Soy Milk Filter Design Using Dfma Method

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Abstract. DFMA technique can be applied throughout the development process, but if it aims to get big profits, DFMA must be able to be applied in the concept of developing and developing prototypes from the design and development process. One DFMA analysis of semi-automatic soy milk filtering equipment can find out the results of semi-automatic soy milk filter analysis.

This research method: planning 2D & 3D design tools, producing, assembling & testing tools, arranging and calculating the influence of Design For Manufacturing & Assembly & Assembly (DFMA) includes assembly time, component costs and production costs.

The assembly of semi-automatic soy milk filter equipment takes 22.45 minutes and in the supporting components and component costs Rp. 3,695,000; - and production costs Rp.85,824, assembly time based on DFMA analysis produces 40% efficiency.

1. Introduction

Design for Manufacture & Assembly (DFMA) is a method to facilitate the manufacturing process in which each component of product preparation or a product development practice emphasizes on things related to manufacturing. Modern manufacturing systems today face a highly competitive global market. This pressure causes manufacturers (manufacturing) to be forced to create more products with less susceptible lifetime and better quality, but at a lower cost. This causes manufacturing companies to think about product design and development accurately so as not to compete in the global market. Included in the design of this soy milk filter also uses DFMA method, because it hopes to form a good tool in function and usability in addition to the cost for making relatively affordable (Boothroyd, 2011).

Didit Adi Darmawan, 2012. The design result is to produce machine soybean with specifications of length 900 mm, width 400 mm and height 1000 mm. Motor is used ¾ HP AC motor. One kilogram of dried soybeans produce 15 liters of soy milk fast food. The estimated cost of soybean milk making machine for home industry is Rp. 3.331.000, -. Hasibuan, 2013 stated the design of Stop contact using DFMA shows that the assembly time was reduced to 19.57%, the number of components decreased by 25.53% and the total assembly cost decreased to 19.14%. Somantri, 2014 stated in the design of tool holders for dovetail grooves using DFMA shows a reduction in the number of components from the initial design of 18 components to 15 components, 33% efficiency. Suwandi, 2017 stated in designing coconut tree climbing aids that the total time needed to make the tool is 194 minutes and costs Rp. 621.200,00.

Design For Manufacturing & Assembly (DFMA); Ulrich, 2001 stated that manufacturing costs are the main determinant in the economic success of the product. Economically, a successful design depends on guaranteeing high product quality, while minimizing manufacturing costs. Effective implementation of DFMA leads to low manufacturing costs without compromising product quality.
Design For Manufacturing & Assembly (DFMA) requires is functionally interconnected team. Designing for manufacturing processes is one of the most integrated implementations involved in product development. DFMA uses information of the various types, including:

a. Sketches, drawings, product specifications and design alternatives.
b. Detailed understanding of the production and assembly processes.
c. Estimated cost and production volume, as well as product launch time.

DFMA method consists of 5 steps: (Benohabib, 2003)

a. Estimating manufacturing costs
b. Reduce component costs
c. Reduce assembly costs
d. Reduce production support costs
e. Consider the influence of DFMA's decision on other factors.

Reducing Design For Assembly DFA is also considered part of DFMA which contains about the minimize of assembly costs. In this section, it will be explained some useful principles for directing DFMA decisions: Boothroyd and Dewhurst (2011)

a. Recommend maintaining an ongoing cost estimate. In addition to these absolute numbers, they propose the concept of assembly efficiency. The DFA index based on the following formula:

\[
DFA\ Index = \frac{(Minimum\ Component\ quantity \times 3\ seconds)}{(Estimated\ Total\ Assembly\ Time)}
\]  

b. Integrating a component If a component does not have the theoretically necessary quality, then there will be a replacement candidate to merge one or more components.

c. Maximize assembly ease

2. Research Methods

In the design of the system there need to be several stages to make a semi-automatic soy milk filter from designing to the work and assembly of the stages as follows:

![Research Flowchart](image)

**Figure. 1.** Research Flowchart

3. Results and Discussions

3.1. Tool Design

Designing the design as the initial process of this research is referring to the design of tools from students of the Faculty of Engineering, The University of Yogyakarta which is then redesigned to see the efficiency of the tool.
3.2. *Filter Tool Design and Creation*

a) *Filter*

The material used to make this centrifugal filter system is a stainless steel plate 304 with a thickness of 0.8 mm that is bent to form a cone and given a hole Ø 6 mm to rinse soy starch juice, on the filter cloth using a 125μ. The function of the sieve is to squeeze the soy sauce..
Figure 4. Filtrate separator filter Design and sieve dimensions

b) Container Pot
To make a container pot from this filter using the same material as the sieve with stainless plate steel 304 with a thickness of 0.5 mm. Container pan function to accommodate the result of soy milk sieve.

Figure 5. Container Pan Design and Pan Dimensions

In the stage of making pot container steps are:
1. Measure the need for stainless plate material by calculating the surface area of the tube blanket.
   \[ L_{\text{blanket}} = \text{Roving pot} \times \text{High pot} \]
   \[ \text{Around} = \pi \times \text{Diameters} \]
\[ 3.14 \times 400 \text{ mm} = 1256 \text{ mm} \]

\[ L \text{ blanket} = \text{Roving pot} \times \text{High pot} \]

\[ = 1.256 \text{ mm} \times 400 \text{ mm} \]

\[ = 502400 \text{ mm}^2 = 5.02 \text{ m}^2 \]

Once the material is measured then it is further cut according to size, at the time the cutting is ±20 mm for the indentation of the rivet, the stainless plate is bent until it forms a tube and is spliced with rivets.

2. Measures the need for stainless plates needed for the bottom of the pan and forms holes in the tenggan section of Ø100 mm

3. Make an output funnel to drain the soy milk to the shelter with a square shape then connect it to the container using a stained joint.

c) Pan Cover and Caster

As with a container pan, the lid of the pan and cast funnel use 304 stainless steel material with a thickness of 0.5 mm. The dimensions of the pan cap are 400 mm, the diameter of the hole Ø 50 mm, the diameter of the casting funnel 200 mm, diameter of the hole Ø 10 mm. Pan cap function to close containers and cast funnels to drain the soy grind that is ready to be filtered.

\[ \text{Figure. 6. The design and dimensions of the pan lid} \]

3.3. Design and Dimensions of The Mount

The design of the mount made using materials consisting of strip iron plates, iron plates, hollow iron pipes. Ø bearing hole diameter 100 mm. Mounting function for container pot and soy milk filtration process.
3.4. Design and Dimensions of Shaft And Pulley

The shaft used made of cast iron diameter 60 mm, shaft diameter θ 50 mm, shaft bolt length diameter θ 40 mm. Shaft function to drain the round from the filter round pulley inside the container pan, the turning process is carried out according to the design and dimensions specified.

The pulley and belt used a power train to carry the spin or motor power of the centrifugal filter can also be used as a lap speed change by raising the pulley ratio.
The pulley used in this tool is circulating in the market with a general specification diameter 4 inches with diameter in the hole $\theta$ 16 mm, the function of the pulley to multiply the spin from the motor to the shaft.

### 3.5. Assembly Chart

From the chart above can be seen as the main components used in the semi-automatic soy milk filter consisting of 8 components, the total assembly time of all components is 22.45 minutes. Thus obtained assembly time efficiency:

a. Basic assembly time per part ($t_a$) = 3 second
b. Minimum of part ($N_{min}$) = 3 part
c. Total Time Assembly ($t_{ma}$) = 22.45 minutes
d. $E_{ma} = \frac{3 \text{ second} \times 3 \text{ part}}{22.45 \text{ minute}} = 0.400$ at 40%  

Calculation of assembly time on semi-automatic soy milk filter by 40%.
3.6. Supporting Component Costs

![Component costs chart]

The chart above shows the supporting components and basic components needed to make a semi-automatic soy milk filter of 23 components used and the total cost of components amounting to Rp. 2,195,000.00 and the cost of making Rp. 1,500,000.00; so the total cost is Rp. 3,695,000.00.

3.7. Production Costs

![Production Costs chart]

The chart above shows the cost of using the production support machine needed for semi-automatic soy milk filter of 3 components and electricity usage cost per (KWH) Rp. 1,460.00 with electricity cost of Rp. 85,824.00.

3.8. DFMA Analys

a. Faster assembly time is designed more thoroughly and measurably.
b. With the cost of components much cheaper is the risk of product failure and the process is already planned.
c. Thus obtained assembly time efficiency of 40%, with component costs
3.9. Machine Design Comparison

The Table below is soy milk making machine design comparison made by the Faculty of Engineering, University Negeri Yogyakarta with Faculty of Engineering, University Pancasakti Tegal.

| Specification                     | Design Of Soybean Milk Making Machine Ft Uny | Design Of Soybean Milk Making Machine Ft Ups |
|-----------------------------------|---------------------------------------------|---------------------------------------------|
| Machine dimensions                | 900 x 400 x 1000 mm                        | 440 x 440 x 500 mm                          |
| Engine power                      | 900 Watt                                    | 700 Watt                                    |
| Top tube capacity                 | 2 Kg                                        | 2 Kg                                        |
| Bottom tube capacity              | 1.5 Kg                                      | 1.5 Kg                                      |
| Soy Milk Capacity                 | 15 Litre                                    | 20 Litre                                    |
| Time to process soybeans into milk| 40 minute                                   | 10 minute                                   |
| Work Time Process                 | 21 days                                     | 13 days                                     |
| Cost                              | Rp. 3,831,000.00                            | Rp. 3,780,000.00                            |

4. Conclusion

From the results and discussions obtained several conclusions as follows:
1. DFMA methods include thinking about manufacturing costs, component costs, production support costs and considering the influence of DFMA decisions on other factors.
2. Assembly of semi-automatic soy milk filter injured time 22.45 minutes with 8 main components
3. The cost of the main equipment and supporting needs amounts to Rp. 3,695,000.00 with the cost of using the production machine Rp. 85,824.00.
4. Assembly time based on DFMA analysis produces 40% efficiency

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