Design of Lesehan Chair by Using Kansei Engineering Method And Anthropometry Approach

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Abstract. Special Region of Yogyakarta (DIY) is known as city for academic. Many people come to get some education in college. They live in boarding house with some supporting facilities. The most common facilities is low table which lead students have to sit on the floor while studying on table which could cause higher risk of back pain and musculoskeletal disorder. To identify the solution to reduce back pain and musculoskeletal risk, it is needed to design a lesehan chair which also appropriate to customer needs. Kansei engineering method was used with a total of 30 respondents participated, 15 kansei words collected, and 12 kansei words selected by doing validation and reliability test. The result of this study showed that quality, aesthetics, and comfort level influence the design of lesehan chair. A design of lesehan chair was created by considering the suitable concept and merging it with the physical design and its anthropometry measurement. In this case, marginal homogeneity test is needed to identify the differences between each kansei words attribute and the design or product recommendation. The marginal homogeneity test results show that the design and product recommendation has fulfilled customer’s desires and needs. For further research, it is needed to analyse and evaluate the posture of lesehan chair users in order to develop and improve its performance.

1. Introduction
Special Region of Yogyakarta (DIY) is one of the most visited city in Indonesia. Not only known with its tourism, Yogyakarta also known as an academic city. Many people come to Yogyakarta not only for vacation but also looking for education in the college. Many students spend their time not only in the college but also in their boarding house. By living in boarding house, they must have some supporting facilities such as chair and table to help them doing their homework, cupboard and etc. Based on the observation, students’ table in generally have lower measure that required students sit on the floor or lesehan chair without buffer seats that has been adjusted for a sitting position on the floor. The students should use seat that has been adjusted for a table with normal sitting position. Therefore, it is needed to design a chair with crossed-legged sitting position or lesehan chair in order to reduce the complaints of back pain and the risk of musculoskeletal disorder. Incorrect sitting position can cause a disease of the backbone and if it is not handled, the effect will be felt in the future [1]. Another impact from incorrect sitting position is musculoskeletal disorder, even an injury or a work accident [2]. And to avoid all of the risks, people should do the correct sitting by sitting upright with a straight back and clothes to the back [1].
A method of product developments that can be used to design the lesehan chair is Kansei Engineering. This method purposed to know what customer needs based on the feeling of psychological, which could help to make it easy for researchers in designing the product. Kansei Engineering is a method to translate a feeling into the parameters of the product [3].

This research aims to design a lesehan chair that compliance with the customer needs and can reduce the risk injury of the backbone. The proposed design of lesehan chair has to be in accordance with the expectation of the customer needs, comfortable and safe to use.

2. Theoretical Review

Based on the previous researches, there were many researches that are related to the design of the seat or chair using Kansei Engineering but a research related to ergonomic lesehan chair still have not found despite the fact that the lesehan chair already sold in the market yet it is still unknown whether it has met the criteria of ergonomics and the needs of consumers.

Archam et al., [4] has done a research related to Kansei Engineering which is integrated to Structural Equation Modeling (SEM) to improve the product quality of local shampoo in Malang. The Kansei Engineering method was expected to be responsive to the consumer’s psychological feeling of the shampoo product. An then using the SEM method to help researchers in calculating the value of the accuracy that could translate the gap between consumer responses and shampoo’s product specification and get variables that affect the quality of shampoo.

Application of Kansei Engineering and anthropometric method had also been done by Marlyana [5], the research is related to the selection of internet café’s room design. This study contains the design of the facility of internet cafes (a commercial public internet service cafe). The problem of this research is perceived by the customer complaints related café facilities such as the chair is not comfortable, the table is too low, and low bulkhead. By using the method of Kansei Engineering and anthropometry approach, it is expected to obtain the desired design of the cafe facilities in accordance with the psychological feeling of the cafe customers..

Restantin [6] also has done a research that integrated ergonomics, value engineering, and kansei engineering. This research was carried out to design a portable dining table and chair which can reduce the fatigue felt by visitors while enjoying the beauty and the culinary of Kuwaru beach. Most portable desk and chair on the market are made only on the basis of common functions and there have been no anthropometric approaches at the time to make the portable desk chair. The research was using the concept of Kansei Engineering in order to get the design of portable dining table and chairs which comfortable and practical by developing the product based on the imagination of the consumers.

2.1. Kansei Engineering

Kansei Engineering is a technology that translates a feeling and customers view about a product into elements of design, or can be defined as an ergonomic consumer-oriented technology for product design [3]. Kansei Engineering was introduced in Japan to incorporate emotional factors (aesthetics or "kansei") on product design. Designs that use the mental and emotional satisfaction keep growing and developed with the help of manufacturing companies in the differentiation and positioning of products [7]. There are some types of developed Kansei Engineering Method [3]:

- **Type 1 : Classification of Categories**
  This method spells out a product concept that are targeted into more detail concept, and when it expands to some order, it will be translated into physical parameter of the design.

- **Type 2 : Kansei Engineering System**
  This type is almost same as type 1, the difference lies in the changes of kansei concept into the physical characteristics. This method is a technique to translate the image of a product in customer’s memory into a real product element design with system helps.

- **Type 3 : Hybrid Kansei Engineering**
This type can be used to predict kansei from the wealth of a products. The difference of this type are its mathematics model and the relations of input to output which is done by searching the value of the coefficients.

- **Type 4 : Virtual Kansei Engineering**
  This type gives real products presentation by combining the representation with the fact. This can be done with a system of data collection standards.

- **Type 5 : Kansei Quality Management**
  This type is the application of quality management which starts from customers kansei in order to maximize customer’s satisfaction.

### 2.2. Ergonomics

Ergonomics is a branch of science that is concerned with the achievement of an optimal relationship between the worker and the work environment [8]. Ergonomics is also a discipline concerned with the understanding of interactions among humans and other elements of the system, and the profession that applies theory, principles, data and methods to design to optimize human well-being and overall system performance [9]. Ergonomics discipline in particular will learn the limitations of the human ability to interact with technology and products. It departs from the fact that human beings have limits, both short term and long term when they were facing the devices [10].

### 2.3. Anthropometry

Anthropometry is the science of measuring the dimensions of the human body, anthropometric data are used as a guideline for the design height, the space, the grip and the space of the workplace and equipment in the work area [11]. Usage of anthropometry in design to determine the user population, determine the dimensions of the body, determine the percentage of the population, determine percentile value of selected anthropometric dimensions, making the design based on anthropometric data and used for the simulator to test the design [11].

Anthropometric is also one of the tools of science that is used to create an ergonomic working condition. Ergonomics is the science of human-based design (Human Centered Design) [12]. An anthropometric measurement of the human body dimension is one part in creating ergonomic conditions. The body dimension data is very useful in design product with the aim of seeking harmony with humans who wear the products. Anthropometric data usages commercialize all the tools to be adapted to the ability of humans, not humans adapted to the tool [12].

To design a lesehan chair with accordance to ergonomic rules then it is needed to design it using anthropometry approach. Anthropometry is the science that connected with the dimensions of the human body. The human dimensions data is very useful in the design of products with a purpose to finding harmonize of a product with human while using it. The design has a high capability to human that take them is very important to reduce the emergence of danger signs caused by work error due to the presence of design error [13].

### 3. Methods

#### 3.1. Kansei Engineering

The observation of this research is done by using a list of questions and questionnaires. According to Nagamachi and Lokman [14], twenty of thirty people as sample are enough and sufficient to be used in the methods of engineering. Twenty people are participated in this study as respondent. Kansei word obtained based on the result of the analysed questionnaire. There were five steps done with the spreading of questionnaire. The first step was conducted to find out costumer desires related to the design of lesehan chair. The second step was conducted to find out the interest rates between each of kansei words to the design of lesehan chair. The third step was conducted to find out the specification
of lesehan chair based on customer needs, while the fourth and fifth steps was conducted to observe if the design and product of lesehan chair had been already satisfy the customer’s desires.

3.2. Anthropometric Consideration
The anthropometric data retrieval is the stage which can help to recognize the ergonomic conditions. Anthropometric data usage was done so the designed tool can be adapted to the human body or the body of the user. Anthropometric data was needed to determine the size of lesehan chair design. The dimensions of the body that is used will be adjusted to the needs of the lesehan chair design. An amount of 30 samples were obtained from anthropometric data bank of DSK & E laboratory. Once the data is obtained, the body dimensions were processed with several stages of testing such as the test of adequacy of the data, the uniformity of data, the normality of data, and percentile. Anthropometry measurement also used in this study to adjust and transform customer needs into more ergonomics design criteria [15]. The body dimensions used to design the lesehan chair were sitting shoulder height as the height of lesehan chair, shoulder width as the width of the back of the chair, the length of buttock to knee as the length of chair seat, hand width as the length of the handle, and hand thickness as the height of handle.

4. Results and Discussion
4.1. Anthropometry Measurements
Anthropometry data that used to design the lesehan chair was taken from the body dimension of 30 respondents with age range of 19 – 20 years old. All data has been tested for its adequacy, uniformity and normality. After the adequacy, uniformity, and normality has been confirmed, the next step is to determine the size of the percentiles. The results of the percentiles calculation can be seen in Table 1.

| Body Dimension          | P5   | P50  | P95  |
|-------------------------|------|------|------|
| Sitting shoulder height | 54.94| 60   | 63.05|
| Shoulder width          | 32.35| 39.35| 48.43|
| Buttocks to knee length | 50.5 | 56.35| 61.1 |
| Metacarpal width        | 6.8  | 8    | 9    |
| Metacarpal thickness    | 1.1  | 2.2  | 3.2  |

The percentile that will be used is the 95th percentile for each dimension according to user needs, which is to create comfort when using the lesehan chair. Each measure was added to the allowance so the body dimensions are 64 cm sitting shoulder as the height of the lesehan chair, 49cm shoulder width as the width of the back rest of the chair, 62 cm length of buttock to knee as the length of the chair seat, 9cm of hand width as the length of the handle, and 3.2 cm of hand thickness as the height of handle.

4.2. Kansei Words
There were 2 questionnaires distributed in this research. The result of the questionnaire 1 was 15 kansei words such as comfortable, durable, innovative design, attractive colour, adjustable, strong, wispy, cheap, unique, easy to clean, portable, multifunction, ergonomic, easy to store, and safe. Based on those result, questionnaire 2 was distributed to know how important each of kansei words to the design of lesehan chair. The recapitulation of the questionnaire 2 result was analyzed using validity and reliability test to determine whether the kansei word was valid and reliable. The validity and reliability test results showed that 12 kansei words were valid so it could be used as research instrument, those kansei words are comfortable, durable, innovative design, attractive color, adjustable, strong, unique, easy to clean, portable, ergonomic, easy to store and safe.
4.3. Factor Analysis

Factor analysis was used to cluster the kansei word into some groups. The purpose of the factor analysis was to find the condensing way of the information which contained numbers of origin variable into a smaller set of variable to minimize the loss of information [16]. The mapping of result can be seen in table 2.

Table 2. The factor analysis result.

| Kansei Word  | Comfort  | Quality | Aesthetic |
|--------------|----------|---------|-----------|
| Safe         | 0.889    | -0.163  | -0.031    |
| Comfortable  | 0.792    | -0.055  | -0.025    |
| Portable     | 0.783    | -0.156  | -0.28     |
| Ergonomic    | 0.756    | -0.125  | 0.110     |
| Easy to save | 0.751    | 0.002   | 0.008     |
| Adjustable   | 0.732    | -0.202  | -0.289    |
| Easy to clean| 0.180    | 0.821   | -0.017    |
| Durable      | 0.360    | 0.810   | 0.099     |
| Strong       | 0.274    | 0.620   | 0.199     |
| Attractive color | 0.368   | -0.145  | 0.712     |
| Innovative design | 0.101 | -0.114  | 0.510     |
| Unique       | -0.027   | -0.283  | 0.436     |

Based on the factor analysis result, 6 kansei words which are safe, comfortable, portable, ergonomic, easy to store, adjustable, can be classified into a variable set of comfort. Factor two which is composed of durable, easy to clean and strong, can be classified into quality variable. The last factor consists of three kansei words, which are attractive colours, unique and innovative design, were classified into aesthetic variable.

4.4. Concept Mapping

Concept mapping was used to determine the physical design characteristics which would be divided into several levels and then processed to be the final physical design. The concept of product at the highest level or zero level in this research is the design of lesehan chair. The mapping of every concept can be seen in table 3, 4 and 5.

Table 3. Concept Mapping 1 : Comfort

| Sub Concept Level 1 | Sub Concept Level 2 | Sub Concept Level 3 | Sub Concept Level 4 | Sub Concept Level 5 | Sub Concept Level 6 | Physical Design Characteristics |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------------------|
| Comfort of lesehan chair | Comfortable to use (Otista, 2012) | Comfortable in the back (Mulyono, 2010) | Size | Height : 64 Cm Width : 49 Cm |
| Do not cause soreness | Position of backrest | 95º and 115º |

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| Sub Concept Level 1 | Sub Concept Level 2 | Sub Concept Level 3 | Sub Concept Level 4 | Sub Concept Level 5 | Sub Concept Level 6 | Physical Design Characteristics |
|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-------------------------------|
| Do not create heat  | Material used       | Coconut fibres      |                     |                     |                     |                               |
| Odorless            | Material used       | Synthetic leather   |                     |                     |                     |                               |
| Comfortable in the cradle (Mulyono, 2010) | Size | Height : 62 Cm | Width : 49 Cm |                     |                     |                               |
| Do not create heat  | Material used       | Coconut fibres      |                     |                     |                     |                               |
| Odorless            | Material used       | Synthetic leather   |                     |                     |                     |                               |
| Practical (Archam et. al, 2013) | Can facilitate (Archam et. al, 2013) | Portable (Archam et. al, 2013) | Size | Handle chair | Height : 9 cm | Width : 3.2 cm | Chair folds | 3 fold |
| Easy to store (Anita 2007) | Size | Chair folds | 3 fold |

### Table 4. Concept Mapping 2: Quality

| Sub Concept Level 1 | Sub Concept Level 2 | Sub Concept Level 3 | Sub Concept Level 4 | Sub Concept Level 5 | Physical Design Characteristics |
|---------------------|---------------------|---------------------|---------------------|---------------------|-------------------------------|
| Quality of lesehan chair | Durable (Rahmasari, 2004) | Not easily broken (Rahmasari, 2004) | Chair frame | Shape | Picture 2 (Questionnaire III. B2) |
|                      |                     |                     | Material used | Iron |
|                      |                     |                     | Material used | Coconut fibres |
|                      |                     |                     | Material used | Coldore |
|                      |                     |                     | Material used | Synthetic leather |
Table 5. Concept Mapping 3: Aesthetic

| Sub Concept Level 1 | Sub Concept Level 2 | Sub Concept Level 3 | Sub Concept Level 4 | Sub Concept Level 5 | Physical Design Characteristics |
|---------------------|---------------------|---------------------|---------------------|---------------------|--------------------------------|
| Top view            | Chair backrest      | Backrest shape      | Picture 2 (Questionnaire III. C1) |
|                     | Cover of chair back | Model               | Cannot be removed   |
| Shape (Larasati, 2012) | Bottom view        | Chair seat          | Picture 2 (Questionnaire III. C1) |
|                     | Cover of chair seat | Model               | Cannot be removed   |
| Aesthetic of lesehan chair | Side view         | Chair hinge         | Picture 3 (Questionnaire III. C5) |
|                     |                     | Hinge shape         | Picture 2 (Questionnaire III. C7) |
|                     | Chair handle        | Handle shape        | Brown               |
|                     | Color (Larasati, 2012) | Chair slipcover    |                     |
|                     | Layout (Dicasani, 2014) | Chair hinge        | Visible             |

4.5. Design Recommendation
The mapping concept was used to determine the characteristics of the physical design based on consumers’ desire to be obtained by distributing questionnaires to each respondent. The final physical design that are in accordance with customer needs was obtained as seen as Table 3, Table 4, and Table 5, and then the next step is to merge the obtained physical design, while the results of the physical design can be seen as Figure 1 and Figure 2, and the actual proposed product can be seen at Figure 3 and Figure 4.
4.6. Marginal Homogeneity Test
Once the proposed design of lesehan chair has been designed, the next step is to test the Marginal homogeneity. The tests were carried out using two phases, namely the proposed design validation test and proposed product validation test. The tests were performed to determine whether the proposed design has been designed in accordance with the customer needs based on the previous stages. The tests were performed using SPSS software as for the results of the marginal homogeneity of proposed design of lesehan chair showed that with a significance level of 5%, the p-value of each attribute kansei word has a value above 0.05 which means that there is no difference between the kansei word with the proposed design. In other words, the design of the proposal has been fulfilling what consumer desires. In the marginal homogeneity test for proposed product, the results showed that the p-value of each kansei word attributes has a value above 0.05 so it can be said that there is no difference between the desired kansei word of what consumer desired with the produced product.

5. Conclusion
Based on research it can be concluded that there were 12 kansei word attributes applied to the proposed design of lesehan chair, namely comfortable, durable, innovation design, attractive color, adjustable, strong, unique, easy for clean, portable, ergonomic, easy to store, and safe, which are in accordance with customer needs. While the validation result of marginal homogeneity test showed that both proposed design and proposed product are in accordance with customer needs. However, there are still flaws in the proposed design of the lesehan chair that is on the additional functions of the lesehan chair. For further research, it is expected to perform analysis of sitting posture while sitting on the proposed product, because the sitting posture of people sit on lesehan chair and a regular chair in general is very different.

References
[1] Saputri I. Posisi Duduk yang Benar, Agar Tulang Belakang Sehat. (online): http://www.memobee.com/posisi-duduk-yang-benar-agar-tulang-belakang-sehat-1279-eij.html (accessed on 27 March 2014)
[2] Purnomo H 2012 Antropometri dan Aplikasinya (Yogyakarta: Graha Ilmu)
[3] Nagamachi M 1995 Kansei Engineering : A new ergonomic consumer-oriented technology for product development. International Journal of Industrial Ergonomics 15 3-11
[4] Archam L D, Setyanto N W, Rahman A 2013 Integrasi Kansei Engineering dan Structural Equation Modeling (SEM) Untuk Meningkatkan Kualitas Produk Shampo (Malang: Universitas Barawijaya)
[5] Marlyana N, Nurwidiana, Taufiq A R 2012 *Penerapan Metode Kansei Engineering dan Anthropometri Pada Pemilihan Desain Fasilitas Ruang Warnet* (Semarang :UNISSULA)

[6] Restantin N Y, Ushada M, Makhmudin A 2012 *Desain Prorotipe Meja dan Kursi Pantai Portabel dengan Intergrasi Pendekatan Ertonomi, Value Engineering, dan Kansei Engineering*. Jurnal Teknik Industri 14 53-62

[7] Yoshimura M, Papalambros P Y 2004 *Kansei Engineering In Concurrent Product Design: A Progress Review* Proceedings of the TMCE 177-186

[8] Tayyari F, Smith J L 1997 *Occupational Ergonomics: Principles And Applications* (London: Chapman & Hall)

[9] Vink P, Koningsveld E A, Molenbroek J F 2006 *Positive Outcomes Of Participatory Ergonomics In Terms Of Greater Comfort And Higher Productivity*. Applied Ergonomics 37 (4) 537–546.

[10] Wignjosebroto S 2006 *Ergonomi, Studi Gerak dan Waktu, Edisi Pertama* (Jakarta: PT. Guna Widya)

[11] Wickens C D, Lee J, Liu Y, Becker S G 2004 *An Introduction to Human Factors Engineering*. (New Jersey: Pearson Educational Internasional)

[12] Santoso G 2013 *Ergonomi Terapan* (Jakarta :Prestasi Pustaka Publisher)

[13] Liliana Y P, Widagdo S, Abtokhi A 2007 *Pertimbangan Anthropometri pada Pendisainan* (Yogyakarta : SDM Teknologi Nuklir)

[14] Nagamachi M, Lokman A M 2009 *Kansei Engineering : A Beginners Perspective* (Tokyo : KDRU)

[15] Mariyana N, Nurwidiana, Taufiq A R 2012 *Penerapan Metode Kansei Engineering dan Anthropometri Pada Pemilihan Desain Fasilitas Ruang Warnet* (Semarang : UNISSULA)

[16] Hair J F, Anderson R E, Tatham R L, Black W C 1995 *Multivariate Data Analysis With Readings, 4th Edition*. (Engleweood Cliffs, NJ : Prentice Hall)