

Conference Paper

## Redesigning Ergonomic Vertical Folding Desk in an Apartment Room using Anthropometric Approach

Handoyo\*, Anindyo Fikri Wiraputra

Department of Industrial Engineering, Universitas Pembangunan Nasioanal "Veteran" Surabaya, Indonesia

\*Corresponding author:

E-mail: [handoyo@gmail.com](mailto:handoyo@gmail.com)

### ABSTRACT

The use of a desk is generally big and can only be used for learning and does not have any additional functions; it causes the table to consume a lot of space in a room. The occupancy of the vertical occupancy is minimal, given the numerous availability. This design hopes to meet the needs of users who live in a place with narrow areas such as apartments, boards, houses, and other living rooms to do some activities related to the function of furniture that will be designed. With the increasing interest of people living in apartments, it is essential to consider furniture that will be used in a relatively narrow room. Thus, it is needed to overcome the conditions of the confined room. This research aims at redesigning an ergonomic and innovative folding desk in the apartment room, to provide comfort in its users. In improving the folding desk, it is hoped that this proposed folding desk will be more ergonomic and can be used daily. The results show that the recommended size for the ergonomic desk is 62 cm wide, 163 cm long, and 29 cm high; also, the recommended size of the seat is 50 cm high.

*Keywords: Redesigning, folding desk, ergonomic, anthropometric approach*

### Introduction

A desk is an essential means of support in the process of human activities (Kristanto & Saputra, 2011). The use of desks are generally big and can only be used for learning and do not have other additional functions. Hence, it spends much space in a room, whereas the wide occupancy in vertical residences is very limited to consider its furniture. This design is expected to meet the needs of users who live in residential areas with a narrow or limited area such as apartments, boarding houses, flats, and other habitable spaces to perform several activities related to the function of furniture to be designed (Raymondus, 2013).

The apartment itself has ten characteristics explained by Harianto (2014). Those characteristics are built in more than two floors and are usually a vertical building, consists of some units on one floor, flexible in achieving maximum utilization of space, efficient and effective also eco-friendly, has shared facilities that are not necessarily owned by housing, generally, there are commercial areas in the apartment building or environment, vertical circulation in the form of stairs or *lifts* and horizontal circulation, security, peace, and privacy are guaranteed, easy and fast access to reach existing facilities; also structures and building materials can last for a long time.

Look at to its function there are three functions of apartment, those are primary functions, as a living place, secondary function which is added in an apartment to give comfort towards its primary function, and complementary function which supports the primary and secondary functions (Eka, et al., 2016). Besides, there are four types based on the apartment unit. Those are studio, a family apartment consisting of one, two, or three rooms, loft, and penthouse (Cahyaningtyas &

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Rahardjo, 2016). Based on its building mass shape, an apartment can be classified into two categories; those are slab apartment and tower apartment (Utami, et al., 2015).

In conducting this study, the researchers use an anthropometry approach to redesign the folding desk used in the apartment. Harrianto (2010) confirms that anthropometry is the measurements of the human body naturally both in carrying out static activities (actual size) and dynamic (adjusted to work). Anthropometry data preparation needs to pay attention to variability because several factors affect the size of the human body (Jennie, et al., 2017). Herawati & Pawitra explains (2013) anthropometric data, which is used as a basis for product design are generally grouped into two types, namely static anthropometry (structural) and dynamic anthropometry (functional).

The application of anthropometric data can be made if the average standard (mean) and standard deviation (SD) are available from a normal distribution (Nurrohman & Yohanes, 2017). There are three principles in the use of those terms, namely the design of facilities based on extreme individuals, the design of facilities that can be adjusted, and the design of facilities based on the average size of the user (Pranindo & Nurkertamanda, 2013).

The design of work equipment based on anthropometric data of the user aims to reduce the level of work fatigue, improve work performance and minimize the potential for work accidents (Jennie, et al., 2017). The product design itself is divided into seven steps that each have their method. The seven steps are purpose classification, function determination, needs arrangement, characteristics determination, improvement details, alternative construction, and alternative evaluation (Priyatna & Wiyancko, 2014). Furthermore, product development is a series of activities that begin with the analysis of perceptions and opportunities, then end with the stages of production, sales, and delivery (Ulrich & Epingner, 2001).

Based on the condition mentioned above, the researcher tries to redesign an ergonomic folding desk to fit in the limited space in the apartment. The ergonomics discipline, in particular, will learn the limitations of the human ability to interact with technology and homemade products (Raymondus, 2013). There are four main objectives of ergonomics, namely maximizing employee efficiency, improving work health and safety, encouraging work safely, comfortable and vibrant, and maximizing work form.

It is also essential to have data homogeneity since it cannot be inserted in the next calculation if the data are not equal. Hence, the data should be tested to meet the requirement. The data also should be adequate to be calculated to avoid data retake. If  $N' < N$  so that the data are considered adequate to be measured. On the other hand, if  $N' > N$  so that the data are less adequate to be calculated. Meaning that the data retake necessary to do. To distribute the data, it needs a normal distribution with the formula of the bell-shaped symmetric towards  $x = \mu$ . This normal distribution or normal curve is also called Gauss distribution with the following formula, where:

$$f(x) = \frac{1}{\sigma \sqrt{2\pi}} e^{-1/2 \left( \frac{x-\mu}{\sigma} \right)^2}$$

## Research Method

This study was conducted at Menara Rungkut City Surabaya in January 2019 until the required data was sufficient. The variables in this study are folding desk as a bound variable and anthropometric data, desk design, and questionnaire as an independent variable. The researchers also used a questionnaire to provide easiness to respondents in giving opinions and answering questions since it is provided with some options to be chosen (Bimo, 2010). Problem-solving steps that can be taken in this study to get the results or solutions from the research to be carried out from beginning to end.

## Result and Discussion

After investigating the data, the researcher classified 40 users who live in Menara Rungkut Apartment Surabaya based on their Hand Reach (HR), Hand Span (HS), and Elbow Height (EH) as it is shown in the table below:

Table 1. User anthropometric data

Number of user	Body Dimension (cm)		
	HR	HS	EH
1	73	180	37
2	72	187	34
3	76	189	30
4	76	181	35
5	75	190	36
6	76	180	31
7	75	187	31
8	77	182	34
9	74	183	33
10	74	189	35
11	74	190	36
12	75	180	36
13	75	191	32
14	76	184	34
15	77	182	30
16	73	180	36
17	73	188	32
18	76	188	33
19	76	182	34
20	75	184	31
21	76	187	34
22	73	186	37
23	74	180	37
24	75	181	35
25	78	186	37
26	73	182	34
27	72	190	35
28	75	182	33
29	77	190	36
30	74	182	32
31	73	182	33
32	75	181	35
33	76	181	32
34	76	187	37
35	75	184	37
36	75	182	34
37	76	190	31
38	77	185	34
39	73	189	34
40	72	185	36
$\Sigma X$	2915	7389	1363

### Initial Desk Design

The initial table design in Menara Rungkut apartment can be seen in the following picture:



Figure 1. Initial desk design

In the figure displayed above, the desk height 50 cm high, the desk width is 40 cm wide, and the desk length is 60 cm long.

### Proposed desk design

#### Data homogeneity test

Based on the chart of data homogeneity test of the apartment users, the results shown in the following table:

Table 2. The result of data homogeneity test

Body Dimension	BKA (cm)	BKB (cm)	x (cm)	ΣX (cm)	Minimal Data	Maximal Data	Notes
HR	86.07	56.67	72.87	6.6	72	78	Homogen
HS	210.34	159.1	184.72	12.81	180	191	Homogen
EH	42.47	25.67	34.07	4.2	30	37	Homogen

#### Data adequacy test

By applying a 5% level of accuracy, 95% eligibility rate, the data adequacy test shown below:

$$N' = \left[ \frac{k/s \sqrt{N \sum X^2 - (\sum X)^2}}{\sum X^2} \right]^2$$

The value of k = 2 and the value of s = 0,05

If  $N' \leq N$  then the data is adequate to do the design

If  $N' \geq N$  then the data is not enough to do the design

The data from the measurement result is sufficient to design the product. The following table is the result of the data adequacy test.

Table 3. The result of the data adequacy test

No.	Body Dimension	N	N'	Notes
1	Hand Reach (HR)	40	0.0064	Adequate data
2	Hand Span (HS)	40	0.0009	Adequate data
3	Elbow Height (EH)	40	0.0324	Adequate data

*Determining the Percentile*

Here the researchers determined the size desk by adjusting the percentile.

- Determine the width of the table

HR of the desk =  $\bar{x} - P_5(SD) = 72,87 - 1,645(6,6) = 62$  cm

The width of the recommended desk is 62 cm wide

- Determine the length of the table

HS of the desk =  $\bar{x} - P_5(SD) = 184,72 - 1,654(12,81) = 163$  cm

The length of the recommended desk is 163 cm long

- Determine the height of the table

EH of the desk =  $\bar{x} + \text{Tolerance} = 24,17 + 5 = 29$  cm

The height of the recommended desk is 39.07 cm high

*Planning the design of recommended folding desk*

The proposed folding desk for users at age 19-40 years was 62 cm wide for the desk width, 163 cm long for the desk length, 29 cm high for the desk height, and 50 cm high for recommended seat height.

Table 4. The result of the questionnaire towards the recommended folding desk

No.	Attribute	Criteria					To- tal
		1	2	3	4	5	
1	The desk height is suitable with sitting position	-	-	13	20	7	40
2	The desk width is suitable with the user's hand span to front	-	-	17	18	5	40
3	The desk length is suitable with the user's hand span to the side	-	-	9	25	6	40
4	The desk material is durable and safe for the users	-	-	19	14	7	40
5	The flexibility when it is not used	-	-	-	24	16	40
6	The desk is having some functions	-	-	8	22	10	40
Total		-	-	66	125	55	240

The table above is the result of the questionnaire, which is responded by forty occupants living in Menara Rungkut Apartment, Surabaya. By applying the analysis of the data analysis, the proposed folding desk can be seen in the following figure:



Figure 2. The proposed folding desk design in the apartment

Compare to the initial desk design, the proposed folding desk design is much more appropriate for people living in the apartment since the size is adequate, safe, and healthy to its users. The comparison between the initial design and proposed design is shown in the following table:

Table 5. The result of the questionnaire of the initial design

No.	Attribute	Criteria					Total
		1	2	3	4	5	
1	The desk height is suitable with sitting position	24	11	5	-	-	40
2	The desk width is suitable with the user's hand span to front	-	19	11	10	-	40
3	The desk length is suitable with the user's hand span to the side	10	14	16	-	-	40
4	The desk material is durable and safe for the users	-	15	17	8	-	40
5	The flexibility when it is not used	14	11	8	7	-	40
6	The desk is having some functions	21	18	1	-	-	40
Total		69	88	58	25	-	240

Table 6. The result of questionnaire of the proposed design

No.	Attribute	Criteria					Total
		1	2	3	4	5	
1	The desk height is suitable with sitting position	-	-	13	20	7	40
2	The desk width is suitable with the user's hand span to front	-	-	17	18	5	40
3	The desk length is suitable with the user's hand span to the side	-	-	9	25	6	40
4	The desk material is durable and safe for the users	-	-	19	14	7	40
5	The flexibility when it is not used	-	-	-	24	16	40
6	The desk is having some functions	-	-	8	22	10	40
	Total	-	-	66	125	55	240

## Conclusion

The results showed that an ergonomic folding desk design is the design that has 62 cm wide, 163 cm long, and 29 cm high. Besides that, the seat height should have 50 cm high. Besides, this desk has several storage functions under the desk pad that are used to store books, stationery, dining places, luggage, and other equipment that support learning activities at school, as well as the legs that can be folded when not in use. Thus, its wide use needs to be considered.

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