http://jurnal.yudharta.ac.id/v2/index.php/jkie

Journal Knowledge Industrial Engineering

E-ISSN: 2541-4461 | P-ISSN: 2460-0113

Optimization of Increasing Productivity Making Onion Crackers with Ergonomic Discipline Approach

Mujiono[a], Sujianto[b]

[a] Department of Industrial Engineering, Institut Technologi National, Malang, Indonesia

[b] Department of Eletrical Engineering, Institut Technologi National, Malang, Indonesia

Corresponding Autor: jiono1864@gmail.com

Article Info

Article history

Received : November 17, 2021

Revised : November 28, 2021

Accepted : December 14, 2021

Published : December 27, 2021

Keywords:

Productivity;

Tool Design;

Ergonomics.

A B S T R A C T

The results of observations made by the research team at MSME (Micro, Small and medium Enterprises) of onion crackers in the cracker cutting section found that for cutting they still use manual tools, namely knives by bending the cutting method so they get tired easily, take a long time and the results are not homogeneous so the results are less optimal. Optimal is meant to be efficient and effective at the available resources, in order to get as much profit as possible by keeping costs as low as possible, by designing an ergonomic cracker cutter. The purpose of designing ergonomic tools in question is the design of tools that produce a work system using anthropometric measurements. In this case, the solution that can be done is to design a tool for cutting crackers using anthropometric measurements with the results: tool height 102.5 cm, tool length 52.9 cm, tool width 51.8 cm, and machine handle diameter length of 2.5 cm. From the calculation results, the results obtained if using the old tool the standard output is 3 kg/hour, whereas if using the new tool the standard output is 9.18 kg/hour, so that the productivity is 206%.

DOI: https://doi.org/10.35891/jkie.v8i3.2753

1. Introduction

The location of this research was carried out in the UMKM (Micro, Small and Medium Enterprises) of onion crackers in the village of Jedong, Wagir sub-district, Malang Regency. This research was conducted in one cutting section and drying section, in the cutting section not to use manual tools, namely using a knife by cutting where the results are still homogeneous, while workers get tired easily because they are not ergonomic and not productive or less than optimal. Optimal is meant to be efficient and effective in the resources owned in order to obtain as much profit as possible by keeping costs as low as possible, by designing ergonomic tools (Das, 2016).

Based on the problems above, the specific goal of the research team is to design an optimal cracker cutting tool with an ergonomic approach, which is to be more effective, efficient, safe and comfortable for operators who use it and can increase productivity for the company (Wigjosoebroto, 2003). Because in reality there are still many UMKM whose productivity is still low. While in Higher Education, there are many ways or techniques to increase productivity, especially in the Industrial Engineering Study Program. So it is unfortunate if it is still underutilized by UMKM.

The urgency of this research is that SMEs still use manual tools for cutting crackers. Meanwhile, in this research, crackers cutting tools will be made with an ergonomic approach. Specifications: 4x4 angled steel frame with a thickness of 4mm (SNI), cylinder side cup 1.5 mm thick, number of blades 1pcs, knock down knife system, steel knife, homogeneous smooth cuts, Honda engine type, using anthropometric measurements (elbow height, side arm reach, forward hand reach, grip diameter).

2. Literature Review

Design functions become more important in defining the physical shape of the product to meet customer needs (Del Rio Vilas, 2013). Aspects Affecting the Design of work facilities can be influenced by several aspects originating from various disciplines of existing expertise (Wigjosoebroto, 2003).

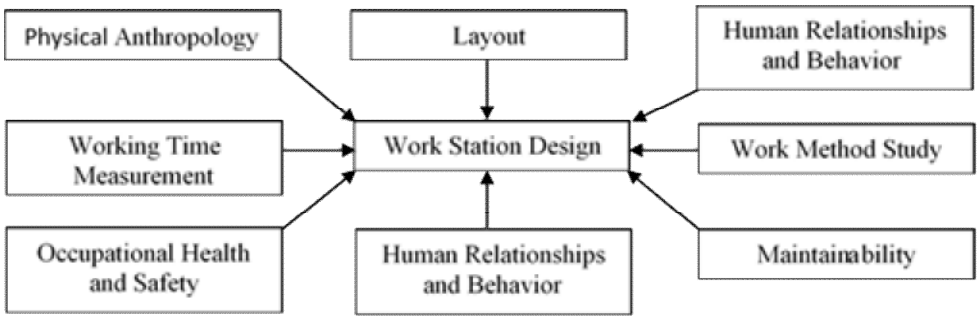


Figure 1. Schematic of Aspects that affect work facilities

Design Criteria is the application of creativity to formulate and provide a solution to a problem, or provide a solution that has been solved in a different way. Criteria for the design of crackers cutting tools are as follows:

a. The construction of the tool to be designed is simple.
b. Easy to operate and the treatment.
c. Uncomplicated design.
d. Ease of operation of the operator.
e. Effective and efficient energy and time.
f. High work productivity

Ergonomics

Ergonomics which consists of the word ergos which means work and nomos which means natural law. Basically ergonomics is a systematic branch of science to utilize information about the nature, capabilities and limitations of humans to design a work system. So that people can live and work on the system well, namely to achieve the desired goals through the work effectively, efficiently, safely and comfortably (Das, 2016). In designing an ergonomic work system, there are five design principles that need to be considered (Wigjosoebroto, 2003).

- Making machines adapted to humans.
- Minimize presentations that are out of design.
- A balanced work design, as well as the reduced use of physical and less procedural matters.
- Emphasize the importance of communication.
- Using machines to increase human abilities.

The main regarding the discipline of ergonomics, as follow (Hardianto, 2014):

1. Ergonomics approach will be able to lead to “functional effectiveness” and enjoyment of the use of the equipment, fasilities and work environment designed.

2. The ergonomics discipline approach is directed at the efforts to improve human work performance such as increasing work safe, reducing, excessive energy, getting tired quickly and minimizing tool damage.
3. The design of equipment, facilities and work environments used relate to the anatomy (structure), physiology (work) and anthropometry (size) of the human body.

To get a good work station, one of them applies the principles of ergonomics and economics of movement divided into three types of discussion (Yanto, 2017).

- The economic principle of movement is related to the limbs.
- The principles of movement economy are linked to workplace arrangements.
- The principle of the economy of movement is related to the design of the equipment.

Ergonomics goals and benefits

Innovative and creative thoughts about an appropriate technology (TTG), namely the manufacture of an ergonomic cracker cutter. Cutting, which is still using ordinary tools, namely by using a knife to slice or cut so that accidents often occur in this cutting. The purpose of the application of this tool ergonomically are (Supranto, 2001):

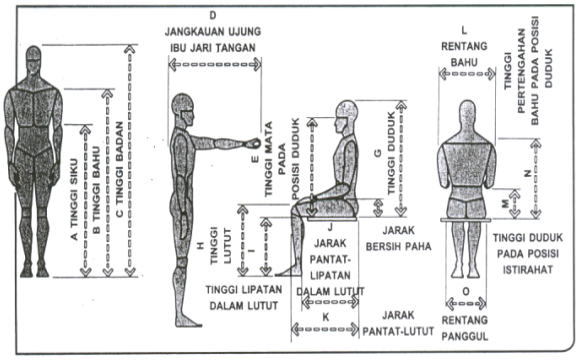
1. Design a cracker cutting tool with ergonomic considerations, using anthropometric measurements.
2. Assisting crackers entrepreneurs so that cutting can be done safely and comfortably to reduce accidents that often occur.
3. In order to shorten the cutting time
4. Can increase productivity

The benefits expected in doing this design are:

1. Assist the manufacture of crackers in designing cutting tools that can be done easily and efficiently and, can produce in large quantities and the size can be homogeneous.
2. The results of the design can be used.
3. To increase cutting productivity.
4. Can be used to consider expand business UMKM.

Anthropometri

Anthropometri relating to measurements of the human body, which are used to determine differences (characteristics or characteristics) in individuals, groups and so on. In connection with the measurement of certain shapes and, anthropometry can also be defined as a science that is specifically related to the investigation which is used to determine differences in individuals and groups. This measurement is of course in accordance with the planning of the work tool. Anthropometric data used for the design of this tool are as follows (Mujiono, 2020):



Data anthropometric data used is anthropometric data that will determine the exact shape, size and dimensions associated with the product from the largest population that will use the design product. In general, 90% - 95% of the target population in the group using a product must be able to

use it properly.

1. Data Uniformity
   The data uniformity test was carried out to obtain uniform data within the control limits. The steps for testing the uniformity of the deviation data are (Nurnianto, 2014):
   Determine the average price of the data:

$$\bar{x} = \frac{\sum x_i}{N}$$

2. Determine the standard deviation:
   for:

$$N < 30 \quad \Rightarrow SD = \sqrt{\frac{N(\sum x^2{}_i) - (\sum x_i)^2}{N(N-1)}} \quad N > 30 \quad \Rightarrow \sigma = \sqrt{\frac{\sum (x_i - \bar{x})^2}{N-1}}$$

3. Determine the Upper Control Limit (BKA) and Lower Control Limit (BKB) using the formula (Mujiono, 2019).

$$N > 30 \quad \Rightarrow BKA = \bar{x} + k \times \sigma$$

$$N > 30 \quad \Rightarrow BKB = \bar{x} - k \times \sigma$$

$k = 95\% = 2$

σ = Standard deviation

k = level of confidence

4. Standard Time:

$$W_n = W_s \times P$$

$$W_b = W_n \times \frac{100\%}{100\% - allownce(\%)}$$

5. Standard Output (Mujiono, 2016) :

$$O_s = \frac{1}{W_b}$$

Dimana :

O_s = Output Standart W_n = Normal time

W_b = Standard time W_s = Cycle time

3. Methodology

In this study, ISO 9001:2015 clause 6.1 used as a requirement to find gaps from the company's actual conditions. The form in this research is based on ISO 31000:2018, which contains six points.

4. Results and Discussion

Using old tools the performance used is based on observations from the operator's activities, the performance is:

Skill	: Good (C_1)	: + 0.06
Effort	: Good (C_1)	: + 0.05
Condition	: Everange	: 0.00
Consistency	: Everange	:0.00+

Po : 0.11
So the amount of Performance (P)
= 1 + Po
= 1 + 0.11
= 1.11

While the Allowance provided by the operator is: Personal Needs = 2%
Influential factors
Power expended (medium) =19%
Work attitude (standing) =1%
Work movement (normal) =1%
Atmosphere (enough) =6 %
=29 %

Next, the Cycle Time is calculated (Ws),
Ws =12.5 menit
Amount of normal time (Wn):

$$Wn = Ws \times P$$
$$= 12.5 \times 1.11$$
$$= 13.87\ menit/kg$$

The standard time (Wb):

$$Wb = Wn \times \frac{100\ \%}{100\ \% - Allowance\ \%}$$
$$= 13.87 \times \frac{100\ \%}{100\ \% - 29\ \%}$$
$$= 13.87 \times \frac{100}{71}$$
$$= 13.87 \times 1.41 = 19.55\ menit/kg$$

Then the standard output (Os):

$$Os = \frac{1}{Wb} = \frac{1}{19.55}$$
$$= 0.05\ kg/menit$$
$$= 3\ kg/\ jam$$

By using the new tool, the Ws cycle time is obtained by: 4.17 minutes/kg. The performance used is based on observations from the operator's activities, the performance is:

Skill : Good (C_1) : + 0.06
Effort : Good (C_1) : + 0.05
Condition : Everange : 0.00
Consistency : Everange : 0.00 +
Po : 0.11
The amount of performance (P)
= 1 + Po
= 1 + 0.11
= 1.11

While the Allowance provided by the operator is: Personal Needs = 2%
Influential factors
Power expended (medium) =19%
Work attitude (standing) =1%
Work movement (normal) =1%

Atmosphere (enough) =6 %
=29 %

Next, the Cycle Time is calculated (Ws),

$Ws = 4.17\ menit\ /kg$

Amount of normal time (Wn):

$$Wn = Ws \times P$$
$$= 4.17 \times 1.11$$
$$= 4.63\ menit / kg$$

The standard time (Wb):

$$Wb = Wn \times \frac{100\ \%}{100\ \% - Allowance\ \%}$$
$$= 4.63 \times \frac{100\ \%}{100\ \% - 29\ \%}$$
$$= 4.63 \times \frac{100}{71}$$
$$= 4.63 \times 1.41 = 6.53\ menit / kg$$

Then the standard output (Os):

$$Os = \frac{1}{Wb} = \frac{1}{6.53}$$
$$= 0.153\ kg / menit$$
$$= 9.18\ kg / jam$$

With productivity of =

$$\frac{Os\ baru - Os\ lama}{Os\ lama} = \frac{9.18 - 3}{3} = 206\ \%$$

Figure 2. Tool Design Result from above

Figure 3. Homogeneous cutting tool test

Table 1. Calculating of Data Sufficiency Test

Data Type	N	N'	If N' > N → enough data	Conclusion
Elbow Height	40	2.57	2.57 < 30	Enough data
Handheld	40	21.25	21.25 < 30	Enough data
Side Reach	40	2.16	2.16 < 30	Enough data
Forward Reach	40	8.29	8.29 < 30	Enough data

Table 2. Data Uniformity Test

Data Type	N	σ	BKA	$\bar{X}$	BKB	Conclusion
Elbow Height	40	4.14	111.58 cm	103.3	95.02 cm	uniform data
Handheld	40	0.4	3.75 cm	2.95	2.15 cm	uniform data
Side Reach	40	2.36	69.12 cm	64.4	59.68 cm	uniform data
Forward Reach	40	3.73	59.33 cm	51.87	44.41 cm	uniform data

Table 3. Normal Distribution

Data Type	X_{count}	X_{table}	If $X_{count} < X_{table}$	Conclusion
Elbow Height	2.30	9.49	2.30 < 9.49	Normal distribution
Handheld	3.56	9.49	3.56 < 9.49	Normal distribution
Side Reach	7.30	9.49	7.30 < 9.49	Normal distribution
Forward Reach	1.53	9.49	1.53 < 9.49	Normal distribution

Table 4. The size percentile data used for the design

Data Type	Percentile 5%	Percentile 50%	Percentile 95%
Elbow Height		102.5 cm	
Handheld	2.5 cm		
Side Reach	52.9 cm		
Forward Reach		51.8 cm	

5. Conclusion

From the results of the analysis above, it can be concluded as working facilities to determine the time of slicing/cutting crackers the design of a tool that produces a work system using anthropometric measurements, anthropometric measurements used are: Elbow height when standing with 50% percentile of 102.5 cm, forward arm reach with 50% percentile of 51.8 cm, side reach of hand with 5% percentile of 52.9 cm, hand grip with 5% percentile of 2.5 cm, and mean while, from the analysis, the standard output of the old equipment is 3 kg / hour, while with the new tool, the standard output is 9.18 kg / hour so that the productivity is 206%

References

Alamoudi, M., Travascio, F., Onar-Thomas, A., Eltoukly, M., 2018. The effects of different carrying methods on locomotion stability, gait spatio-temporal parameters and spinal stresses. Int. J. Ind. Ergon. 67, 81–88.

Allen, J., 2007. Photoplethsmography and its application in clinical physiological measurement. Physiol. Meas. 28 (3), R1–R39

Birrell, S.A., Hooper, R.H., 2007. Initial subjective load carriage injury data collected with interviews and questionnaires. Mil. Med. 172 (3), 306–311.

Birrell, S.A., Hooper, R.H., Haslam, R.A., 2007. The effect of military load carriage on ground reaction forces. Gait Posture 26 (4), 611–614.

Carstairs, G.L., Ham, D.J., Savage, R.J., Best, S.A., Beck, B., Billing, D.C., 2018. A method for developing organisation-wide manual handling based physical employment standards in a military context. J. Sci. Med. Sport 21 (11), 1162–1167.

Cook, G., Burton, L., Hoogenboom, B.J., Voight, M., 2014. Functional movement screening: the use of fundamental movements as an assessment of function-part 2. Int J Sports Phys Ther 9 (4), 549–563.

Corkill, G., Lieberman, J.S., Taylor, R.G., 1980. Pack palsy in backpackers. West. J. Med. 132 (6), 569–572

Das B, Sengupta A.K. 2016. Industrial Workstation design : a. Systematic ergonomics approach, Applied Ergonomics, Vol 27, No.3,157-163. http://dx.doi.org/10.1016/003-6870(96)00008-7.

Del Rio Vilas. D, Longo F, Monteil N.R 2013. A General themanufacturing workstation design optimization : a. Combined ergonomics and operational approach,simulation,Vol. 89, No. 3, 306-329. http://dx.doi.org/10.1177/0037549712462862.

Fauzi, A., Mas'ud, M. I. (2019). Proses Manufaktur pada Mesin Primer dan Sekunder CV. Karunia Menggunakan Metode Linier Programming. Journal Knowledge Industrial Engineering(JKIE), 6(2), 59–65.https://doi.org/10.35891/jkie.v6i2.2055

Hanik, U., & Mas'ud, M. I. (2019). Perencanaan Inovasi Pengembangan Agrowisata Bukit Flora Dengan Pendekatan Metode Bisnis Model Kanvas. JKIE (Journal Knowledge Industrial Engineering), 6(3), 81–90.

Hardianto,2014, Ergonomi Suatu Pengantar, PT. Remaja Rosdakarya.

Junaedi, D., Mas'ud, M. I. (2018). Penerapan Metode Forecasting dalam Perencanaan Produksi Bakpia dengan Menggunakan Software POM Guna Memenuhi Permintaan Konsumen. Journal Knowledge Industrial Engineering (JKIE), 5(3), 121–128. https://doi.org/10.35891/jkie.v5i3.2042

Mujiono, 2016, Perbaikan sarana kerja untuk perontok jagung dengan kaidah ergonomi, Vol 6, No.2, Jurnal Inovatif, ITN Malang.

Mujiono. 2019. Desain alat perajang rumput gajah dengan kaidah ergonomi. Jurnal Industri Inovatif , ITN Malang.

Mujiono, 2020, Optimal Milk Disposal Equipment Design in Bottle With Ergonomics Approach, Vol. 1, No. 2, Journal of Sustainable Technology and Applied Science (JSTAS) ITN Malang.

Nurmianto, Eko. Ergonomi Studi Gerak dan Waktu, 2014. ITS Guna Widya Surabaya.

Silder, A., Delp, S.L., Besier, T., 2013. Men and women adopt similar walking mechanics and muscle activation patterns during load carriage. J. Biomech. 46 (14), 2522–2528.

Simpson, K., Munro, B., Steele, J., 2012. Does load position affect gait and subjective responses of females during load carriage? Appl. Ergon. 43 (3), 479–485.

Supranto, J .2001. Statistik Teori dan Aplikasi, Edisi Keenam. Erlangga,Jakarta.

Takai, S., Dohno, H., Watanabe, Y., Yoshino, N., Ogura, T., Hirasawa, Y., 2002. In situ strain and stress of nerve conduction blocking in the brachial plexus. J. Orthop. Res. 20, 1311–1314.

Wigjosoebroto, Sritomo. 2003. Ergonomi, Studi Gerak Dan Waktu, Edisi Pertama, cetakan kedua.

Yanto, Billy Ngaliman 2017, Ergonomi Dasar-Dasar Studi Waktu dan Gerakan untuk Analisis dan Perbaikan Sistem Kerja, CV Andi.