Anthropometry application of students in the design of campus tables and chairs

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Abstract. The purpose of the research is to design comfortable tables and chairs for learning and gathering students in the campus. The method used is anthropometry and percentiles used to design tables and chairs, statistical tests are used to process anthropometric data and those used are data adequacy tests, data uniformity tests, test data normality with Kolmogorov-Smirnov, Excel software for statistical test calculations, SPSS software for Kolgomorov-Smirnov normality test simulation. The results obtained are the dimensions used by the hand range, elbow height, hand range, popliteal height, popliteal buttocks. Adequacy tests that the data of all dimensions identified are sufficient data, test the uniformity of the data that one data for identified hand span dimensions is not uniform while data for other dimensions are uniform. Kolmogorov-Smirnov normality test for all dimensions data is normally distributed. The conclusion is the table was designed using a percentile of 50% for hand span dimensions, percentile 95% for popliteal height dimensions and sitting elbow height. The chair was designed using percentile 5% for popliteal height dimensions, percentile 50% for hand span dimensions, percentile 95% for popliteal buttocks dimensions.

1. Introduction
Anthropometry is used to get ergonomic facilities and infrastructure designs for users, in this case, students. The design of learning facilities and infrastructure is done for convenience. Comfort can improve quality. Quality improvement in a university is very necessary, quality improvement can be seen from the output produced by students. Improved quality of students is seen from the learning gained. Student learning can be improved through the availability of adequate facilities for their learning, both during the learning process and outside the learning process.

Learning facilities must be designed as comfortable as possible, so it needs to be based on the principles of ergonomics. [1] says that ergonomically designed equipment needs to be carried out based on ergonomic principles. Ergonomics principles are carried out to avoid students from complaints of musculoskeletal disorder. The musculoskeletal disorder is a condition that muscles experience a load of static and repetitive activity that occurs sequentially for a long time leading to complaints of damage to the joints, ligaments, and tendons [2]. The musculoskeletal disorder is caused due to unnatural work posture during activities. Besides working, aspects of everyday life can contribute too. Therefore, MSDS depends on work and non-employment factors [3].

The problem in the study is the absence of ergonomic study tables and chairs when students study outside the classroom. The object of research is students. Students at the time of learning using the chairs that have been provided, the chairs are not in accordance with the dimensions of the student body. The
discrepancy in the dimensions of the body of the student with the chair marked by the student while sitting, some of his legs hanging, the student's popliteal buttocks bigger than the width of the bench.

Since ancient times, the human body has been measured for several reasons. During the ancient era, measuring the human body was mostly practiced for figurative art. Finally, this practice was adopted by the naturalist field and later by anthropologists to identify basic human morphological characteristics [4]. The importance of anthropometric data in product design and workplaces has been recognized for years [5].

The purpose of the research is to design tables and chairs that are useful for studying and gathering students in the campus.

2. Method
Ergonomics is the study of work laws. Its goal is to fit work to individuals, as opposed to fitting workers to the work, through developing knowledge that results in efficient adaption of work methods to the individual’s physiological and psychological characteristic. Therefore, the objective of ergonomics applied is to identify and alleviate those work stresses that adversely affect the health, safety, and efficiency of workers [6].

Anthropometry as “the science of measurement and the art of application that establishes the physical geometry, mass properties, and strength capabilities of the human body”. In simple meaning, Anthropometry can be defined as the study which deals with body dimensions i.e. body size, shape, strength and working capacity for design purposes and body composition [7].

2.1. Object of research
Most anthropometric measurements are carried out following the techniques described [8]. The object of the study was 37 students to represent students from one of the XYZ Universities. The age of students who are the object of research is between 17 years to 21 years, averaged 19 years by reason of students who are active at that age, so that the benches and tables that will be made can be used. PT XYZ is located in Langsa City, Aceh Province, but PT XYZ students consist of several tribes in Indonesia, namely the Javanese tribe, the Mandailing tribe, the Aceh tribe and the Malay tribe.

2.2. Research procedure
All anthropometric measurements are carried out in accordance with Anthropometric Standards [9]. Anthropometric measurements were carried out for 2 days, measurements were taken using body martin for practical reasons and understood by students. Measurements were made by students who have experience in anthropometric measurements. The measurement was carried out by six students divided into three groups, in which one group consisted of two people. Errors in measurement are minimized by means of the students who take retrained measurements to take measurements with a predetermined dimension for one hour for five days. When measuring, for one person to be measured, repeated measurements were taken by the three groups of students. Measurements were made at noon around 10:00 a.m., with the reason that at this time the observer and participants were fresh.

3. Result

3.1. Dimension
The dimensions used in the measurement are seen from what will be designed, in this case, the design of tables and chairs. The four dimensions used for table design are the hand range, popliteal height + elbow height, hand reach in figure 1.
The three dimensions used for chair design are popliteal height, popliteal buttocks, and hand stretches in Figure 2.

3.2. Statistical tests
Statistical tests are performed for each dimension used. The statistical test used is data adequacy test, data uniformity test and data normality test using Kolmogorov-Smirnov. Mean and standard deviation are summarized for each dimension and are presented per gender for each grade [10].

Anthropometric data that was measured then processed to obtain the mean and standard deviation are found in Table 1.
Table 1. Mean and standard deviation.

| Dimension           | Mean | Standard Deviation |
|---------------------|------|--------------------|
| Popliteal Height    | 42.78| 2.07               |
| Popliteal Buttocks  | 42.70| 3.64               |
| Hand Span           | 163.95| 10.19             |
| Elbow height sits   | 23.57| 3.56               |
| Hand Reach          | 76.76| 5.30               |

Table 1 shows that the popliteal mean height dimension is 42.78 and the standard deviation is 2.07. The mean and standard deviation is obtained, then the data uniformity test and the data adequacy test are performed. Data uniformity test is carried out for each dimension, the data uniformity test for the dimensions of the hand span represents all dimensions, as shown in Figure 3.

![Figure 3. Dimension data uniformity test of hand range.](image)

Data adequacy test with s determination of 0.05 and 95% confidence level with k is 2, meaning that the average measurement data is allowed to deviate by 5% from the actual average of 95% [11], found in Table 2.

Table 2. Data adequacy test.

| Dimension           | N   | N'  | Information |
|---------------------|-----|-----|-------------|
| Popliteal Height    | 37  | 3.64| Valid       |
| Popliteal Buttocks  | 37  | 11.28| Valid      |
| Hand Span           | 37  | 6.00| Valid       |
| Elbow height sits   | 37  | 5.97| Valid       |
| Hand Reach          | 37  | 7.44| Valid       |

Table 2 shows all data N' < N, valid data for the research.

The Kolmogorov-Smirnov data normality test uses the testing stage by comparing the D value obtained with the value Dα (0.05), normality test using SPSS software. The dimensions of the hand span represent all dimensions for SPSS software, found in Table 3.
Table 3. SPSS of hand range.

| Dimension | RT |
|-----------|----|
| N         | 37 |
| Normal Parameters | | |
| Mean      | 1.6395E2 |
| Std. Deviation | 1.01897E1 |
| Most Extreme Differences | | |
| Absolute | .109 |
| Positive | .087 |
| Negative | -.109 |
| Kolmogorov-Smirnov Z | .662 |
| Asymp. Sig. (2-tailed) | .774 |

a. Test distribution is Normal.

The normal data test for hand span dimensions in table 3 looks normally distributed, the data normality test details are in Table 4.

Table 4. Data normality test recapitulation.

| Dimension            | D_count | D_table | Information |
|----------------------|---------|---------|-------------|
| Popliteal Height     | 0.10    | 0.23    | Normal      |
| Popliteal Buttocks   | 0.14    | 0.23    | Normal      |
| Hand Span            | 0.15    | 0.23    | Normal      |
| Elbow height sits    | 0.10    | 0.23    | Normal      |
| Hand Reach           | 0.09    | 0.23    | Normal      |

In table 4 all dimensions $D_{\text{count}} < D_{\text{table}}$ so that all dimensions are normally distributed, like hand span $D_{\text{count}}$ value 0.15 < $D_{\text{table}}$ value 0.23.

4. Discussion

In accordance with the purpose of the study, which is to design tables and chairs that are comfortable for learning and gathering students on campus, the percentile design must be determined first. Percentile is used to adjust the design dimensions with student dimensions. The percentile for each dimension is determined by the needs of students as users. Percentile of each dimension is seen in the recapitulation found in Table 5.

Table 5. Percentile.

| Dimension            | P5      | P50     | P95     |
|----------------------|---------|---------|---------|
| Popliteal Height     | 39.39   | 42.78   | 46.18   |
| Popliteal Buttocks   | 36.73   | 42.70   | 48.67   |
| Hand Span            | 147.24  | 163.95  | 180.66  |
| Elbow height sits    | 17.73   | 23.57   | 29.41   |
| Hand Reach           | 68.07   | 76.76   | 85.45   |

Table 5 shows that the range of hand dimensions has the 5th percentile with a value of 147.27 and a P95 percentile with a value of 180.66.

After getting the percentile, the design is shown in Figure 4.
Table Design

Chair Design

Figure 4. Table and chair design.

Figure 4: The design of tables and benches is made with the following provisions:

- **Table design provisions:** using hand span dimensions for table lengths, popliteal height dimensions + elbow height sits for table height design, a hand reaches to determine table width.
- **Chair design provisions:** use popliteal height dimensions for seat height, popliteal buttock dimensions for seat width, hand range for chair length.

5. Conclusions

The table was designed using a percentile of 50% for hand span dimensions, percentile 95% for popliteal height dimensions and sitting elbow height. The chair was designed using percentile 5% for popliteal height dimensions, percentile 50% for hand span dimensions, percentile 95% for popliteal buttocks dimensions.

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