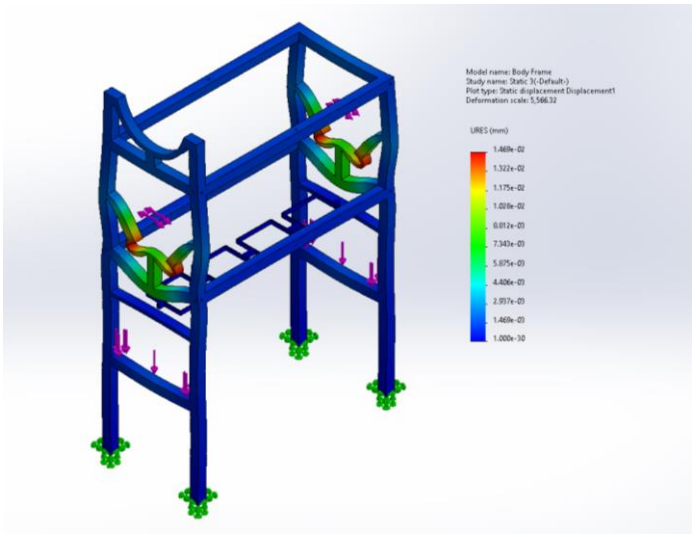


Figure 3.5 Analysis Displacement from Solidwork Study Simulation.

3.2.3 Strain Analysis

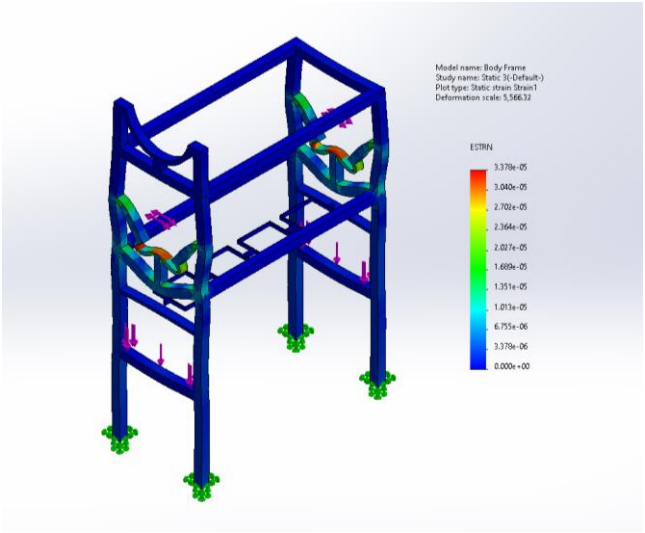


Figure 3.6 Analysis Strain from Solidwork Study Simulation.

3.2.4 Factor of Safety

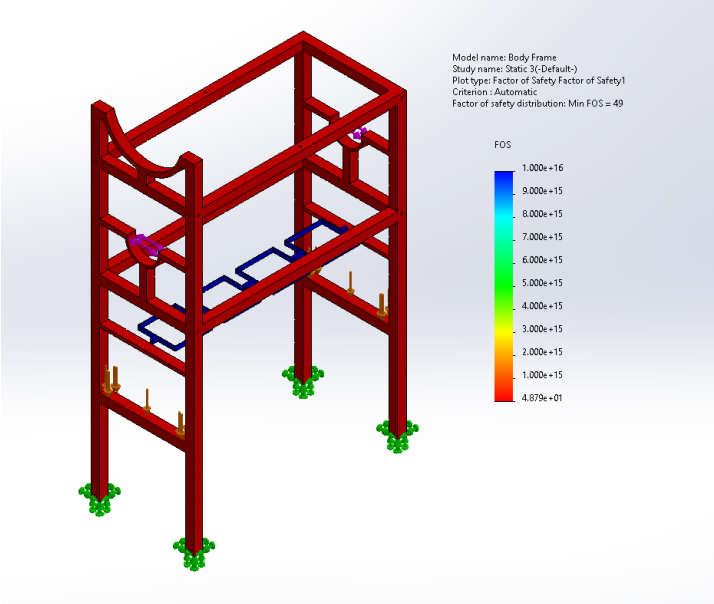


Figure 3.7 Factor of Safety from Solidwork Study Simulation.

3.3 Cost Estimation Analysis

In this section, the estimation cost must be evaluated to identify whether the machine is affordable and suitable for small industry.

Table 3.2 The estimation cost to develop the machines.

No	Component	Quantity	Price (RM)	Total Price (RM)
1	Crankshaft	1	500	500
2	Connecting Rod + Cap	4	50	200
3	Ankle Connecting	4	30	120
4	Shaping Plate	4	20	80
5	Body Frame	1	500	500
6	Caster Wheel	4	20	80
7	Cover Plate	2M	18	36
8	Motor	1	500	500
9	Mini conveyer	1	400	400
		Total		2416

4. Conclusion

This machine has been designed based on the compatibility to the user. This machine does not use a complex but simple operation. The cost for development of the machine is consider as affordable for small and medium industry. There are a few recommendations that can be made, such as replacing the moving plate with a moving conveyer belt. However, in order to accomplish a comprehensive system and method, further time and dedication are required.

Acknowledgement

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