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Ergonomic Work Station Design In Internet Rental Services At Warnet Bina Boyolali

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Article Info	ABSTRACT
Corresponding Author: Name : **Haryanto** E-mail: haryanto12@gmail.com	Responding to the rapid progress of the internet and the large public need for internet service users, many internet cafes have been opened. Many internet cafes in designing their work stations are less ergonomic so that it often causes complaints for users. Therefore, it is necessary to conduct research on how to design an ergonomic work station in order to provide comfort for internet rental service users. The research was conducted at the Bina Boyolali internet cafe with the object of research regarding the size of computer tables and chairs. Computer desks and chairs are facilities provided at Bina's internet cafe. The tables and chairs used by the internet cafe operators felt uncomfortable, which was caused by the sitting position which eventually caused fatigue in the limbs. The research process begins with collecting data through a Nordic Body Map questionnaire to find out whether visitors are comfortable with the conditions of the existing work station. From the questionnaires distributed to 60 respondents, it can be seen that 1.32% of visitors felt very comfortable with the size of the table and chair size, the location of the board and the distance from the monitor to the eyes. Visitors who feel comfortable are 19.34%, those who feel quite comfortable are 42.63%, those who feel less comfortable are 34.41% and feel uncomfortable are 2.31%. This shows that the Bina Boyolali internet cafe work station is still less ergonomic so that many visitors feel uncomfortable. From the questionnaires distributed to 60 respondents, it can be seen that 1.32% of visitors felt very comfortable with the size of the table and chair size, the location of the board and the distance from the monitor to the eyes. Visitors who feel comfortable are 19.34%, those who feel quite comfortable are 42.63%, those who feel less comfortable are 34.41% and feel uncomfortable are 2.31%. This shows that the Bina Boyolali internet cafe work station is still less ergonomic so that many visitors feel uncomfortable. From the questionnaires distributed to 60 respondents, it can be seen that 1.32% of visitors felt very comfortable with the size of the table and chair size, the location of the board and the distance from the monitor to the eyes. Visitors who feel comfortable are 19.34%, those who feel quite comfortable are 42.63%, those who feel less comfortable are 34.41% and feel uncomfortable are 2.31%. This shows that the Bina Boyolali internet cafe work station is still less ergonomic so that many visitors feel uncomfortable. **Keywords:** Work Station, ergonomics, chairs, actual tables, internet cafes, ergonomics

INTRODUCTION

The need for information facilities from day to day will continue to increase and develop in line with the development of telecommunications technology in the multimedia field. Of various kinds of technology that via the internet is the most rapidly growing[1]. In addition to being fast and practical, users can also obtain actual information globally and various transactions can also be carried out via the internet[2]. Responding to the rapid progress of the internet and also the large public need for the use of internet services, recently many internet cafes have been opened. So that this internet cafe gets a positive response from people who use internet services, especially for those who do not have personal computers or also have computers that are not equipped with internet facilities.

In setting up an internet cafe that is quite adequate does not require a large enough capital. However, many internet cafes in designing their work stations are less ergonomic, causing complaints for consumers[3]. BINA Boyolali internet cafe was established to provide services to consumers. The owner wants to provide the best service. Namely by providing facilities that can attract consumers. Among them are fast internet access, spacious and comfortable rooms. With the facilities offered, it is hoped that consumers will feel at home and comfortable. However, in designing the internet cafe owner, BINA has not paid attention to the size of the table, chair height, keyboard height, eye distance from the monitor and the room. this can cause complaints for users. Complaints that arise are usually pain in the back, in the waist, in the arms due to static muscle loading, complaints in the eyes due to the distance between the eyes and the monitor that do not fit, and complaints in the leg muscles due to an inappropriate chair or room.[4].

Internet cafe design must pay attention to the comfort and privacy of the wearer. Consumer comfort is influenced by the surrounding environment such as temperature, lighting, noise, chair height to table height, chair width, keyboard height and eye visibility to the monitor.[5]. Therefore, in designing work stations on internet service rentals, it is necessary to pay attention to comfort for internet service users aiming to attract the attention of consumers and for users to use them as long as possible.[6].

From the 60 questionnaires which were divided randomly, it can be seen that 1.32% of visitors felt very comfortable with the size of the table and chair size, the location of the keyboard and the distance from the monitor to the eyes. Visitors who feel comfortable are 19.34%, those who feel quite comfortable are 42.63% who feel less comfortable 34.41% and feel uncomfortable are 2.31%. This shows that the Bina Boyolali internet cafe work station is still less ergonomic so that many visitors feel uncomfortable. The existence of these problems, it is necessary to make improvements to the design of work facilities used by consumers with the considerations that have been stated above. Improvements that will be made are by redesigning the computer desk and adding a chair facility design that is in accordance with anthropometric data.

METHOD

The models and frameworks used in the research on the design of computer desks and chairs are:

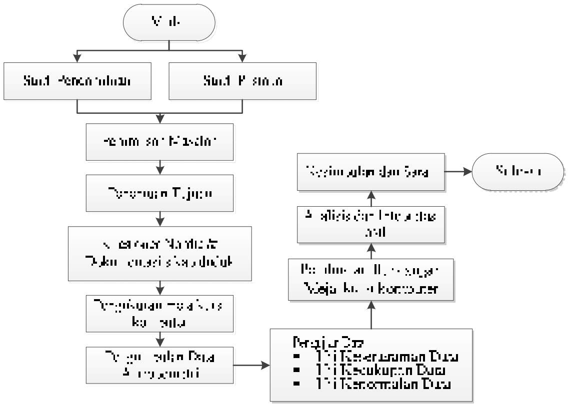

Figure 1. Research Flow

Ergonomics as 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 achieving the desired goals through the work effectively, safely and comfortably. The main purpose and objective of the ergonomics discipline approach is directed at efforts to improve human work performance such as increasing work speed, accuracy and work safety. In addition, it also aims to reduce excessive work energy, reduce fatigue that is too fast, improve the utilization of human resources and minimize damage caused by human error.

This stage begins with a preliminary study, literature study, problem formulation, determining research objectives and determining research data.

Tools and materials used

a. The meter is used for the physical dimensions of the internet cafe work station and also for measuring student anthropometric data.
b. The flexible curve is used to measure body contours such as measuring the depth of the lumbar basin, the height of the lumbar basin and the height of the outer back.
c. Anthropometric chairs are used to measure the size of the human body in an upright sitting position.
d. Wood as a material for making computer table and chair frames
e. Foam as a material for making chair backs and seat mats so that users can sit comfortably.
f. Paint is used to paint computer chairs and tables made
g. Computer set.

Anthropometric data consisting of: Popliteal buttocks (PP), Shoulder width (LB), Sitting Shoulder Height (TBD), Hip width (LP), Popliteal height (TP), lumbar basin depth (PPL), lumbar basin height (TPL) , Outer back height (TPU), Hand reach (JT), Arm length (PL), Hand stretch (RT), Standing elbow height (TSB), Sitting elbow height (TSD), Sitting eye height (TMD)

The physical dimensions of the old work station measured were the height of the seat pad, the height of the backrest, the width of the backrest, the length of the backrest, the length of the seat pad, the width of the seat pad, the length of the table, the height of the table, the width of the table, the height of the keyboard and the position of the monitor.

RESULTS AND DISCUSSION

The actual physical dimension data of desks, computer chairs, internet rental work stations consist of:

Table 1. Data on the actual physical dimensions of the internet rental work station

No	Part	current
1	Chair base height	28 cm
2	Backrest height	37 cm
3	Backrest width	15cm
4	The length of the seat	113 cm
5	Width of seat	43 cm
6	Backrest height	37 cm
7	Armrest length	118 cm
8	table height	76 cm
9	Table length	125 cm
10	table width	49 cm
11	Backrest angle	20°

The work station design process for internet tenant services is based on the following steps:

Goal classification stage. This stage uses the objective tree method (destination tree) which describes the design process. The goal tree is a diagram that shows that goals at a lower level are the meaning of achieving higher goals.

Function determination stage. In this stage, function analysis is used. The initial stage of the function analysis is to determine the function of the internet workstation broadly and then narrow it down. By listing the important functions of an internet workstation, it is possible to identify the aspects that need to be included in a design. The method used is to define the function broadly at first, and then narrow it if needed.

Needs adjustment stage. From the analysis of the functions above, identification of possible criteria to achieve each important function is carried out. This list presents criteria for sub-solutions which when combined can form the solution of the overall design. Based on the previous stage, the need for the design of an internet cafe workstation must consider the following factors: Ergonomic, sturdy construction, easy to make and aesthetic value.

Data Processing Phase. The data that has been collected are anthropometric data and data on the physical dimensions of the actual work station to be processed. The results of data processing will be realized in an ergonomic work station prototype.

Static Analysis Stage. The first step in this uniformity test is the calculation of the mean and standard deviation to determine the upper and lower control limits for each anthropometric data. Data uniformity test for each anthropometric data, namely:

a. cTest uniformity of popliteal buttock spacing (pp). The mean value for the popliteal buttock distance was 41.64 cm. The calculation results obtained that the standard deviation for the 60 Popliteal buttock distance data is 1.306. Based on the calculation of the popliteal buttock distance data, the upper control limit (BKA) is 44.25 cm and the lower control limit (BKB) is 39.02 cm.
b. Shoulder Width (lb) uniformity test. The average value or mean for Shoulder Width is 39.13 cm. The calculation results obtained that the standard deviation for the 60 data for shoulder width is 2,405 cm. Based on the calculation of the shoulder width data, the upper control limit (BKA) is 43.94 cm and the lower control limit (BKB) is 34.32 cm.
c. Sitting Elbow Height uniformity test (tsd). The mean or mean value for Sitting Elbow Height is 24.78 cm. The calculation results obtained that the standard deviation for 100 Sitting Elbow Height data is 25.78. Based on the calculation of the Sitting Elbow Height data, the upper control limit (BKA) is 27.09 cm and the lower control limit (BKB) is 22.47 cm.
d. fShoulder Sitting Uniformity Test (tbd). Average or mean value for Height Shoulder Sitting is 55.82 cm. Calculation results obtained standard deviation for 100 data HighShoulder Sitting is 25.78. Based on the calculation of the Sitting Shoulder Height data, the upper control limit (BKA) is 59.09 cm and the lower control limit (BKB) is 52.55 cm.
e. Hip Width Uniformity Test (lp). The mean value for Hip Width is 31.43 cm. The calculation results obtained that the standard deviation for the 60 Hip Width data is 1.42. Based on the calculation of the hip width data, the upper control limit (BKA) is 34.27 cm and the lower control limit (BKB) is 28.59 cm.
f. Arm Length uniformity test (pl). The mean or mean value for Arm Length is 25.47 cm. The calculation results obtained that the standard deviation for 100 arm length data is 25.78. Based on the calculation of arm length data, the upper control limit (BKA) is 27.06 cm and the lower control limit (BKB) is 23.08 cm.
g. High popliteal uniformity test (tpo). The mean or mean value for popliteal height is 39.86 cm. Calculation results obtained standard deviation for 60 data Popliteal height is 0.97 cm. Based on the calculation of the popliteal height data, the upper control limit (BKA) is 41.81 cm and the lower control limit (BKB) is 37.90 cm.
h. Uniformity test Hand reach (m). The mean or mean value for hand reach is 73.16 cm. The calculation results obtained the standard deviation for 60 data. Hand reach is 5.36 cm.

Based on the calculation of the hand reach data, the upper control limit (BKA) is 83.88 cm and the lower control limit (BKB) is 62.44 cm.

i. j. Test of Uniformity of Hand Span (rt). The mean value for Hand Stretch is 159.37 cm. The calculation results obtained that the standard deviation for the 60 arm's stretch data was 5.13 cm. Based on the calculation of the arm span data, the upper control limit (BKA) is 169.66 cm and the lower control limit (BKB) is 149.08 cm.

j. Sitting Eye Height uniformity test (tmd). The average or mean value for Sitting Eye Height is 70.94 cm. The calculation results obtained that the standard deviation for the 60 data of Sitting Eye Height is 2.18. Based on the calculation of Sitting Eye Height data, the upper control limit (BKA) is 75.31 cm and the lower control limit (BKB) is 66.56 cm.

k. Outer back height uniformity test (tpu). The average or mean value for the Outer Back Height is 48.19 cm. The calculation results obtained that the standard deviation for the 100 outer back height data is 25.78. Based on the calculation of the outer back height data, the upper control limit (BKA) is 52.71 cm and the lower control limit (BKB) is 43.67 cm.

l. Lumbar basin depth uniformity test (ppi). The mean value for the Lumbar Basin Depth is 2.67 cm. The calculation results obtained the standard deviation for the 60 data. Lumbar basin depth is 0.38 cm. Based on the calculation of the Lumbar Basin Depth data, the upper control limit (BKA) is 2.67 cm and the lower control limit (BKB) is 1.90 cm.

m. j. Lumbar Basin Height uniformity test (tpi). The mean or mean value for Lumbar Basin Height is 13.99 cm. The calculation results obtained that the standard deviation for the 60 popliteal buttock distance data is 1.55. Based on the calculation of the Lumbar Basin Height data, the upper control limit (BKA) is 17.09 cm and the lower control limit (BKB) is 10.89 cm.

n. Ankle Height uniformity test. The mean or mean value for ankle height is 8.78 cm. The calculation results obtained that the standard deviation for 60 ankle height data is 1.55 cm. Based on the calculation of the sitting elbow height data, the upper control limit (BKA) is 11.87 cm and the lower control limit (BKB) is 5.67 cm.

Data Sufficiency Test. The data adequacy test serves to determine whether the data obtained are sufficient. Before conducting the data adequacy test, first determine the degree of freedom s = 0.05 which indicates the maximum deviation of the research results. In addition, a 95% confidence level is also determined with k = 2 which shows the measure of the measurer's confidence in the accuracy of the anthropometric data.

Table 2. Recap of the calculation results of the data adequacy test

	pp	lb	tsd	tbd	lp	pl	tpo	jt	rt	tmd	tpu	ppi	tp	tmk
N'	5	10	6	2	5	3	2	14	3	3	6	56	32	36
N	60	60	60	60	60	60	60	60	60	60	60	60	60	60

Based on table 1, it can be seen that the actual number of observational data is greater than the number of theoretical observations.

Percentile calculation. After the data uniformity test and data adequacy test were carried out at the data collection stage, it was continued with the calculation of percentiles. Percentile calculation aims to determine the size of the design results.

Table 3. Determination of percentile value

Limb	percentile	Information
popliteal buttock distance (pp)	10	So that people who have short popliteal buttocks can feel comfortable with the seat pad
shoulder width (lb)	95	So that people with big shoulders can lean back comfortably

Sitting Elbow height (TSD)	5	So that people who have low elbows can rest their hands comfortably
Hip width (lp)	95	So that people who have big hips can feel comfortable with the width of the seat base
Sleeve length (pl)	95	So that people with long arms can feel comfortable with long armrests
Popliteal height (tpo)	10	So that people with short legs don't hang down and people with tall legs can use the seat comfortably
Hand reach (m)	5	So that people with short hands can reach all the equipment on the table
Handspan(rt)	5	So that people with short hands can reach all the equipment on the table
Lumbar Basin Depth (ppi)	5	Backrest that is too protruding will put pressure on the lumbar region
Lumbar Basin Height (tpi)	95	In order to be able to hold the lumbar region towards the back and provide loose space around the buttocks bulge, especially for people who are wide

Discussion

Based on the analysis of observations in the field, it is known that the chairs used are wooden chairs and the table used is a flat wooden table. The actual physical dimensions of the chair do not pay attention to ergonomics, so it is known that the height of the backrest is too low, the absence of armrests, the seat is too thin, the backrest is too upright so that it causes pain in the back, hands and fatigue. The slouched position is the wrong sitting position, the initial impact is fatigue, besides that in the long term it can cause bone abnormalities. Tables and chairs are not comfortable for internet service users, so they need to be repaired. Data processing is carried out to obtain the dimensions of the design results based on anthropometric data.

The data processing that has been carried out has resulted in the dimensions of the new mela and chair designs, namely;

Table 4. Dimensions of tables, chairs using anthropometric data

No	Design Dimension	Size
1	Seat height	41.68 cm
2	Width of seat	34.90 cm
3	The length of the seat	40.58 cm
4	Backrest width	44.48 cm
5	Backrest height	48.01 cm
6	Backrest depth	2.03 cm
7	Armrest height	22.88 cm
8	Armrest length	27.05 cm
9	table height	70.98 cm
10	table length	150.91 cm
11	table width	63.34 cm
12	Place the keyboard	27.05 cm
13	CPU location	64.34 cm

The design dimensions in table 3 above are derived from processing anthropometric data through data testing and determining percentiles. Seat height is the height from the floor to the top surface of the seat mat. For ergonomic design requirements, seat height must be based on popliteal height using the 10th percentile (P10), the addition of 2.5 cm is an adjustment to shoe height. Calculation of seat height using popliteal height obtained 41.68 results.

The width of the seat mat serves to provide support for the hips and lower thighs. To determine the width of the seat mat, anthropometric data is used, namely hip width (LP). Here the 95th percentile is used with the intention that people who have broad hips can use the seat comfortably. The addition of an adjustment factor of 1.4 cm is an adjustment to the variability of clothing, so that the resulting seat width is 34.90. The length of the seat pad affects the popliteal buttock (PP) distance. Here is used the 10th percentile (P10) because if the length of the seat is too long it will compress the popliteal area while the seat that is too short will disturb the balance of sitting. The addition of an adjustment factor to clothing of 1.4 cm needs to be done to obtain sitting comfort,

The width of the backrest that is too large will interfere with freedom of movement, while the backrest that is too narrow cannot support the weight of the back perfectly. The width of the backrest is obtained based on data on the back width (LB) at the 95th percentile. The addition of an adjustment factor of 1.4 cm to the variability of clothing needs to be considered. Calculation of the width of the backrest obtained 44.48 results. The height of the backrest refers to the height of the outer back (TPU) at the 95th percentile. The addition of an adjustment factor to the variability of clothing is +0.6 and – and 4.5 cm to body shrinkage to optimize the function of the backrest.

The height of the backrest is determined based on the height of the lumbar curvature (TPI) at the 95th percentile. The addition of a clothing factor of 1.6 cm to the variability of clothing. The calculation is Backrest Depth = PPI (P5) = 2.03The armrest height was calculated based on the sitting elbow height (TSD) using the 5th percentile (P5). Armrests that are too high will cause too much shoulder load. Calculation for armrest height = TSD (P5) = 22.88. The length of the armrest is along the forearm (PL) using the 95th percentile (P95) this is intended so that people with long arms can use the armrest comfortably. The calculation of the armrest length is = PL (P95) = 27.05. If adjusted to the construction, the length of the armrest is the same as the length of the seat, which is 22.08 cm.

The height of the table is affected by the height of the computer chair. The height of the keyboard drawer must remain below the operator's elbow so that the hands do not get tired quickly. The height of the table is calculated by increasing the height of the keyboard drawer by 9 cm for the height of the mouse and the height of the keyboard. So the height of the table is 70.98 Determination of the length of the table is determined based on the length of the arm span (RT). The percentile used is the 5th percentile (P5) with the intention that people who have short hands can reach all the equipment on the table. The width of the computer desk must not exceed the hand's reach (JT), while the percentile used is the 5th percentile (P5). The calculation of the width of the computer desk is = JT (P5) = 64.34. The keyboard must be easily accessible to operate comfortably. Therefore, the arrangement of the keyboard position from the operator's sitting position uses data on arm length (PL) using the 5th percentile (P5). The calculation of the keyboard location is calculated by = PL (P5) = 27.05

The determination of the location of the CPU as one of the main components of computer equipment must be placed within the reach of the operator even though the frequency of its control is relatively rare, namely when turning the computer on and off. From an ergonomic point of view, the CPU must be located in the low percentile, namely the 5th percentile (P5) of the reach of the hand (JT). The calculation of the monitor's location from the operator's sitting position = JT (P5) = 64.34. The location of the monitor from an ergonomic point of view is that the operator's point of view in the horizontal direction is between 10 degrees – 20 degrees and the viewing angle on the vertical direction is 90 degrees. This is intended to avoid reflection of the monitor with the operator. The distance between the monitor and the operator is between 45-50 cm so that the eyes can see the display on the monitor screen clearly.

As for the comparison between the actual tables, chairs and the design results, it consists of completeness of tables and chairs, dimensions of tables and chairs. The completeness of the design in question is that the current table and chairs are tables and chairs made of wood and the size is not ergonomic, chairs without armrests, backrests that do not fit well, causing back pain, tables that do not use footrests, causing pain. on the thigh. While the table, the design chair is a chair whose height is adjusted to the height of the computer desk so that the operator of the internet cafe service user feels comfortable. The designed seat also has armrests that can support the hand if the operator experiences fatigue in the arm that can be reclined.

The results of the comparison of the dimensions of the table and chairs to determine the difference in the dimensions of the current table, chair and the results of the table, chair design. For a comparison of the dimensions of the current table, chair and table, design chair, it can be seen in table 4 as follows;

Table 5. The results of the comparison of the dimensions of the current table, chair and design results

No	Size Dimension	Current size cm	Design result cm
1	Seat height	28	41.68 cm
2	seat width	43 cm	34.90 cm
3	seat length	113 cm	40.58 cm
4	Backrest width	15	44.48 cm
5	Backrest height	37	48.01 cm
6	Backrest depth	-	2.03 cm
7	armrest height	-	22.88 cm
8	Armrest length	-	27.05 cm
9	table height	83	70.98 cm
10	table length	100	150.91 cm
11	table width	57	63.34 cm
12	Place the keyboard	-	27.05 cm
13	CPU location	-	64.34 cm

CONCLUSION

The dimensions of the designed table and chairs are as follows: seat height 41.68 cm, seat width 34.90 cm, seat mat length 40.58 cm, backrest width 44.48 cm, backrest height 48.01 cm, backrest depth 2.03 cm, armrest height 22.88 cm, armrest length 27.05 cm, table height: 61.98 cm, table length 150.91 cm, table width 64.34 cm.

With a value engineering approach, the design value of the current table, chair and design can be compared. The design of the table, chair currently has a smaller value than the design of the design. This shows that the proposed work station design is better than the actual work station.

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