



REDESIGN OF SEWING OPERATOR SEAT USING REVERSE ENGINEERING METHOD

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ABSTRACT

we often see that many of the chairs that tailor tend to have a long shape and the width of the seat is quite narrow. The problem of working attitude faced by the sewing machine while running from a non-ergonomic work chair is the attitude of forced labor such as: lifting the operator up, and lifting the shoulder. If the ergonomic problem is not corrected, it will certainly give an excessive burden, musculoskeletal complaints which will be followed by a decrease in the level of work productivity. Therefore, it is necessary to conduct research in an effort to overcome the problems that arise. For this purpose, research was conducted on the Development and Design of Sewing Operator Chairs Using the Reverse Engineering Method. The number of research samples taken were 26 operators. In this study, it was found that there were 5 parts of the operator's seat that were repaired, namely in the seat connection, seat support mat, backrest, seat mat, and frame. And for the Popliteal Length percentile data at the 50th percentile, Hip width using the 95th percentile, Popliteal height using the 50th percentile.

Keywords: Sewing Operators, Reverse Engineering (RE), Ergonomics

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1. Introduction

Sewing is the work of connecting fabrics, fur, animal skins, pepagan, and other materials that a sewing needle and thread can pass through. Sewing can be done by hand using a hand needle or with a sewing machine. Various kinds of clothing products are produced, such as school uniforms, formal wear, sports uniforms, and others. Activities in the convection business certainly cannot be separated from the supporting facilities, one of which is chairs. The chair is one of the facilities used to sit and has several legs to support the user's body weight and some also have a chair back. Chairs are widely used as a means of supporting various activities, both for relaxing and for supporting work.

Often we see that many of the chairs used by tailors tend to have a long shape and have a fairly narrow seat width. In terms of the shape of the long chair, when viewed from its designation, the chair is not only used for sewing, but also for placing clothes that have been sewn and placed next to the seat. Then in terms of the shape of the chair which has a narrow seat width, the chair does not take up much space.

The problem of working attitude faced by the operator when running the sewing machine as a result of the non-ergonomic work chair is that it causes forced labor such as bending, lifting

the arms, and lifting the shoulders. The potential risks that often occur to workers are:

1. Workers often maintain stiff shoulder, elbow, and wrist postures when sewing because the height or chair position is not in accordance with the worker's anthropometry.
2. Workers have to sit for long periods of time in the same position, which results in pain in the back, neck, buttocks, and reduces circulation to the legs. From the description above, the main problem and need to be repaired immediately is the problem of the work chair that is not in accordance with the operator's anthropometry.

If this ergonomic problem is not immediately corrected, it will of course be able to provide excessive load, causing musculoskeletal complaints which will be followed by a decrease in work productivity levels (Nofirza & Syahputra, 2016). Therefore, it is necessary to do research in an effort to overcome the problems that arise. For this purpose, research was conducted on the Development and Design of Sewing Operator Chairs Using the Reverse Engineering Method.

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2. Literature Review

2.1 Concept Development

The essence of design planning lies in the development of concepts. The design concept is a combination of spoken, written and prototype forms that will be improved and how the customer shows the advantages or disadvantages (Sokhibi, 2017).

The concept development process includes the following activities:

1. Identifying Consumer Needs (Identifying Customer Needs)

The objective of this activity is to understand consumer needs and connect effectively to the development team. The output of this step is a neatly organized set of customer requirements statements, arranged in a hierarchical list, with weightings of importance for each requirement.

The purpose of the method of identifying customer needs are:

- Ensuring that the product has been focused on consumer needs.
- Identify hidden and unspoken consumer needs (latent needs) as well as explicit needs.
- Become the basis for compiling product specifications.

2. Develop Target Specifications (Establishing Target Specifications)

Specifications are the translation of consumer needs into technical needs. The output of this step is a list of target specifications. The process of creating a target specification consists of 3 steps:

- Prepare a matrix list of needs with the level of importance that is derived from the level of importance of the needs that it reflects.
- Gather information about competitors and combine it with the level of satisfaction of customers' products.
- Set the ideal and marginal achievable target values for each matrix.

3. Concept Generation At this stage the things to do are:

- Determine the technical specifications of the sewing machine operator chair to be designed such as the basic model and shape of the frame.
- Determining the percentile size of Indonesian anthropometry used for designing sewing machine operator chairs
- Selecting the sewing machine operator seat frame component material according to product requirements.

4. Concept Selection

Concept selection is the activity of selecting various concepts which are analyzed in succession, then eliminated to identify the most promising concepts. Concept selection consists of two stages, namely:

a. Concept screening

The purpose of concept screening is to quickly narrow down the number of concepts and to refine concepts.

b. Concept assessment

At this stage, the team assigns a relative importance weight to each selection criterion and focuses on better comparison results with an emphasis on each criterion

2.2 Reverse Engineering

Reverse Engineering (RE) is a step in the process of developing technical data to support resource efficiency and to increase productivity (Tjandra et al., 2012). In RE Accurate data for long term development and tools for engineering capabilities are of utmost importance. Success in reverse engineering is generally measured by the return of the amount of capital within a certain time. Likewise, the success of RE is also measured by the overall effectiveness of the long-term and short-term objectives. The following is the difference between the traditional design process and reverse engineering. It can be seen in Figure 1.

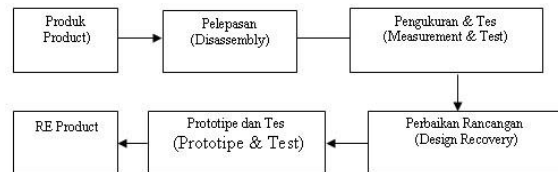


Figure 1. Traditional design process and RE Design Process diagrams

From Figure 1 it can be seen that in the traditional design process, the product is made after a request from the customer is then designed and prototyped and tested, after that a new product is made. Whereas in the RE process design, existing products are removed and measured if they need to be tested, in this process the dimensions of each part that have been removed (disassembly) are measured and then tested for fittings or the dimensions are measured and the geometry is identified. The next process is making a prototype and finally testing the prototype. If the prototype meets the specifications, then the product can be remade and ready to be marketed (Eka Pratama, 2020).

The important things in Reverse Engineering (RE) are:

- RE is a series of production
- RE goals are to produce a product/component with high efficiency and quality at low cost.
- RE identifies system weaknesses in various ways.
- In the manufacture of new RE products, documents to support equipment and equipment maintenance document systems are very important.

The advantages of Reverse Engineering (RE) are:

- RE is also targeted to modernize the singular component of a system, not the desired system to improve the production system.
- RE is a Quality Function; RE uses TQM. Where TQM is a process for managing (handling) work based on the evaluation of work process analysis. RE also follows ISO 9000 quality assurance. RE is widely used in production systems. Most systems, both human resource and manufacturing, can use the RE process to increase efficiency and productivity.

2.3 Ergonomics

Ergonomics is concerned with focusing on humans and how they interact with products, equipment, facilities and in the workplace environment in everyday life (Surya et al., 2013).

Ergonomics emphasizes increasing work effectiveness and efficiency with the aim of increasing human values. One example is: prioritizing the safety of K3 employees, reducing fatigue and others (Daywin et al., 2019).

Ergonomics is related to the application of various information which contains human limitations, abilities, characteristics of behavior, motivation in designing the daily work environment (Wijaya et al., 2016).

1. Ergonomics Principle

The principles of ergonomics include usability, safety, comfort, flexibility and strength. In addition, the principles of ergonomics that you should know are reducing excessive workloads, reducing stress levels, creating a comfortable work area, doing movements to stretch while working and others.

2. Ergonomic Benefits

The benefits that we can get from ergonomics are as a means to improve performance that prioritizes accuracy, safety and reduces energy while working. In addition, the benefits of ergonomics are to reduce time, cost, optimize human resources through training in various skills. Optimizing and streamlining time and providing comfort for employees while working.

3. Research Method

This research was conducted on several sewing machine operators in Sidayu District, Gresik. The time of the research was carried out in February 2021-June 2021. The tool used in this research is Software Inventor 2016. At this time the sewing chair used can be seen in Figure 2. The sewing chair used by sewing operators tends to have no support on the back and Most of them are still in plastic form.



Figure 2. Sewing chairs used by sewing operators

4. Result and Discussion

A. Anthropometric data for sewing operator in sitting position

Table 1 shows the data taken in this study, with a total sample of 26, and the data taken on the dimensions of popliteal height, popliteal length, and hip width.

Table 1. Anthropometric data of sewing operator sitting position

No	Popliteal		Hip Width
	Height	Length	
1	46	44	39
2	48	46	38
3	48	46	40
4	50	45	41
5	51	46	43
6	48	47	43
7	50	46	40
8	47	45	42
9	48	45	41
10	49	45	50
11	48	47	41
12	47	47	40
13	48	46	40
14	49	46	42
15	49	45	41
16	49	46	40
17	48	47	39
18	48	45	42
19	49	45	40
20	49	45	41
21	48	46	44
22	50	45	44
23	49	47	40
24	47	46	42
25	48	47	41
26	46	47	49

B. Percentile Data Analysis

Table 2 shows the analysis of percentile data in application to seat design for sewing machine operators

No	Dimension	Percentil	Information
1	Popliteal Height	50	The 50th percentile is used because the seat will have a width that can be used by operators who have small or large postures
2	Popliteal Length	95	The 95th percentile is used because the chair will have a length that can be used by operators who have a large body posture. With a fairly wide seat length, it is expected to add comfort in doing work
3	Hip Width	50	The 50th percentile is used because the chair will have a height that can be used by operators who have small or large postures

C. Ergonomic Design Analysis

1. Connection Model

The component design for this joint concept is designed simply to be easy to remove and easy to maintain, and the connection is made stronger so that it is not easy for material failure to occur when exposed to the operator's load, this chair frame can rotate to make it easier for the operator to operate the sewing machine, and there is also an additional spring on the connection holder. The concept of seat connection can be seen in Figure 4.



Figure 4. Seat connection concept

2. Chair Support Model

The concept for leg support has been changed significantly, the legs of the chair are not given wheels so that the chair does not move from place to place when the operator operates the sewing machine. There is also an additional footrest. The concept of the seat support base can be seen in Figure 5.



Figure 5. The concept of the chair support

The seat height is not too high according to the operator's anthropometry so that the lower side of the thigh is not compressed. This causes operator comfort, because the seat height is adjusted between the knee and head distance when the operator is in a sitting position.

3. Backrest Model

The concept of the backrest designed is that in general the components needed for the seat back are fewer and easier to manufacture. The shape of the backrest is made simpler and stronger because it is curved according to the operator's back posture. The concept of the chair backrest can be seen in Figure 6.



Figure 6. Backrest concept

The size, configuration and location of the backrest are the most important and necessary considerations to ensure proper fit between the operator and the seat. The seat back function is provided to support the waist or back area.

4. Model of the seat

The seat mats have been repaired, the first time using foam which if you sit on it often can be thin and make the sewing machine operator uncomfortable when sitting. Replaced with synthetic rubber so that it can adjust the buttocks sitting on the chair. The concept of the seat mat can be seen in Figure 7.



Figure 7. The concept of the seat cushion

5. Frame model

The frame model in this prototype is designed so that the sewing machine operator's seat is comfortable and strong when occupied by the operator and the operator can still concentrate on running the machine, with the seat design on the frame being slightly advanced so that the operator's position can remain upright when operating the sewing machine and when the operator leans his body into the back of the seat the operator can be comfortable because the seat position can follow the operator's movements when sitting. The concept of the back of the chair can be seen in Figure 8.



Figure 8. The concept of the seat back

5. Conclusions And Suggestions

5.1 Conclusion

Based on the research results it can be concluded that:

- a. Popliteal length uses the 50th percentile because the seat will have a width that can be used by operators who have small or large postures.
- b. The width of the hips uses the 95th percentile because the seat will have a length that can be used by operators who have large postures.
- c. Popliteal height uses the 50th percentile because the chair will have a height that can be used by operators who have small or large postures.
- d. After doing reverse engineering, there were 5 parts of the operator's seat that were repaired, namely in parts: Seat connection, seat support mat, backrest, seat mat, and frame.

5.2 Suggestion

The Association of UMKM Sidayu as a place of research is expected to consider the suggestions given by implementing policies in accordance with the results of observations made, with the aim of being able to provide benefits in the future.

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