

## Design and Build of Dacron Pillow Filling Machine to Increase Production Capacity and Reduce Production Costs

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**Abstract-** This research was conducted at Mr. Khambali's SME. Mr. Khambali's pillow SME is engaged in producing pillows and bolsters with an average daily production of 140 units. The problem in Mr. Khambali's pillow SME is that the production output often does not meet demand because the process of stuffing the dacron into the pillow sack takes 8 minutes. This research aims to increase production capacity and reduce production costs. The method used in this research is Anthropometry, which is a reference for designing the machine to ensure its safe and comfortable use. Then, work time measurement is conducted using the time study method, and the calculation of production costs is compared before and after the design process. The results obtained from the design process are an increase in production from 140 units to 230 units per day and a reduction in production costs from IDR. 23,801 to IDR. 14,705. This research concludes that after designing the Dacron pillow-filling device, production increased by 90 units, and production costs decreased by IDR. 9,096.

**Keywords:** Anthropometry, Production capacity, Production cost

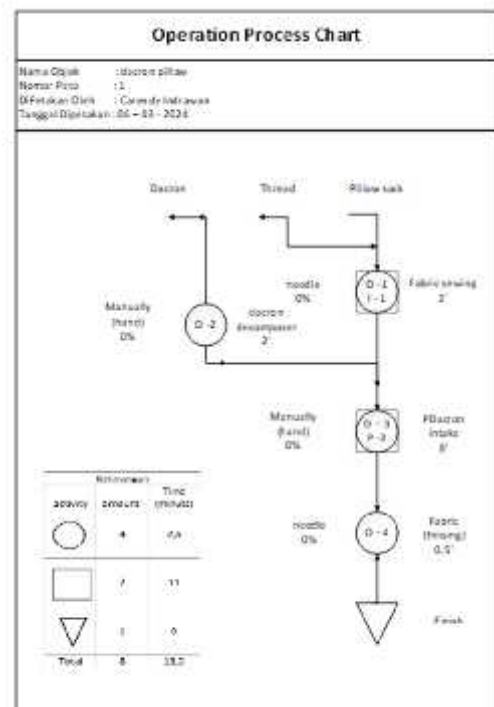
### I. INTRODUCTION

Mr. Imam Khambali's Pillow SME was established in 2017 and is located in Simonggirang Village, Prambon District, Sidoarjo Regency. This SME specializes in the production of pillows and bolsters. Mr. Imam Khambali's Pillow SME operates with both Make To Order (MTO) and Make To Stock (MTS) production systems. The MTS system is applicable when customers place orders for 400 units or more. The products manufactured by this SME include foam pillows, foam bolsters, dacron bolsters, and mattresses, and one of the products studied in this research is dacron pillows.

Dacron pillows are items used to support the head during sleep, made from dacron (a silk

fiber extracted from cotton plants). The dacron pillows produced by this SME are rectangular and weigh between 600 and 700 grams. These products are popular among consumers due to their soft and comfortable nature.

The UMKM Bantal Pak Imam Khambali employs seven workers, including two pillow fabric sewers, two pillow fluffers, two pillow fillers, and one final sewing worker. In the production of dacron pillows, there are four processes with different processing times. As shown in the OPC (Operation Process Chart) below:



**Figure 1.** OPC pillow production

Mr. Khambali's Pillow SME produces pillows from Monday to Saturday. The daily production of dacron pillows amounts to approximately 140 units, and on average, it can reach 350 units per month, as shown in the table below:

**Table 1. Demand**

Month	Production Data (Units)	Demand data (Units)
August	3.562	3.551
September	3.534	3.562
October	3.570	3.561
November	3.553	3.542
Desember	3.520	3.552

Based on the data, there is unmet demand at Mr. Khambali's Pillow SME. To fulfill this demand, the SME often resorts to overtime work, which increases operational costs. Additionally, the SME frequently rejects orders and refuses to accept orders from other customers. This is because they need to meet production targets and complete existing orders before taking on new ones, causing other customers to seek products elsewhere. Another issue is the frequent accumulation of raw materials (dacron), which disrupts workflow and reduces production efficiency.

Observations and interviews revealed that the primary reason for the unmet production demand is the low production capacity due to a time-consuming process: stuffing dacron into pillow sacks, which takes 8 minutes per unit. This process consumes significant time, resulting in low product output and causing a backlog of dacron, further hindering production efficiency.

To address these challenges, the researcher proposes a solution: the creation of a Dacron pillow-stuffing machine. The introduction of this machine is expected to increase production capacity and reduce production costs associated with dacron stuffing, enabling the SME to meet customer demand.

**II. METHOD**

In conducting the research, several stages were undertaken as follows:

1. **Problem Formulation** The first stage involves identifying the problem statement at Mr. Khambali's Pillow SME. The problem statement addressed in this research is the failure to meet customer demand.
2. **Literature Review** The literature review aims to gather data by searching for information from references or literature. In this research, the literature review involved gathering information from

books such as Product Design, Design and Development of Manufacturing Products, Anthropometry for Work Systems, Ergonomics, Analysis and Design of Work Systems, and Engineering Economics. These books served as references for data management.

3. **Field Study** The field study aims to obtain direct data conducted at Mr. Khambali's Pillow SME, specifically focusing on the Dacron pillow product. Data acquisition was carried out through observation processes at the SME and interviews conducted with the SME owner and employees.
4. **Data Collection** Data collection in this research included gathering data on production capacity, production process times, number of employees, employee work hours, and anthropometric data of employees.

**Table 2. Body dimensions**

body dimensions	Purpose of measurement
Elbow height	To determine the height of the machine frame.
Shoulder height	To determine the height of the hopper support to the floor.
Hand Leght	To determine the reach of the hand to the machine.
Vertical grip reaches height	To determine the height of the output pipe.

This calculation is performed by 2 workers during the dacron pillow stuffing process.

5. **Data Management** The data obtained from anthropometric data collection undergoes data management, which involves testing data uniformity, adequacy, standard deviation, precision degree, and percentile calculation with sizes of 5th, 50th, and 95th. The results of data management are used to determine the ergonomic size of the Dacron pillow stuffing machine. The percentile calculation is formulated with the following equation.

$$P = \bar{x} - .F \sigma \dots\dots\dots(1)$$

6. Machine Design Machine design is the stage of creating a tool according to the calculation data from anthropometry.
7. Analysis and Discussion Analysis and discussion are stages following the machine design. The results of the machine design are analyzed and compared. The first analysis involves analyzing the time calculation in producing one dacron pillow. The measurement is conducted using the stopwatch time study method. The calculations in this method include testing data uniformity, finding standard deviation, calculating control limits, testing data adequacy, determining performance rating, determining allowance, determining standard time, and establishing standard output. Additionally, the calculation of Production Cost (HPP) will be compared before and after the machine design.
8. Conclusion and Recommendations Conclusion is the final stage in conducting the research. The conclusion should be relevant to the objectives of this research. Meanwhile, recommendations are suggestions or inputs provided by the researcher to Mr. Khambali's Dacron pillow SME.

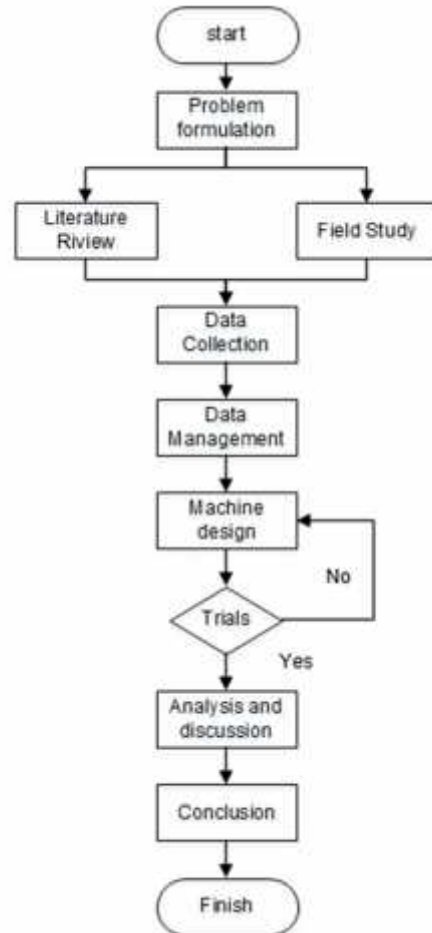


Figure 2. Flow Chart Study

**III. ANALYSIS**

**3.1. Data collection and processing**

Anthropometry is a combination of Greek terms, "Anthro" meaning human, and "Metri" meaning measurement. It means measuring humans. From the aspect of physical anthropology, it refers to a process resulting from the measurement of the need to understand human physical variations (Kusnawa, 2015).

**Table 3.** Anthropometric data

Name	Anthropometric data of the body (cm)			
	Elbow Height (cm)	Shoulder height (cm)	Hand Leghtt (cm)	Vertical grip reaches height
kambali	92	146	75	78
Lastri	89	143	73	77
khotimah	90	144	74	77
binti	89	143	73	78

After obtaining the data in the table above, anthropometric data management will be conducted to calculate the standard deviation. Subsequently, percentile calculations will be performed, which will later be used for determining the appropriate size of the dacron pillow filling machine according to human body dimensions for comfortable and safe

**Table 4.** Employee body size

body dimensions	average	Standard deviation
Elbow height	90	1.414
(Shoulder height)	145	1.414
Hand Leght	71.75	0.957
Vertical grip reach height	76.5	0.577

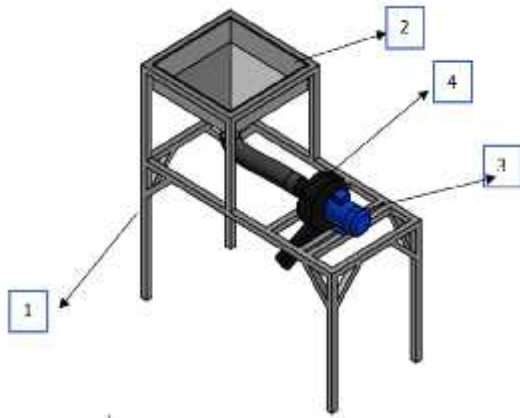
Based on Table 4, each standard deviation is known and will be used for percentile calculations. Percentile calculations are performed using equation (1). Then, each percentile value will be determined as shown in the table below.

**Table 5.** Percentile Result

body dimensions	Percentile results		
	5-th	50-th	95-th
Elbow height	87	90	92
Shoulder height	141	145	146
Hand Leght	70	71.75	73
Vertical grip reach height	75.5	76.5	77.4

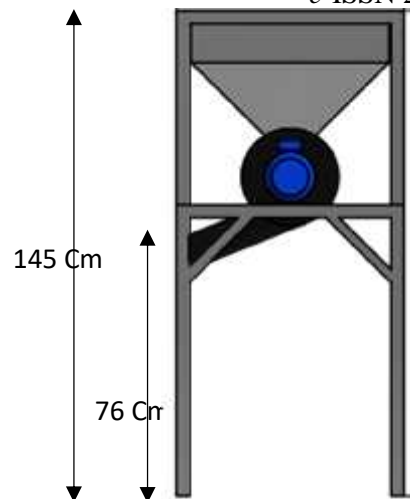
Based on Table 5, the percentile results for the 5th, 50th, and 95th percentiles are known. From these results, the percentile results for each body dimension will be chosen. For the Elbow height dimension, the 50th percentile result with a size of 90 cm is selected. This choice is made to determine the frame of the Dacron pillow-filling machine so that workers can comfortably use it because the size is neither too tall nor too short. For the Shoulder height body dimension, the 50th percentile result with a size of 145 cm is chosen. This selection is made to determine the height of the hopper to the ground of the dacron pillow filling machine so that workers can comfortably use it to fill raw materials because the size is neither too tall nor too short. For the Hand Leght body dimension, the 5th percentile result with a size of 67 cm is chosen. This selection is made to determine the area of the machine. For the Vertical grip reach height body dimension, the 50th percentile result with a size of 76 cm is chosen. This selection is made to determine the height of the output pipe to the ground of the dacron pillow filling machine so that workers can comfortably use it because the size is neither too tall nor too short.

The values of each body dimension will be used to determine the design size of the Dacron pillow-filling machine, as shown in the image below.

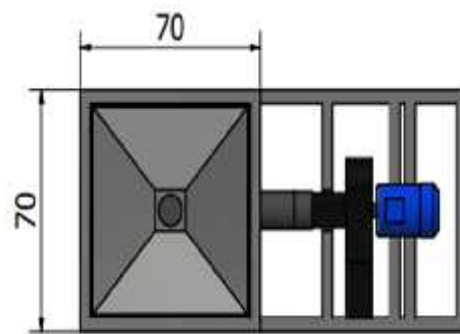


**Figure 3.** Dacron Machine

1. Frame The machine frame component consists of several parts:
  - Machine frame The machine frame is made of 4x4 hollow iron with a thickness of 2 mm, serving as the legs of the table measuring 150 cm in length, 90 cm in height, and 70 cm in width.
  - Dynamo holder The dynamo holder is made of 4x4 hollow iron with a thickness of 2 mm, serving as the dynamo support with a length of 70 cm.
2. Machine Drive
  - Electric motor The electric motor used to drive the fan is a single-phase electric motor, 2800 RPM, and 1 HP.
  - Drive fan The drive fan is made of PVC material with a diameter of 26 cm
3. Hopper
  - Hopper The hopper is made of iron plate with dimensions of 70 cm in length, 70 cm in width, and 40 cm in height, and it is funnel-shaped.
  - Hopper support The hopper support is made of angle iron with dimensions of 70 cm in length, 70 cm in width, and 40 cm in height, and it is funnel-shaped.
4. blower snail
  - Auger The auger is made of an iron plate with a diameter of 30 cm.
  - Suction hose The suction hose is made of pipe with a pipe diameter of 2.5 inches.



**Figure 4.** Side view machine



**Figure 5.** Machine top view

After designing the tool by incorporating anthropometric measurements of the workforce, the implementation of the Dacron pillow-filling machine will be carried out. This implementation aims to ensure that the design aligns with the research objectives. Below is the machine that has been successfully implemented, as depicted in the image below.



**Figure 6.** Machine dacron

After implementation, a trial will be conducted. The result obtained from the trial indicates that the time taken to fill the Dacron pillows using the Dacron pillow filling machine is 3.5 minutes. This marks a reduction in production time compared to the previous method of manual filling, which took 8 minutes. With this decrease, it is expected to increase the production output at Mr. Khambali's SME.

#### IV. DISCUSSION

##### 4.1. Analysis of productivity and standard output

The productivity and standard output analysis aims to provide a comparison before and after the design of the Dacron pillow-filling machine. Productivity measurement is conducted by collecting data through observation 25 times during the process of filling dacron into sacks. This process involves 2 workers, each obtaining a daily output before design of 70 units with an 8-hour working time. Standard output measurement is done using the stopwatch time study method. The calculations in this method involve testing data uniformity, finding standard deviation, calculating control limits, conducting data sufficiency tests, determining performance rating, determining allowance, determining standard time, and determining standard output. The results obtained from these measurements are as follows, shown in the table below.

**Table 6.** Ratio Output

Ratio	Output per day	Output O'clock	per
Before planning	140	8,7	
After Planning	230	20.1	

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$$P = \frac{f \quad s \quad -n \quad s}{n \quad a} \times 100\%$$

$$P = \frac{2 \quad -1}{1} \times 100 \%$$

$$P = 64 \%$$

##### 4.2. Analysis of Production cost before and after planning.

Production cost analysis aims to determine the comparison of the price of polyester pillow products before and after planning. In the production cost analysis, costs are collected for the daily production process of polyester pillows. These costs include material costs, labor costs, machining costs, and overhead costs. The costs are as shown in the table below."

**Table 7.** Ratio Cost

Type of cost	Before planning	After Planning
Cost raw material	IDR. 2.754.000	IDR. 2.754.000
Labor cost	IDR.480.000	IDR.480.000
Cost machine	-	IDR. 20.050
cost overhead	IDR.962.300	IDR.962.300

After collecting cost data from Table 7 above, we will then calculate Production cost. Production cost is calculated by dividing the total overall costs by the daily capacity. The result of the Cost of Goods Manufactured calculation is shown in the table below.

**Table 8.** Ratio Production cost

Activity	Output per day	Production cost
Before planning	140	IDR.23.801
After Planning	230	IDR. 14.705

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Looking at Table 8 above, it can be seen that the cost of goods manufactured before planning is IDR. 23,801, while after planning it is IDR. 14,705. The decrease in the cost of goods manufactured after planning the polyester pillow filling machine is."

Production cost Now = Production cost Before –  
Production cost After

Production cost New = IDR. 23.801 – IDR. 14.705

Production cost New = IDR. 9.310

#### IV. CONCLUSION

The results of the ergonomic design using anthropometric methods for Mr. Khambali's MSME polyester pillow filling machine are as follows: a frame height of 90 cm, a height of the

hopper to the floor of 145 cm, a frame width of 70 cm, and an output height to the floor of 76 cm.

Analyzing the standard output calculation results after designing the polyester pillow filling machine, it yielded 230 units, while before the design, it produced 140 units per day. The presence of the polyester pillow filling machine increases productivity by 64% compared to the previous condition.

The results and analysis of the comparison of the production cost before the design amounted to IDR. 23,801, while after the design, it is IDR. 14,705. From these results, the design of the polyester pillow-filling machine is considered profitable and worthwhile to enhance production output at Mr. Khambali's MSME.

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