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Ergonomic Design Of Hand Sanitizer Dispenser Stand With Foot Pedal Model

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ABSTRACT

The COVID-19 pandemic that occurred in early 2020 until now is a new phenomenon in human life. Various sectors of life have been affected by the COVID-19 pandemic. To prevent the spread of the COVID-19 pandemic, the Government has made every effort, including appealing to avoid crowds, maintain distance, wear masks, limit mobility and diligently wash hands with water or hand sanitizer. Especially for the use of hand sanitizers placed in public places, tools are needed to place hand sanitizers that by the range of dimensions of the human body. So it is necessary to design a hand sanitizer stand by considering ergonomic aspects. Methods that have been used in this research was experimental with an ergonomic approach. The object of research is the design of a hand sanitizer dispenser stands with a foot pedal model by incorporating ergonomic aspects. The data collection procedure used is anthropometric data from the Javanese community. Then the anthropometric data were tested for normality, uniformity test, and data test. The design dimensions were obtained from percentile calculations based on anthropometric data. The results showed that the height of the bottle hand sanitizer stands was 91.73 cm; the hand sanitizer stand pedal width 13.67 cm; for the hand sanitizer stand, the pedal length is 24.32 cm.

INTRODUCTION

The World Health Organization (WHO) declared that coronavirus is a pandemic in January 2020. The spread of this deadly disease will be alarming at such a rapid growth rate around the world (Goh et al. 2020). The rate of spread and devastating effects of this virus is very quickly becoming an urgent call and concern for humans to reduce it (WHO 2021). The struggle against this covid pandemic is still long and efforts are needed from all parties. Until February 2, 2022, there are 223 countries in the world have experienced the COVID-19 pandemic, with the number of positively infected reaching approximately 388 million people and those who died reaching 5.71 million people. Meanwhile, in Indonesia, positive cases of Covid 19 reached 4.446.694 people, and 144.453 people died (Covid19 2022).

To prevent the spread of Covid-19 transmission, WHO and the Indonesian Ministry of Health have made several efforts to prevent the spread of COVID-19 through isolation, early detection, and basic

protection (Directorate General of P2P 2020). One of the basic efforts to avoid the spread of the COVID-19 virus is to wash your hands frequently with soap or hand sanitizer.

Hand sanitizer is a product in the form of a gel that contains an antiseptic which, if used, does not need to be rinsed with water. Its use is very effective to kill transient and resident flora compared to using water, using ordinary soap, or antiseptic soap (MOH 2013). Washing hands using a hand sanitizer can reduce the number of germs by 17.29 CFU/cm2, where the average decrease is 1.33 CFU/cm2 with an effectiveness of 60% (Cordita & Soleha, 2019).

Especially for the use of hand sanitizer, a tool is needed to place it, in the form of a hand sanitizer dispenser stand. Because during this Covid-19 pandemic what is needed is contactless technology to prevent and break the spread of the virus. One simple contactless technology is a hand sanitizer dispenser stand with the foot pedal. We can find a lot of hand sanitizer dispenser stands with foot pedals in the various public area around us. Usually, designs created in emergency scenarios during the COVID-19 pandemic require fast completion and development and are executed remotely. Whereat the beginning of this pandemic access was very limited. For example, workshops that were closed, laboratories were also closed (Moharir & Porwal, 2020). So that the convenience aspect in the design is neglected. Therefore, an alternative that can be used as a solution is to include ergonomic aspects in its design.

Ergonomics is a systematic branch of science to utilize information about the nature, capabilities, and limitations of human beings in designing a working system so that people can live and also work on a good system that is to achieve the desired goals by going through effective work, easiest, safe and comfortable (Ginting, 2010). The target of applying ergonomics is all workers, both in the traditional, modern, and informal sectors. In the traditional sector, it is generally done by hand and using tools, and workmanship can be improved ergonomically. In the modern sector, the application of ergonomics has entered in the form of attitudes, work procedures, and decent work planning, which is an essential condition for high work efficiency and productivity (Tawarka, 2010). Besides, Ergonomics emphasizes the human fit environment, minimizes fatigue, and discomfort through product design and development (Rahman et al., 2020). To obtain the element of comfort, anthropometric measurements are needed to be considered in designing and assisting in achieving a level of comfort (Taifa & Desai, 2017).

In an ergonomic product design, the concept of anthropometry must be applied. Anthropometry is the science of measurement and the art of application that establishes the physical geometry, mass properties, and strength capabilities of the human body. Some of the factors that influence anthropometric data variations are age, sex, ethnicity, and occupation. one method of collecting anthropometric data can be digital photography (Iridiastadi & Yassierli, 2019). Dimensions measured in anthropometry data retrieval must be adjusted to the product to be designed.

Some of the previous studies that have been carried out by Derisma et al. (2020) with the title Design and Implementation of Corona Virus Prevention Sterilization Tools for Health Workers at the Bungus Teluk Kabung Public Health Center, Padang. One of the results of this research is the design of the hand sanitizer to step on the pedal with the dimensions of the height of the hand sanitizer 123.2 cm and the height of the holder where the liquid hand sanitizer is 112.8 cm and the width of the pedal is 40 cm (Derisma et al., 2020). Meanwhile, another research was conducted by Hakim et al. (2021) with the title Design Sink and Automated Portal with Considering Anthropometry to Prevent COVID19 Transmission. The conclusion of the study is more discuss the use of automatic sensor tools in its design (Hakim et al., 2021). And the research was conducted by Candra Prilyanto with the title Hand Washing Tool Design With Simple Technology (Foot Pedal) in 2020. The research only discusses fluency the process of getting out of water and soap averages less than 2 times the footing (Prilyanto, 2020). Harshada S. Kadu et.al in 2021 conducted a study entitled an automatic hand sanitizer dispensing machine with the conclusion that the machine can not only dispense cleaning fluid automatically but can also measure body temperature, oxygen levels, and body pulse and there is a lightning alarm (Kadu et al., 2021). Then the research conducted by Arnab Das et.al in 2021 entitled Development of a Novel Design and Subsequent Fabrication of an Automated Touchless Hand Sanitizer Dispenser to Reduce the Spread of Contagious Diseases with research results in the form of an automated hand sanitizer dispenser system is a novel concept, and it is cost-effective compared to the conventional ones. The presented device is expected to play a key role in contactless hand disinfection in public places, and reduce the spread of

infectious diseases in society (Das et al., 2021).

Based on previous research that has been done, there is a study that considers the ergonomic aspect in its design, namely another research conducted by M Hanifuddin Hakim, but the ergonomic aspect is carried out on the automatic sink design. Meanwhile, research that has been done on the design of a hand sanitizer stand dispenser with a foot pedal has not found a design that incorporates ergonomic aspects into its design. Therefore, the research gap is to include ergonomic aspects in designing a hand sanitizer dispenser stand. So this research aims to design a hand sanitizer dispenser stand foot pedal model with an ergonomic aspect approach, to obtain a design that is by human characteristics as users.

RESEARCH METHOD

The method that has been used in this research is an experiment with an ergonomic approach in designing a hand sanitizer dispenser stand with a foot pedal. The data used in the design of this product is the anthropometric data of the Javanese people. Because this research was conducted in a university where the majority of the population is Javanese. Anthropometric data collection procedures were carried out by direct measurements (Mulyati et al., 2020). The research procedure is carried out in several stages of the procedure as follows:

a. Stage 1: Data Collections

Data collection in this study is in the form of anthropometry data. Anthropometry data is a measurement of body dimensions or characteristics other physical bodies are relevant to the design of what are worn people (Tawarka, 2004). Anthropometric data will determine the shape, size, and precise dimensions relating to the product being designed and the humans who will operate the product (Susanti et al., 2015). The anthropometry data used in this study were the height of the standing elbow, foot width, and foot length. The number of respondents who measured anthropometric data was 28 Javanese people. the number of respondents is sufficient to meet the requirements of the data adequacy test.

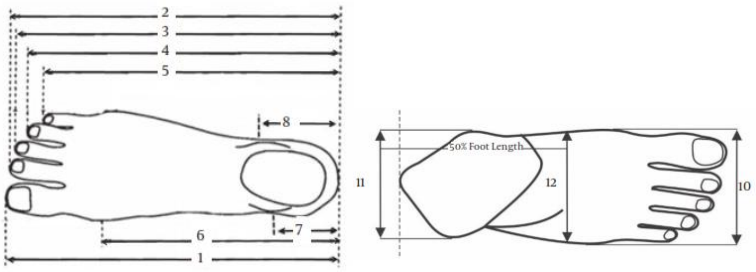

Figure 1. Foot dimensions measured (Hajaghazadeh et al., 2018)

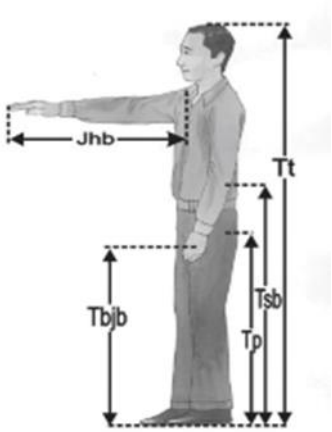

Figure 2. Body dimensions measured for standing position (Hari Purnomo, 2013)

b. Stage 2: Data Test

The first anthropometry data test aims to determine the normality of anthropometry data. The normality test is testing the data to see if residual values are normally distributed or not. Normally distributed data will minimize the possibility of the occurrence of bias. In this study, to determine normality data distribution using the Kolmogorov-Smirnov Test via SPSS 21 program for windows. What if the Asymp. Sig. something variable is greater than the level of significant 5% (> 0.050) then The variable is normally distributed, whereas if the value is Asymp. Sig. a variable is smaller than the level of significant 5% (<0.050) these variables are not normally distributed (Ghozali, 2018). The second data test is the uniformity test of the anthropometric data. Data uniformity testing is required to separate data that has different characteristics. While the third test is an anthropometry data adequacy test. Data adequacy tests are required to ensure that the data that has been collected is objectively sufficient. Ideally, measurements should be carried out in large quantities, even to an infinite number of measurement data so that the measurement results are feasible for use (Hari Purnomo, 2003). The formula used is as follows:

$$N` = \frac{\frac{k}{s}\sqrt{(N\sum X^2) - (\sum X^2)}}{\sum X^2} \quad (1)$$

c. Stage 3 : Percentile value Calculation

Anthropometric data used in the design will be presented in a percentile form. percentile is a picture that shows the number of parts of one-hundredth of people from a population who have a certain body size (smaller or larger). The percentile values used in this study were the percentile values for standing elbow height, foot width, and foot length. which percentile value will be used as a design dimension.

d. Stage 4 : The Dimension of Ergonomic Hand Sanitizer Dispenser Stand

The dimensions of the ergonomic hand sanitizer dispenser stand obtained after the percentile value of the anthropometry data of the standing elbow height, foot width, and foot length have been determined. The percentile values used are the 95th percentile, the 50th percentile, and the 5th percentile.

e. Stage 5 : Design

After the percentile data has been known, the next step was to start designing the hand sanitizer dispenser stand according to the percentile data for standing elbow height, foot width, and foot length. The materials used in this design include an iron plate for footsteps, hollow iron for the product frame,

PVC pipe as product frame cover.

RESULTS AND DISCUSSION

The measurement results of anthropometry data of the Java ethnic were presented in Table 1 below.

Table 1. The measurement results of anthropometry data of the Java ethnic

No	Standing Elbow Height (cm)	Foot Width (cm)	Foot Length (cm)
1	102	10	25
2	105	8	26
3	97	10	25
4	105	9	27
5	99	11	24
6	95	10	24
7	98	9	22
8	95	9	24
9	98	12	23
10	105	11	27
11	99	10	25
12	95	9	25
13	98	9	22
14	95	12	22
15	98	11	23
16	102	10	24
17	105	9	22
18	97	9	24
19	105	12	23
20	99	11	27
21	100	10	24
22	98	12	22
23	102	10	25
24	105	8	26
25	97	10	25
26	105	9	27
27	99	11	24
28	95	10	24

There were 28 (twenty-eight) measurement results from each anthropometric data. The data was taken by direct measurement to users of hand sanitizer dispenser stand in the environment of Universitas Muria Kudus, namely students with Javanese ethnic.

Anthropometry Data Normality Test

Anthropometry normality data test performed by Kolmogorov-Smirnov test on SPSS software. If Kolmogorov Calculates < Kolmogorov Table, then > the decision is normally distributed data. With an alpha value of 0.05 (Montororing, 2021).

Table 2. Data normality test result

Anthropometry Data	σ	$\overline{X}$	Sig.
Standing Elbow Height	3.658	99.75	.013
Foot Width	1.170	10.04	.012
Foot Length	1.611	24.32	.101

Table 2 above can be concluded that the results of the measurement of Standing Elbow Height, Foot Width, and Foot Length data are known to be Sig. > 0.05. So it can be interpreted that the anthropometric data is distributed normal or in other words that the data above has a distribution evenly distributed data that represents the population

Anthropometry Data Uniformity Test

This anthropometry data uniformity test is conducted using SPSS software. So, it will be known as upper Control Limit and lower control limit. Data is said to be uniform if it comes from the same reason system and is between the two control boundaries and is said to be not uniform if it comes from a different cause system and is outside the control limit (Sutalaksana, 2006). Table 3 below is the result of a uniformity test of anthropometry data using the help of SPSS software.

Table 3. Anthropometry data uniformity results

Anthropometry Data	$\overline{X}$	UCL	LCL
Standing Elbow Height	99,75	105	95
Foot Width	10,04	12	8
Foot Length	24,32	27	22

Because the average value of the anthropometry data standing elbow height between the upper dick boundary and the lower control limit. then the data is declared uniform. Similarly, in the anthropometry data the width of the soles of the feet and the length of the soles of the feet.

Anthropometry Data Adequacy Test

A data adequacy test is needed to ensure that the data that has been collected is objective enough. Ideally, measurements should be carried out in large numbers, even up to an unlimited number of measurement data so that the measurement results are feasible to use (Sutalaksana 2006). The data adequacy test is conducted to determine whether the data used is sufficient or not, namely N'<N. By using a 95% confidence level and 5% accuracy level, the results of the data adequacy test can be seen in Table 4 below:

Table 4. Anthropometry data adequacy test

Anthropometry Data	N	`N
Standing Elbow Height	28	2,07
Foot Width	28	20,98
Foot Length	28	6,76

Based on the table above, because all 'N values of all anthropometry data are smaller than the N value, then the data is considered sufficient.

Persentile value Calculation

A percentile value is a measure used to represent the population of an ergonomically designed user group. The percentile size used is 5th for small percentile size, 50th for average percentile size, and 95th for large percentile size. To be able to find out the size of the percentile can be calculated by using the following formula:

$$P_5 = \bar{x} - 1{,}645\,\sigma \quad \text{.....(2)}$$

$$P_{50} = \bar{x} \quad \text{.....(3)}$$

$$P_{95} = \bar{x} + 1{,}645\,\sigma \quad \text{.....(4)}$$

So by using the formula of percentile P5th, percentile 50th, and percentile 95th, obtained the value of percentiles as in Table 5 below:

Table 5. Percentile value

Anthropometry Data	Percentile (cm)		
	5-th	50-th	95-th

Standing Elbow Height	91,73	99,75	105,77
Foot Width	8,12	10,04	13,67
Foot Length	21,67	24,32	26,97

Dimensions Of Ergonomic Hand Sanitizer Dispenser Stand

In determining the size or dimensions of the ergonomic hand sanitizer dispenser stand, this is only done based on the percentile value result variable that has been obtained. While the variables based on the dimensions of the ergonomic hand sanitizer stand dispenser were not included in this research. The percentile values used are the 5-th percentile for the height of the ergonomic hand sanitizer dispenser stand, the **50th** percentile for the pedal length (stepping on the foot) of the ergonomic hand sanitizer dispenser stand, and the 95-th percentile for the width of the pedal (stepping on the foot). The results of the overall size of the ergonomic trolley can be seen in Table 6 below.

Table 6. Dimension of ergonomic hand sanitizer dispenser stand

Anthropometry Data	Ergonomic Stand Hands Antizer Parts	Percentile (cm)	Dimention (cm)
Standing Elbow Height	Height of the hand sanitizer bottle	5-th	91,73
Foot Width	Step Pedal Width	95-th	13,67
Foot Length	Pedal Length Stepping	50-th	24,32

The results of the dimensions of this ergonomic hand sanitizer dispenser stand then made an engineering drawing. The technical drawing design of the ergonomic hand sanitizer dispenser stand can be seen in figures 3 and 4 below:

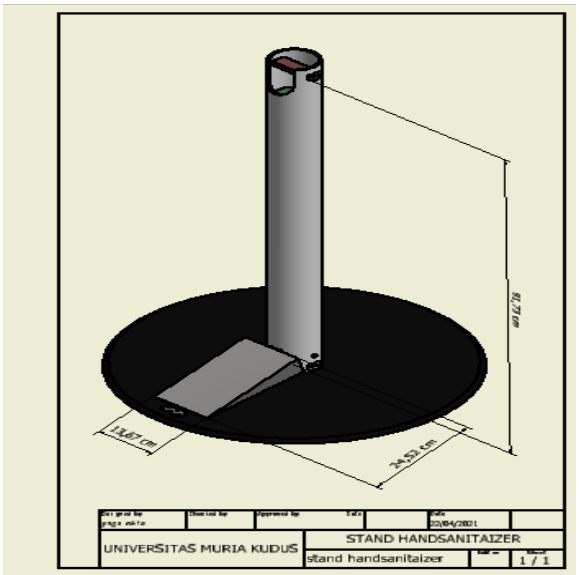

Figure 3. Engineering drawings of 3D ergonomic design of hand sanitizer dispenser stand

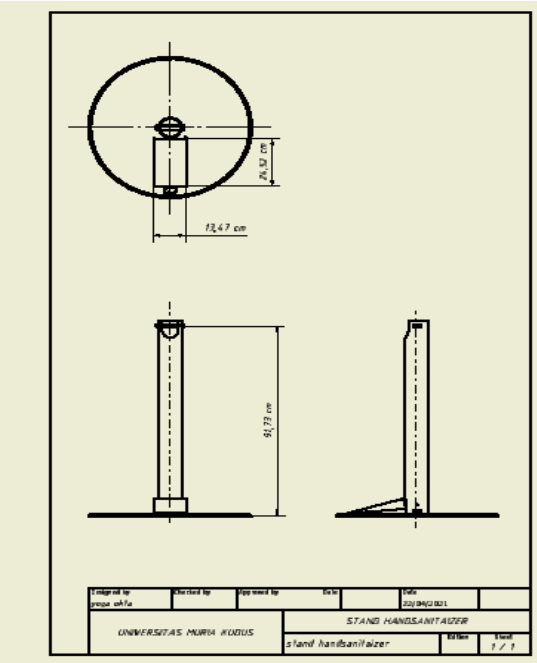

Figure 4. Engineering drawings of 2D ergonomic design of hand sanitizer dispenser stand

CONCLUSION

The dimensions of the ergonomic hand sanitizer stand dispenser design are obtained for the height of the hand sanitizer bottle holder which is designed using a 5-th percentile, which is 91.73 cm in height with the aim of making it easier for the population of people with short bodies. For the width of the pedal, which is designed using the 95-th percentile, which is 13.67 cm with the intention of making it easier for the population of people with maximum foot width. And the size of the Pedal Length Stepping uses the 50-th percentile which is 24.32cm with the intention to accommodate the population of people with minimum and maximum leg lengths. The implication of the results of this research that was expected to provide convenience and comfort for users of the ergonomic hand sanitizer stand dispenser. As for suggestions for further research in the form of adding an automatic dryer to the hand sanitizer dispenser stand which is designed according to ergonomic aspects.

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