Conference Paper

Ergonomic Design of Table and Chair at Cafe Gajahmada, Mojokerto

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ABSTRACT

Cafe Gajahmada is a cafe on the main street of Mojokerto which has a minimalist architectural style. This cafe provides fast food and is equipped with Wi-Fi so that visitors can surf the internet for free and become an interesting place to socialize. Along with the times, existing tables and chairs do not meet ergonomic standards because when visitors use notebooks, sometimes spills occur so that the water hits the notebook. There is no safe place to put drinks because the design of the tables and chairs is only intended as a place to eat. In addition, the chairs used is not ergonomic, where, when sitting, there is discomfort in the hips because the seat design does not match the dimensions of the visitor's body, and also the material is made of hard material, so it is not comfortable to sit for long with the intensity of time. This study aims to design an ergonomic cafe table and chair to provide comfort to visitors when using it. Based on the results of the study, the size of an ergonomic cafe table and chair is table height is 78 cm, and table width is 47 cm, table length is 72 cm, seat height is 44 cm, seat width is 38 cm, seat length is 40 cm, chair back width is 41 cm, and the seatback height is 55 cm.

Keywords: Body dimension, comfortable, design, ergonomic

Introduction

Along with the times, people's lifestyles are increasingly modern, and notebook users are also increasing, among young executives or business people who often conduct business transactions in public places, or among students who are busy doing assignments while enjoying the food ordered, so that various kinds of food appear. Kinds of fast-food restaurants, where visitors always use tables and chairs during activities.

Some literature reviews used in this research review the methodology and applications of anthropometry in ergonomics and product design (Dianat et al., 2018), Designing ergonomic tables and chairs that can support activities and needs in playing games with the Design Thinking Process (Aprillina et al., 2019), Anthropometric measurement for the ergonomic design of students' furniture is India (Taifa & Desai, 2017), Hand Anthropometry of Indonesia Young Adult Females (Nidiaputri & Ardiyanto, 2017), Design of Spring Iron Products Using the Method Kano (Nurjannah & Purnomo, 2018), Ergonomic Computer Workstation Design for University Teachers in Bangladesh. Finally, an ergonomic computer workstation was proposed by considering anthropometric measurement and guidelines to reduce the musculoskeletal disorders among the teachers (Kibria & Rafiquzzaman, 2019), Designing a New Ergonomic Student Backpack. The results showed that the new backpack using a medical belt based on ergonomic features with appropriate features provides a greater sense of comfort for users. It is improved compared to the

existing backpack, which is available in the Iranian market and design based on previous studies (Mansoorian et al., 2019), Application for Determining Ergonomic Chair Design in Batik Activities to Increase Productivity (Sugiharto & Sokhibi, 2019), and Table Design as A Tool for Welding Processes Based on Ergonomic Principles (Sutrisno et al., 2020).

Cafe Gajahmada is a cafe on the main street of Mojokerto, has a minimalist architectural style. This cafe provides fast food and is equipped with Wi-Fi so that visitors can surf the internet for free and become an interesting place to socialize. Along with the times, existing tables and chairs no longer meet ergonomic standards because when visitors use notebooks, sometimes spills occur so that the water hits the notebook because there is no safe place to put drinks since the design of the table and chairs is only intended as a place to eat. In addition, the chair used is not ergonomic, where when sitting, there is discomfort in the hips because the seat design does not match the dimensions of the visitor's body, and also the material is made of hard material, so it is not comfortable to sit for long with the intensity of a long time. The purpose of this study is to design an ergonomic cafe table and chair to provide comfort to visitors when using it.

Material and Method

In the research method, the following steps are carried out :
1. Anthropometric data collection. Dimensions of the Human Body used :
    - Knee Fold Height (Tt)
    - Shoulder Height Sitting Position (Tb)
    - Shoulder Width (Lb)
    - Hip Width (Lp)
    - Elbow Length (Ps)
    - Hand Reach Distance (Jjt)
    - Sitting Position Elbow Height (Ts)
    - Knee to Butt Fold Distance (Pp)
2. Data Uniformity Test

    The data uniformity test was carried out to determine whether the data used uniform or not using a control map. Non-uniform data exceeds the control limit, which is then discarded (Wignjosoebroto, 2016). The steps for testing the uniformity of the data are as follows:

    a. The average value of the observations.
    $$\overline{x} = \frac{\sum x_1}{n} \qquad (1)$$

    Where :

    $\overline{x}$ = Average observations
    x = Measurement data results

    b. Standard deviation.
    $$\sigma = \sqrt{\frac{\sum (xi - \overline{x^2}}{n-i}} \qquad (2)$$

    Where :
    σ = standar deviation of the population
    n = The number of observations
    x = Measurement data results

    c. Upper Control Limit (UCL) dan Lower Control Limit (LCL).
    $$UCL = \overline{X} + k\sigma \qquad (3)$$
    $$LCL = \overline{X} - k\sigma$$

    Where:
    $\overline{X}$ = Average observations.
    σ = Standard deviation of the population

k = Consistent confidence level index:
Confidence level 0%-68% the price of k is 1
Confidence level 69%-95% the value of k is 2
Confidence level 96%-100% the value of k is 3

3. Data adequacy test
The data adequacy test is carried out to find out whether the amount of data taken is sufficient or not, if (N'≤ N) then the data is sufficient, and if (N'>N) the data is insufficient and must be re-measured until the data is sufficient (Wignjosoebroto, 2016).

Data adequacy test formula:

$$N' = \left(\frac{\frac{k}{s}\sqrt{N\left(\sum Xi^2\right) - \left(\sum Xi\right)^2}}{\sum Xi} \right)^2$$

Where :
    N' = the number of observations that should be made   (4)
    x   = measurement result data
    s   = desired level of accuracy

4. Determine Percentile
The percentile value was used to determine the size of the cafe table and chair design. The percentile value was calculated based on Table 1.

Table 1. Percentiles and calculations in a normal distribution

Percentiles	Calculations
1-st	$\bar{X} - 2.325\ \sigma_{\bar{x}}$
2,5-th	$\bar{X} - 1.960\ \sigma_{\bar{x}}$
5-th	$\bar{X} - 1.645\ \sigma_{\bar{x}}$
10-th	$\bar{X} - 1.280\ \sigma_{\bar{x}}$
50-th	$\bar{X}$
90-th	$\bar{X} + 1.280\ \sigma_{\bar{x}}$
95-th	$\bar{X} + 1.645\ \sigma_{\bar{x}}$
97,5-th	$\bar{X} + 1960\ \sigma_{\bar{x}}$
99-th	$\bar{X} + 2.325\ \sigma_{\bar{x}}$

(Source: Wignjosoebroto, 2016)

Table 1 shows the formula used to calculate the size of the product design by using the percentile value suitable for designing the product design. The design of cafe tables and chairs in this study used the 5th, 50th, and 95th percentiles.

5. Designing of cafe table and chair
Designing cafe table and chair by taking into account the results of percentile calculations and other available data.

6. Trial of the use of the cafe table and chair designed by the design
The cafe table and the chair were designed using a trial process for cafe visitors until an ergonomic design was obtained.

7. Conclusion

Result and Discussion
Data uniformity test
    The data uniformity test is used to determine whether the data is uniform or not.
Knee Fold Height (Tt)

$$\bar{x} = \frac{x_1 + x_2 + \cdots + x_n}{\sum n} = \frac{41 + 40 + \cdots + 41}{30} = 41.57$$

$$\sigma x = \sqrt{\frac{\left(x_1 - \overline{X}\right)^2 + \left(x_2 - \overline{X}\right)^2 + \cdots + (x_n - \overline{X})^2}{n - 1}}$$

$$\sigma x = \sqrt{\frac{(41 - 41.57)^2 + (40 - 41.57)^2 + \cdots + (41 - 41.57)^2}{35 - 1}}$$

$$= 20.97 = 1.14$$

The data uniformity test for Knee Fold Height (Tt) with the confidence level used 95%, then k = 2 :

UCL = $\overline{X}$ + k. σx ; UCL = 41,57 + (2) 1.14 = 43.85
LCL = $\overline{X}$ - k. σx ; LCL = 41,57 - (2) 1.14 = 39.29

The data is made up of UCL and LCL control maps, as shown in Figure 1.
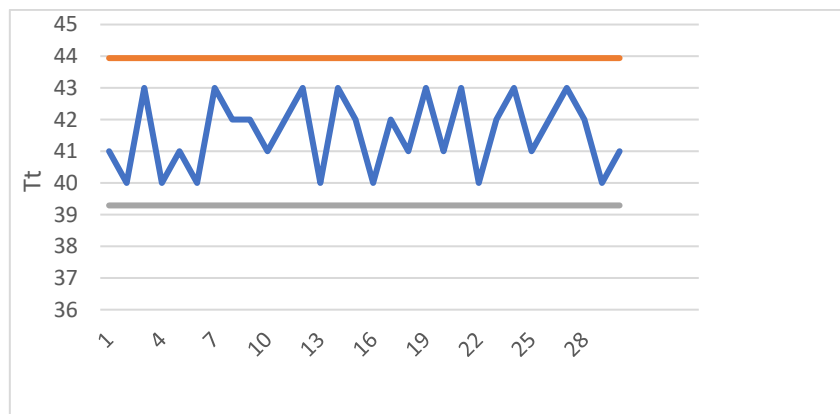

Figure 1. Knee Fold Height (Tt) Data Uniformity Test

Figure 1 shows that the dimensions of the knee-fold height (Tt) are uniform. The recapitulation of the measurement results of the data uniformity test for other body dimensions can be seen in Table 2.

Table 2. Data uniformity test results

Body Dimension	UCL (cm)	LCL (cm)	$\bar{X}$ (cm)	σx (cm)	Min data (cm)	Max data (cm)	Description
Tt	43.85	39.29	41.57	1.14	40	43	Uniform Data
Tb	56.88	52.76	54.82	1.03	53	57	Uniform Data
Lb	40.75	37.19	38.97	0.89	38	40	Uniform Data
Lp	38.14	34.26	36.20	0.97	35	38	Uniform Data
Ps	50.85	46.29	48.57	1.14	47	51	Uniform Data
Jjt	77.41	70.89	74.15	1.63	72	76	Uniform Data
Ts	69.60	62.96	66.28	1.66	64	69	Uniform Data
Pp	42.00	37.60	39.80	1.10	38	41	Uniform Data

Table 2 shows the results of the data uniformity test for all body dimensions so that all measurement data can be used for further data processing.

Data Sufficiency Test

The data adequacy test is used to prove that the sample data taken can represent the visitor population or not. The data adequacy test uses an accuracy level of 5% and a 95% confidence level.

Knee Fold Height (Tt) Data Sufficiency Test :

$$N' = \left(\frac{\frac{k}{s}\sqrt{N\left(\sum Xi^2\right) - \left(\sum Xi\right)^2}}{\sum Xi} \right)^2 \qquad\qquad N' = \left(\frac{\frac{2}{0,05}\sqrt{30(51871) - (1247)}}{1247} \right)^2 = 1.07$$

The value of N' (1.07) N (30), the data from the measurements taken sufficient to represent the dimensions of the cafe visitor's body. The results of the data adequacy test for other body dimensions can be seen in Table 3.

Tabel 3. Data sufficiency test results

No	Body dimensions	N	N'	Description
1	Knee Fold Height (Tt)	30	1.07	Enough data
2	Shoulder Height Sitting Position (Tb)	30	0.74	Enough data
3	Shoulder Width (Lb)	30	0.90	Enough data
4	Hip Width (Lp)	30	1.05	Enough data
5	Elbow Length (Ps)	30	0.92	Enough data
6	Hand Reach Distance (Jjt)	30	0.82	Enough data
7	Sitting Position Elbow Height (Ts)	30	0.98	Enough data
8	Knee to Buttocks Folding Distance (Pp)	30	1.09	Enough data

Table 3 shows the results of the data adequacy test for all body dimensions where the data is sufficient, so there is no need for additional measurements.

3. Cafe Table and Chair Design Size by Percentile Value
- The size of seat height using 50 percentile

  Seat height   = $\overline{X}$ + shoe height allowance

                   = 41,57 cm + 2 cm = 43.57 = 44 cm

  The seat height size is 44 cm.
- The size of the seat width uses 95 percentile

  Seat width   = $\overline{X}$ + P95 (SD)

                = 36.2 cm + 1.645 (0.97) = 38 cm

  The size of the seat width is 38 cm.
- The length of the seat holder uses 50 percentile

  Seat length   = $\overline{X}$

                = 39.8 cm = 40 cm

  The seat length is 40 cm
- The height of the seat back uses 50 percentile

  Seat back height = $\overline{X}$

                = 54.82 cm = 55 cm

The height of the seat back is 55 cm.
- The width of the seat back uses 95 percentile

Seat back width = $\overline{X}$ + P95 (SD)
= 38.97 cm + 1.645 (0.89) = 41 cm

The width of the seat back is 41 cm.
- The length of the table uses 5 percentile

Table length = $\overline{X}$ - P95 (SD)
= 74.15 cm – 1.645 (1.63) = 72 cm

The length of the table is 72 cm.
- The width of the table uses 5 percentile

Table width = $\overline{X}$ - P95 (SD)
= 48.57 cm – 1.645 (1.14) = 47 cm

The width of the table is 47 cm.
- The height of the table uses 50 percentile

Table height = $\overline{X}$ + shoe height + 10 cm above the elbow
= 66,28 cm + 2 cm + 10 cm = 78,28 cm = 78 cm

The height of the table is 78 cm.

Cafe tables and chair design

Figure 2. Cafe Table and Chair Design

Figure 2 shows the ergonomic design of the cafe table and chair because they are following the dimensions of the cafe visitor's body as well as on the table there is a hole as a place to put a glass to minimize spills of drinks and seepage of dew from glasses containing cold drinks. There is also a hanger to put a bag. The seat and back of the chair are made of thicker sponge so that it is comfortable when using it. Default.

Conclusion

Based on the body dimensions of the visitors to Cafe Gajahmada, the table height is 78 cm, table width is 47 cm, table length is 72 cm, seat height is 44 cm, seat width is 38 cm, seat length is 40 cm, seat backrest width is 41 cm, and height of the seatback is 55 cm. The seat and back of the chair are made of thicker sponges to be comfortable when using it. On the table, there is a hole as a place to put a glass to minimize spills of drinks and seepage of dew from glasses containing cold drinks, and there is also a hanger to put a bag.

Acknowledgment

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