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Redesign Of The Peanut Huller To Increase Productivity

Wahyu Adi Nugroho
University of Muhammadiyah Surakarta

Article Info	ABSTRACT
Corresponding Author: Name : **Wahyu Adi Nugroho** E-mail: wahyuadi@gmail.com	The health and safety of workers is very important, especially for home industries such as the peanut peeling industry. During work, workers feel soreness in the back, waist, arms, wrists and elbows. Therefore, it is necessary to do research on this matter. This study aims to increase productivity by redesigning the peanut peeler machine. In redesigning a work facility in the form of a peanut machine, things that need to be considered are the anthropometry of the operator's body size, complaints during work, the time of the peanut peeling process and heart rate during work. To determine the effect between the treatment before and after the design, a comparison test was conducted using the Paired Sample T-Test. The results showed that the standard time in the conditions before the design was 0.102 hours/kg and the standard output was 29.5 kg/hour. Meanwhile, after the design of 0.023 hours/kg and the standard output is 130.5 kg/hour with an increase in standard output of 101 kg/hour. Energy consumption after working in conditions before design is 4.58 Kcal/minute and after design is 3.7 Kcal/minute with a decrease in energy consumption level of 0.88 Kcal/minute. **Keywords:** productivity, peeler, peanut, energy, design

INTRODUCTION

Farmers in the Gunungkidul area in general still carry out their work activities manually/simple, even if they use tools, the tools are still simple and human labor still plays the most important role in farming, for example plowing fields still using cattle or hoes with human power, thus also in peeling peanuts still use human hands so that the peeler's hands are usually swollen on the thumb and forefinger. Peeling peanuts is usually done after the peanuts are completely dry, this is intended to get quality peanuts or not easily rotten.[1]. The peanut peeler is indeed quite helpful for farmers and traders in peeling peanuts, but after using the peanut peeler for too long the body will feel sore, especially in the arms, hips and back.[2]. The target or schedule for depositing peanut seeds to the customer is often late because of the large number of peanuts ordered and the existing tools are not able to meet the customer's needs.[3].

In designing an ergonomic peanut peeler, it is very necessary to have body dimensions that fit the size of the peanut peeler[4]. Anthropometric data will be used for the size of the peanut peeler that will be designed[5]. While the relevant anthropometric data to be used is the body standing position, the length of the palms and the width of the palms[6]. This research will focus on improving the peeling time of peanuts. This is done with the aim that the stripping of peanuts has a minimum time so that the residents of Wukirsari Hamlet, Baleharjo Village, Wonosari District, Gunungkidul Regency can be more effective and efficient.

The explanation above illustrates that the population needs a peanut peeler that can minimize the time of peeling peanuts, so that it affects the effectiveness and efficiency. And can help residents in peeling peanuts so that they can meet customer requests[7].

METHOD

The stages of research carried out are:

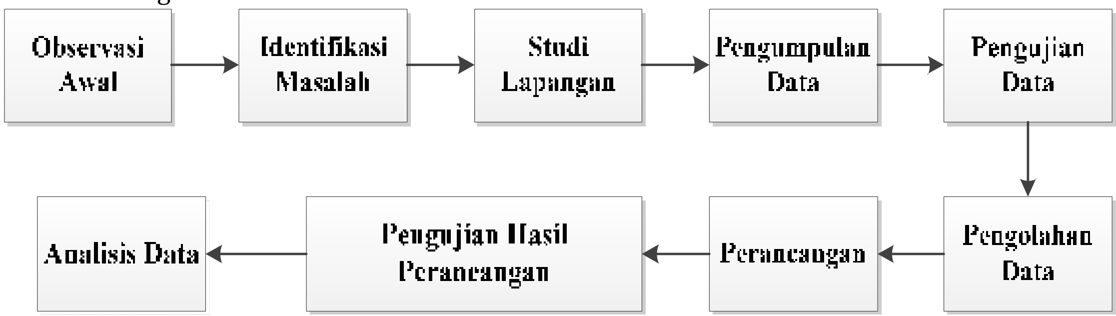

Figure 1. Research Stage

Primary data is data that is directly obtained from sources through direct observation and recording, namely the dimensions of the operator's body, the size of the current field of work facilities and data on the time of peeling peanuts at that time. After the data is collected, the data testing is carried out as follows:

a. Anthropometric Data Uniformity Test and Process Time Data Peeling Peanuts. Data uniformity test can be done by calculating the Upper Control Limit (BKA) and Lower Control Limit (BKB). If there is data that is outside the control limits, then the data is not used in the calculation. The data uniformity test can be known by equations 7, 8, 9 and 10.
b. Sufficiency Test of Anthropometric Data and Time Data of Peanut Peeling Process. This data adequacy test is used to determine whether or not the data from the observations that have been collected are sufficient. If N'≤ N then the data is sufficient. On the other hand, if N'>N, it must be re-observed until the data is sufficient. Meanwhile, for the data adequacy test, it can be seen by equation 11.
c. Normality Test of Anthropometric Data and Process Time Data of Peanut Peeling. The statistical test carried out is the normality test. This normality test is used for anthropometric data after design. The goal is to find out that the data is normally distributed so that the data can represent the observed population.

Data processing in this study includes:

a. Anthropometric Data. After collecting data, the next step is processing anthropometric data to determine the measurements used in the design.
b. Peanut Peeling Process Time Data. Perform data processing time of the peanut peeling process before and after the design to determine the increase in productivity after the design.

After the data on the anthropometric measurements of the operator's body dimensions are collected, the next step is to design according to these data. The next stage is to test the results of the design carried out on the peanut peeling activity of the residents of Wukirsari hamlet, Baleharjo village, Wonosari sub-district, Gunungkidul district. At the test stage of the design results, measurements of worker productivity after the design are carried out. In this design test, the Standardized Nordic Questionnaire (SNQ) method is also used to determine the feasibility of the design[8].

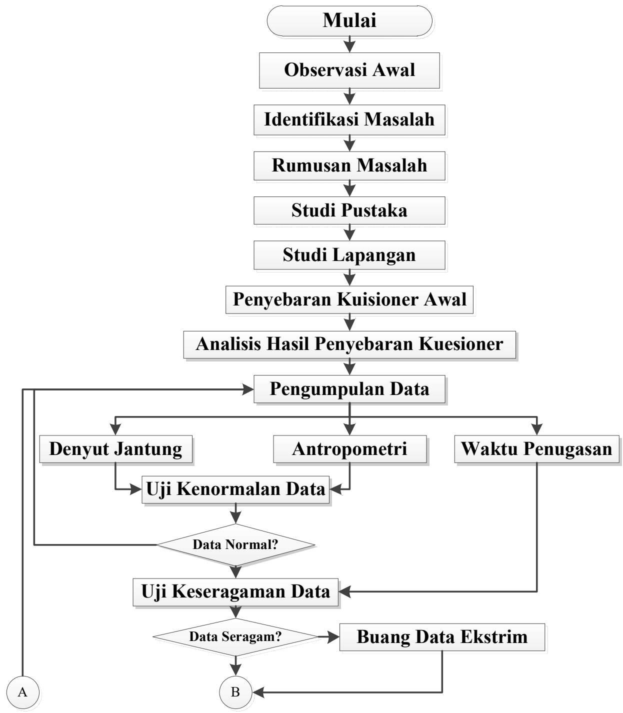

Figure 2. Troubleshooting Flowchat

RESULTS AND DISCUSSION

Questionnaire data were taken from peanut peeling operators with 5 employees.

Table 1. Results of Questionnaire Answers

No	Complaint Type	Questionnaire Answer Amount			
		Uncomfortable	%	Comfortable	%
1	Back	4	17	1	50
2	Waist	4	17	1	50
3	Arms	5	22	0	0
4	Wrist	5	22	0	0
5	Elbow	5	22	0	0
	Total	23	100	2	100

Heart rate data is obtained from the measurement results with a digital pulse meter when the operator has not done work and after completing the work. Heart rate data is taken from one operator or worker with average ability or skill. The heart rate data before and after work can be seen in table 2 below:

Table 2. Heart Rate Data before Design

No.	Heart Rate (Pulse/minute)		No.	Heart Rate (Pulse/minute)	
	Before work	After work		Before work	After work
1.	75	99	16.	74	98
2.	73	98	17.	73	96
3.	74	96	18.	72	99
4.	75	98	19.	74	97
5.	73	100	20.	73	96
6.	72	97	21.	75	98
7.	74	98	22.	73	97

8.	75	96	23.	72	99
9.	73	99	24.	74	98
10.	74	97	25.	75	96
11.	75	100	26.	73	98
12.	74	98	27.	72	96
13.	74	99	28.	74	99
14.	73	96	29.	75	97
15.	72	97	30.	73	98

Data collection was carried out using a stopwatch because the type of work carried out was continuous. The measurement data can be seen in table 3 below:

Table 3. Data of Peanut Peeling Time before Design

No.	Time (second/3 kg)	No.	Time (second/3 kg)	No.	Time (second/3 kg)
1.	270	11.	269	21.	268
2.	268	12.	268	22.	268
3.	268	13.	268	23.	268
4.	269	14.	269	24.	269
5.	268	15.	269	25.	270
6.	270	16.	270	26.	268
7.	268	17.	268	27.	269
8.	269	18.	269	28.	268
9.	270	19.	269	29.	270
10.	270	20.	268	30.	269
		TOTAL			8064

Anthropometric data is the data needed in determining the measurements in the design so that the design results will be in accordance with the dimensions of the worker's body size. The anthropometric data needed in the design can be seen in table 4 below:

Table 4. Anthropometric Data for Design

No	Anthropometric Size	Symbol	Basic Measurements carried out
1.	Waist Height	tp	Measured from the waist to the bottom of the foot
2.	Body Width	Lt	This measurement is taken from the outermost right arm to the outermost left arm
3.	Popliteal Height	Tpo	Measured from the bottom of the foot buttocks

The anthropometric data from the measurements used in determining the size of the furniture design can be seen in table 5 below:

Table 5. Anthropometric Data Measurement Results

No	Anthropometric Data (cm)			No	Anthropometric Data (cm)		
	tp	Lt	Tpo		tp	Lt	Tpo
1.	90	47	75	**16.**	93	47	77
2.	90	48	76	**17.**	93	48	75
3.	91	47	77	**18.**	93	48	75
4.	92	47	77	**19.**	90	47	76
5.	92	47	76	**20.**	93	46	75
6.	93	46	76	**21.**	89	46	76
7.	94	47	76	**22.**	89	46	74
8.	92	48	75	**23.**	94	48	75
9.	92	45	76	**24.**	91	47	76
10.	89	45	74	**25.**	93	47	76

11.	89	45	76	**26.**	93	48	75
12.	92	45	76	**27.**	93	48	77
13.	92	46	75	**28.**	91	47	76
14.	93	46	74	**29.**	90	46	75
15.	89	45	75	**30.**	91	47	76
		TOTAL			2745	1400	2268

From the results of the heart rate normality test before work, it can be seen that the significance value is 0.25, because the significance value is > 0.05, it can be concluded that the data is normally distributed. Calculation of uniformity of data on heart rate measurements before work obtained upper control limit (BKA) = 75.68 and lower control limit (BKB) = 71.52 which means the data is uniform. From the calculation results obtained N' = 1 while N = 30 then the data adequacy test on heart rate before work is stated N'< N then the data is sufficient.

From the results of the heart rate normality test after work, it can be seen that the significance value is 0.512, because the significance value is > 0.05, it can be concluded that the data is normally distributed. Calculation of uniformity of data on heart rate measurement after work obtained upper control limit (BKA) = 100.97 and lower control limit (BKB) = 94.59 which means the data is uniform. From the calculation results obtained N' = 1 while N = 30 then the data adequacy test on heart rate after work is stated N'< N then the data is sufficient.

After the heart rate data is sufficient for data processing, the next step is to calculate oxygen consumption and energy consumption before designing. Calculation of oxygen consumption is done by interpolation based on the table of the relationship between metabolism, respiration, energy expenditure and heart rate as a medium for measuring workload. The calculation of oxygen consumption and energy consumption before design can be seen in table 6 below:

Table 6. Oxygen Consumption and Energy Consumption before Design

No	Heart Rate (pulses/minute)	Before work		No	Heart Rate (pulses/minute)	After work	
		Oxygen Consumption (liter/minute)	Energy Consumption (Kcal)			Oxygen Consumption (liter/minute)	Energy Consumption (Kcal)
1.	75	0.50	2.40	1.	99	0.94	4.70
2.	73	0.46	2.21	2.	98	0.96	4.61
3.	74	0.48	2.30	3.	96	0.92	4.42
4.	75	0.50	2.40	4.	98	0.96	4.61
5.	73	0.46	2.21	5.	100	1	4.80
6.	72	0.44	2.11	6.	97	0.94	4.51
7.	74	0.48	2.30	7.	98	0.96	4.61
8.	75	0.50	2.40	8.	96	0.92	4.42
9.	73	0.46	2.21	9.	99	0.98	4.70
10.	74	0.48	2.30	10.	97	0.94	4.51
11.	75	0.50	2.40	11.	100	1	4.80
12.	74	0.48	2.30	12.	98	0.96	4.61
13.	74	0.48	2.30	13.	99	0.98	4.70
14.	73	0.46	2.21	14.	96	0.92	4.42
15.	72	0.44	2.11	15.	97	0.94	4.51
16.	74	0.48	2.30	16.	98	0.96	4.61
17.	73	0.46	2.21	17.	96	0.92	4.42
18.	72	0.44	2.11	18.	99	0.98	4.70
19.	74	0.48	2.30	19.	97	0.94	4.51
20.	73	0.46	2.21	20.	96	0.92	4.42
21.	75	0.50	2.40	21.	98	0.96	4.61
22.	73	0.46	2.21	22.	97	0.94	4.51
23.	72	0.44	2.11	23.	99	0.98	4.70

24.	74	0.48	2.30	24.	98	0.96	4.61
25.	75	0.50	2.40	25.	96	0.92	4.42
26.	73	0.46	2.21	26.	98	0.96	4.61
27.	72	0.44	2.11	27.	96	0.92	4.42
28.	74	0.48	2.30	28.	99	0.98	4.70
29.	75	0.50	2.40	29.	97	0.94	4.51
30.	73	0.46	2.21	30.	98	0.96	4.61
□	**2208**	**14.16**	**67.94**	□	**2930**	**28.56**	**137.29**
X	**73.6**	**0.48**	**2.26**	**X**	**97.7**	**0.95**	**4.58**

Calculation of the uniformity of the peanut stripping time data before the design obtained the upper control limit (BKA) = 270.8 and the lower control limit (BKB) = 266.8 which means the data is uniform.

From the calculation results obtained N' = 22.2 while N = 30 then the data adequacy test on the heart rate before work is stated N'< N then the data is sufficient. After the anthropometric data is obtained, the next step is to test the uniformity and adequacy of the data. The data uniformity test has the aim that the data that we will use are within the predetermined control limits so that if there is data that exceeds the control limits, the data is discarded and not used in calculations because it has extreme values. The data adequacy test aims to ensure that the data used is sufficient so that the data can be processed at a later stage. The next stage is to determine the upper control limit (BKA) and lower control limit (BKB) for waist height measurement data using a 95% confidence level and 5% accuracy degree where the index value (k) based on a confidence level of 2 is: Upper Control Limit (BKA) and Lower Control Limit (BKB). Calculation of uniformity of waist height measurement data obtained upper control limit (BKA) = 97.5 and lower control limit (BKB) = 85.5 which means the data is uniform. From the calculation results obtained N' = 0.5 while N = 30 then the data adequacy test on heart rate before work is stated N'< N then the data is sufficient. Calculation of uniformity of waist height measurement data obtained upper control limit (BKA) = 97.5 and lower control limit (BKB) = 85.5 which means the data is uniform. From the calculation results obtained N' = 0.5 while N = 30 then the data adequacy test on heart rate before work is stated N'< N then the data is sufficient. Calculation of uniformity of waist height measurement data obtained upper control limit (BKA) = 97.5 and lower control limit (BKB) = 85.5 which means the data is uniform. From the calculation results obtained N' = 0.5 while N = 30 then the data adequacy test on heart rate before work is stated N'< N then the data is sufficient.

Calculation of uniformity of body width measurement data obtained upper control limit (BKA) = 51 and lower control limit (BKB) = 44.8 which means the data is uniform. From the calculation results obtained N' = 1 while N = 30 then the data adequacy test on heart rate before work is stated N'< N then the data is sufficient.

The calculation of the uniformity of the popliteal height measurement data obtained that the upper control limit (BKA) = 77.6 and the lower control limit (BKB) = 73.6, which means the data is uniform. From the calculation results obtained N' = 0.2 while N = 30 then the data adequacy test on the heart rate before work is stated N'< N then the data is sufficient.

Table 7. Calculation of Anthropometric Data Uniformity Test

No.	Measurement	Symbol	X	□	BKA	BKB	Description
1	Waist Height	tp	91.5	2.6	97.5	85.5	Uniform Data
2	Body Width	Lt	46.6	1.2	49	44.2	Uniform Data
3	Poplitel height	tpo	75.6	0.7	77.6	73.6	Uniform Data

Table 8. Calculation of Anthropometric Data Adequacy Test

No.	Measurement	Symbol	N	N'	Description
1	Peanut stripping time before designing	Wp	30	22.2	Enough Data
2	Waist Height	tp	30	2	Enough Data

3	Body Width	Lt	30	1	Enough Data
4	Popliteal Height	Tpo	30	0.2	Enough Data

The percentile measures used in this study were the 5th percentile size, 50th percentile size mean and the 95th percentile size large percentile. The percentile size is used so that the size used in the design can cover the human population who will use the product design results with dimensions that are the same or smaller than the percentile size.

Table 9. Percentile Calculation

No.	Measurement	Symbol	percentile		
			5-th	50-th	95-th
1	Waist Height	tp	87.2	91.5	95.8
2	Body Width	Lt	44.63	46.64	48.57
3	Poplitel height	tpo	74.45	75.6	76.75

The size of the peanut peeler machine can be seen in the following table:

Table 10. Size of Peanut Peeler

No.	Machine Parts	Size(cm)
1	Machine height	91.5
2	Chimney length	48.57
3	Machine axle height	75.6

If the operator is used to using the new work facility, further measurements can be made as research data. The time data for the stripping process of learning conditions can be seen in table 11 below:

Table 11. Data on Processing Time for Stripping Learning Conditions

No.	Time (second /3 kg)	No.	Time (second /3 kg)	No.	Time (second /3 kg)	No.	Time (seconds /3kg)	No.	Time (seconds/3 kg)
1.	79	11.	78	21.	78	31.	77	41.	75
2.	79	12.	76	22.	78	32.	77	42.	76
3.	78	13.	79	23.	77	33.	77	43.	76
4.	77	14.	78	24.	78	34.	76	44.	75
5.	78	15.	76	25.	76	35.	76	45.	76
6.	76	16.	79	26.	75	36.	77	46.	75
7.	76	17.	76	27.	78	37.	77	47.	76
8.	77	18.	78	28.	79	38.	76	48.	77
9.	77	19.	77	29.	78	39.	76	49.	76
10.	77	20.	76	30.	78	40.	77	50.	76

Calculation of uniformity of data on heart rate measurement before work obtained upper control limit (BKA) = 77 and lower control limit (BKB) = 72.6 which means the data is uniform. From the calculation results obtained N' = 1 while N = 30 then the data adequacy test on heart rate before work is stated N'< N then the data is sufficient. Calculation of uniformity of data on heart rate measurement after work obtained upper control limit (BKA) = 87.51 and lower control limit (BKB) = 82.35 which means the data is uniform. From the calculation results obtained N' = 1 while N = 30 then the data adequacy test on heart rate after work is stated N'< N then the data is sufficient. By looking at the standard time and standard output, we can see whether the operator's performance after the design has increased or not.

Discussion

From the results of data processing, a work facility design was carried out in the form of a peanut peeler machine where the size used was anthropometric data of the operator's body dimensions. From the results of the design, the original machine was too high, making it difficult for the operator to insert peanuts into the chimney and in turning the axle, the machine was still using hands with a work intensity of 7 hours of work and judging from the ergonomics aspect, the work position was not ergonomic.

Table 12. Comparison of Average Oxygen Consumption and Energy Consumption before and after Design

No.	Description	Before Design		After Design	
		Before work	After work	Before work	After work
1	Oxygen Consumption (Liters/minute)	0.48	0.98	0.50	0.7
2	Energy Consumption (Kcal/minute)	2.26	4.58	2.31	3.7

Based on table 12 the average energy consumption required by an operator before work and before the design is carried out is 2.26 Kcal and after work is 4.58 Kcal. This means that the energy expended before working is 2.26 Kcal and the energy expended after working is 4.58 Kcal. Meanwhile, after the design, the average energy consumption before working is 2.31 Kcal and after work is 3.7 Kcal. This means that the energy expended when not doing work is 2.31 Kcal and the energy expended after doing work is 3.7 Kcal. So by using a peanut peeler after designing the operator can save energy as much as 0.88 Kcal/minute and oxygen as much as 0.

The standard time of the peanut peeling process before the design is 6.11minutes/3 kg and the standard output is 29.5kg/hour. The standard time for peeling peanuts after the design is 1.68 minutes/3 kg and the standard output is 107.15 kg/hour.

From the results of data processing, before the design is carried out, the standard time and standard output are 0.102 hours/3 kg and the standard output is 29.5 kg/hour or 206.5 kg/day. While the standard time and standard output produced in the conditions after the design is 0.028 hours/3 kg with a standard output of 107.15 kg/hour or 750.05 kg/day. From these results, there was an increase in the completion time of 77.65 kg/hour or 543.55 kg/day. So there is an increase in the number of standard output by 263%. The main difference lies in several things, as shown in table 13 below.

Table 13. Differences in analysis between manual stripping machines and design results.

differentiator	Start engine	Design machine
Work system	Manual	Equipped with tools in the form of a dynamo/motor drive
Procedure	The tool is moved by hand so it requires a lot of energy.	Works automatically
Processing time	Long	Fast
Operator position	Workers have to tiptoe because the peeler is taller.	Normal standing
Raw material	Teak wood	Teak wood and drive
Productivity	0.102 hours / 3 kg	0.028 hours/3 kg

The designed peanut peeler is equipped with an auxiliary tool in the form of a driving machine/motor so that in the production process it uses electric power. In the production process the cost of workers is ignored because they work on their own without outside workers.

CONCLUSION

Based on the results of research and calculations, the following conclusions can be drawn: With the application of human body size anthropometry in designing a peanut peeler machine, it turns out that it can have an effect in changing the working position of the operator who was originally standing on tiptoe to insert peanuts because the chimney mouth is too high, it becomes easy because the machine is shortened according to the operator's waist height. This shows that working with the work position after the design can reduce the discomfort experienced by the operator. By changing the engine crank to electric motor power, the peanut peeling target is optimal. This shows that the peanut peeler machine after the design is very helpful in meeting the target. Calculation of energy consumption after working in conditions before design is 4.58 Kcal/minute, while energy consumption after working in conditions after design is 3.7 Kcal/minute. This shows that there is a decrease in the level of energy consumption by 0.88 Kcal/minute. The reduced level of energy consumption that occurs in conditions after design means that work with position work after the design can reduce the fatigue experienced by the operator. In conditions after the design can affect the standard time and standard output. In the conditions before the design, the standard time was 6.11 minutes/3 kg and the standard output was 29.5 kg/hour. While the standard time in the conditions after the design is 1.68 minutes/3 kg and the standard output is 107.15 kg/hour. This means that there is an increase of 77.65 kg/hour. Improvement of the operator's work position can increase the standard output so that there is an increase in work productivity by 263%.

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