Research Article

Design Of Pt Xyz Work Station By Calculating The Standard Time, Single-Minutes Exchange Of Dies (Smed) And 5s Method

Rendiyatna Ferdian[1], Asep Anwar[2]

[1,2]Department of Industrial Engineering,Widyatama University
[1]rendiyatna.ferdian@widyatama.ac.id , [2]asep.anwar@widyatama.ac.id
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ABSTRACT: A good work station can support an increase in worker productivity. Increased productivity will have a direct impact on company profits and provide workers with morning comfort. In this research, the role of work station design with reference to standard time, Single-Minutes Exchange of Dies (SMED) and 5S method was carried out. Standard time is used to see how long workers do a job. The SMED method aims to replace an external setup activity with an internal setup that reduces the setup time for an activity. To support the SMED method, it is necessary to design a work station based on the 5S principle. The resulting work system design results in the form of a work station that has considered ergonomic principles to support the performance of workers. The results of the design carried out are expected to increase comfort for workers.
Keywords: Work Station, Productivity, Standard Time, SMED, 5S

1. Introduction

The design of a good work system can affect the production process, these conditions can make the production process run well so that the company will produce quality products and maximum profits. There are several things that need to be considered in designing a work system, one of which is the time to manufacture the product. The time to manufacture a product is an important factor in designing a work system, therefore the measurement of time in a job needs to be done. The results of time measurement can be used to plan labor requirements, production scheduling, especially to find out which products an operator can produce.

The process of making work standardization is intended to provide an overview for the company regarding the time it takes to make its products. In addition, by determining the standardization of the work system, a good work environment can be obtained for workers so that it is expected to produce high productivity from the workers.

PT XYZ is a company engaged in the manufacture of scissor jacks. The purpose of this research is to measure working time which includes the selection of operating elements, measurement of cycle times, data processing to determine the standard time for a scissor jack assembly activity at PT XYZ. In addition, this research aims to design a machining workstation for operators based on the principles of ergonomics and work system engineering.

2. Literature review

Work System Design

The work system design aims to produce a good work system to increase productivity in the production system. Sutalaksana et al. 2006 stated that a good work system design must be based on four main criteria, namely time, physical, psychological, and sociological. Based on these criteria, a work system is said to be good if it provides the fastest turnaround time, uses the lightest physical exertion, provides the lowest psychological and sociological impact. Another factor that influences the design of a work system is the human factor (workers). To be able to design a good work system requires attention to the capabilities and limitations of hum
ans in carrying out their jobs.

Standard Time

Time measurement activities are carried out to obtain the time required by a normal worker to reasonably complete a job in a best work system. In general, working time measurement techniques are divided into two, namely direct and indirect.

SMED

SMED (Single-Minute Exchange of Dies) is a method to minimize setup time when product types change. In the industrial world, SMED can be useful for increasing the productivity of a machine. The use of a good SMED will minimize the idle time of a machine so that it is expected that the output produced by the machine will increase. An example of a company that has implemented SMED principles in the industrial world is PT Toyota Motor Manufacturing. PT Toyota implements that the production line is made only for the same type so that they do not need to do mold changes or do a long setup process for the product change process.

5S Methodology

5S comes from Japanese, namely Seiri, Seiton, Seiso, Seiketsu, Shitsuke which is a method used to reduce unnecessary activities. In the industrial world, 5S will play a role in increasing productivity by making improvements to work flow management, where the implementation of 5S in a company will facilitate the flow of work. In the industrial world, an example of a company that applies the 5S principle is the motorized vehicle manufacturer PT Toyota. Seiri, in the PT Toyota production system, goods that are no longer used and can still be used will be marked so that it makes it easier for the operator to determine which items should be disposed of and which are not. Seiton, an example of implementing seiton is by using a signboard strategy, so that the operator can quickly find out the location of the objects needed. Seiso, is a method for structuring the workplace so that it will create work motivation from the operator's side. Seiketsu, namely maintaining the quality of the work environment so that it is maintained neatly. Shitsuke, is the final step in the 5S method, namely self-awareness and work ethics for operators in the work environment(Sezgin & Cesur, 2019).

3. Methodology

The stages carried out in this study began with the collection of field data regarding the standard time and current working conditions. After that, perform statistical tests to determine the standard time for work activities and make a design proposal for a work station. The statistical test consists of normal test, uniform test, and data adequacy test. The final step in this research is to make an analysis based on the results of the data processing that has been carried out. The complete picture of this research step is shown in **Figure 1**.

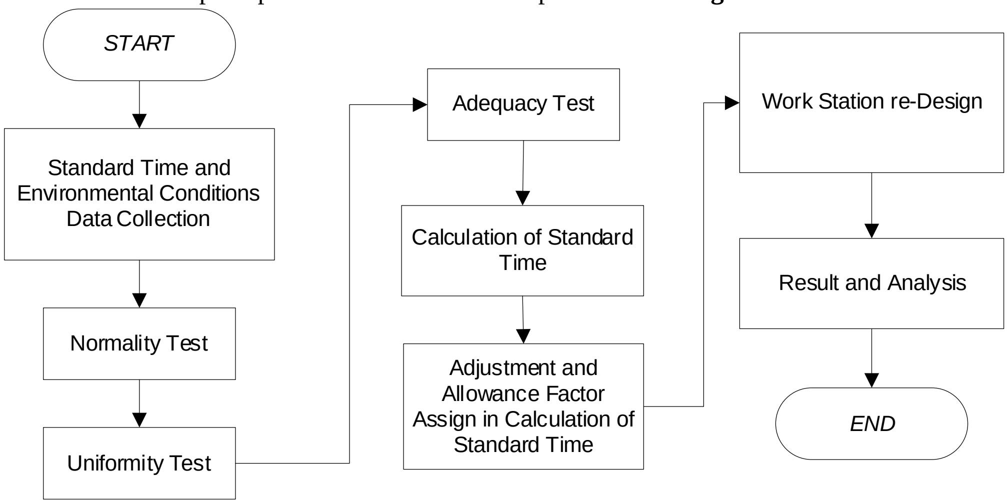

Figure 1 Flow Methodology Research

4. Result and analysis

Normality Test

The normality test aims to compare empirical data with theoretical normal distribution data which has the same mean and standard deviation as the empirical data. Normally distributed data is one of the requirements for the characteristics of the data that the population has. The normality test used in this study is the Greary's Test, with the following results:

$$U = \frac{\sqrt{\frac{\pi}{2}}}{\sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n}}}\left(\frac{\sum|x_i - \bar{x}|}{n}\right) = \frac{\sqrt{\frac{3.14}{2}}}{\sqrt{\frac{67.543}{30}}}\left(\frac{36.279}{30}\right) = 1.010$$

Testing for normality, which is looking at Zhitung's position in the standard normal curve which has two ends of the critical region (the two-sided critical region). The assumption is that the level of significance (α) = 0.05 with the area of each critical area is (α / 2) = 0.025 so that the confidence interval starts from Z0.025 to Z0.075 or (1-α) 100% = 95%. From the standard normal distribution tables, it is known that (Zα / 2) = Z0.075 = 1.96.

$$Z = \frac{(u-1)\sqrt{n}}{0.2661} = \frac{(1.010-1)\sqrt{30}}{0.2661} = 0.202$$

The calculated Z value is 0.202, then the Z value is in the range -1.96 to 1.96, so the data is **normally distributed**

Uniformity Test

The uniformity test aims to determine whether the data comes from the same system or not. This test is carried out using a variable control chart with the results shown in **Figure 2**. It can be seen from the plot data that there are some data where the values are out of reach. These conditions can be caused by several conditions such as service levels, environmental disturbances, and others. Not all data are within the limit and lower bound ranges, so it can be concluded that the data are **not uniform**.

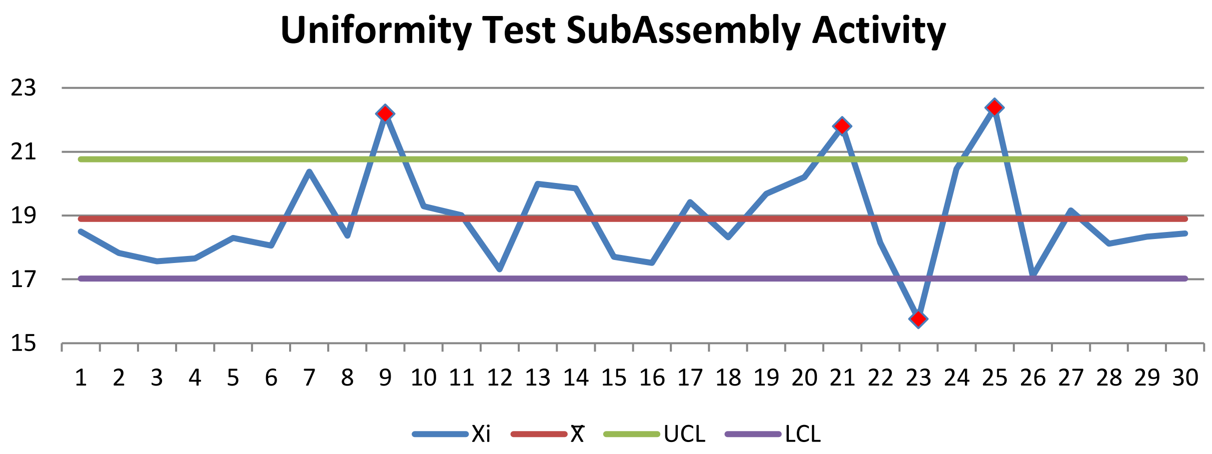

Figure 2 Uniformity Test

Adequacy Test

The adequacy test aims to prove that the amount of sample data taken is representative or represents the number of existing populations. In this sufficient test, an accuracy level of 5% and a confidence level of 95% is used, the results of the sufficient test are as follows:

$$N' = \left[\frac{40\sqrt{N\sum(x_i{}^2) - (\sum x_i)^2}}{\sum x_i}\right]^2 = \left[\frac{40\sqrt{30(10777.796) - 321307.586}}{566.840}\right]^2 = 10.09$$

The amount of data is said to be sufficient if N' ≤ N where N is the amount of sample data taken.

Conclusion: The value of N is greater than N', so that the data is sufficient.

Standard Time

The process of calculating the standard time begins with the calculation of the cycle time, where the cycle time is obtained from the directly observed average assembly time. So, it is known that the cycle time for the sub assembly 1 assembly activity is 18,895 seconds. The next process is to find normal time. Determination of normal time begins with determining the adjustment factor. The following is a table of Westinghouse's adjustment factors.

Table 1 Westinghouse's Adjusments Factors

Factors	Class	Symbols	New Adjusment
Skills	Fair	E1	-0.08
Efforts	Excellent	B1	0.07
Working Condition	Average	D	0
Consistency	Fair	E	-0.02
Performance Factors			-0.03

From the table it is found that the total adjustment given is -0.03. This factor value is then entered into the normal time calculation.

$$Wn = Ws \times (1 + p) = 18.895 \times \left(1 + (-0.03)\right) = 18.328\ seconds$$

The next process is calculating the standard time, the standard time is calculated by considering the allowance factor that occurs. The following is a table of allowance factors.

Table 2 Allowance Factors

Number	Factors	Allowance %
A	Energy Expended	4
B	Work Gesture	1
C	Work Movement	0
D	Eye Fatigue	6.5

E	Workplace Temperature	22.15
F	Atmosfer	0
G	Good Environmental	11
H	Personal Needs	2
Allowance Factors		46.65

From the table it is found that the total allowance given is 46.65%. This factor value is then entered into the standard time calculation.

$$Wb = Wn \times \left(1 + {}^{l}\!/_{100}\right) = 18.328 \times \left(1 + {}^{46.65}\!/_{100}\right) = 26.878\ seconds$$

Work Station ReDesign

PT XYZ manufactures the scissor jack components. There are five machines and two unconnected conveyors to produce the jack components. The five machines have the same specifications. Each machine has two vise and produces two different parts. The entire workflow is fine and the waiting time is minimum. Here are improvements to the workstation to maximize movement and convenience for workers.

Figure 3 Workstation Condition

The new workstation repair has several supporting components, namely:

1. The machine, used to make the jack production part.
2. The jack of the machine is used to adjust the height of the working table where the machine is located.
3. Power supply, as the main source of electrical energy for the jack production machine parts.
4. Working machine, where the jack production part is made.
5. Operation keys, are used to operate the work machine as needed.
6. Engine indicator, as an indication of the ignition of a machine or vice versa.
7. Operating cable, connecting the signal from the operation button with the engine indicator.
8. Vise, serves as a print part of the jack production.
9. Wooden table, serves as a vise base where the height is the same as the height of the machine.

For the design of a new workstation, several improvements are needed, such as:

1. The addition of a wooden table whose height is equivalent to the jack part machining place and placed next to the working machine.
2. The vise tool is moved to the wooden table.
3. Decrease the position of the operation buttons (according to the 5th percentile calculation) as shown in **Figure 4**.

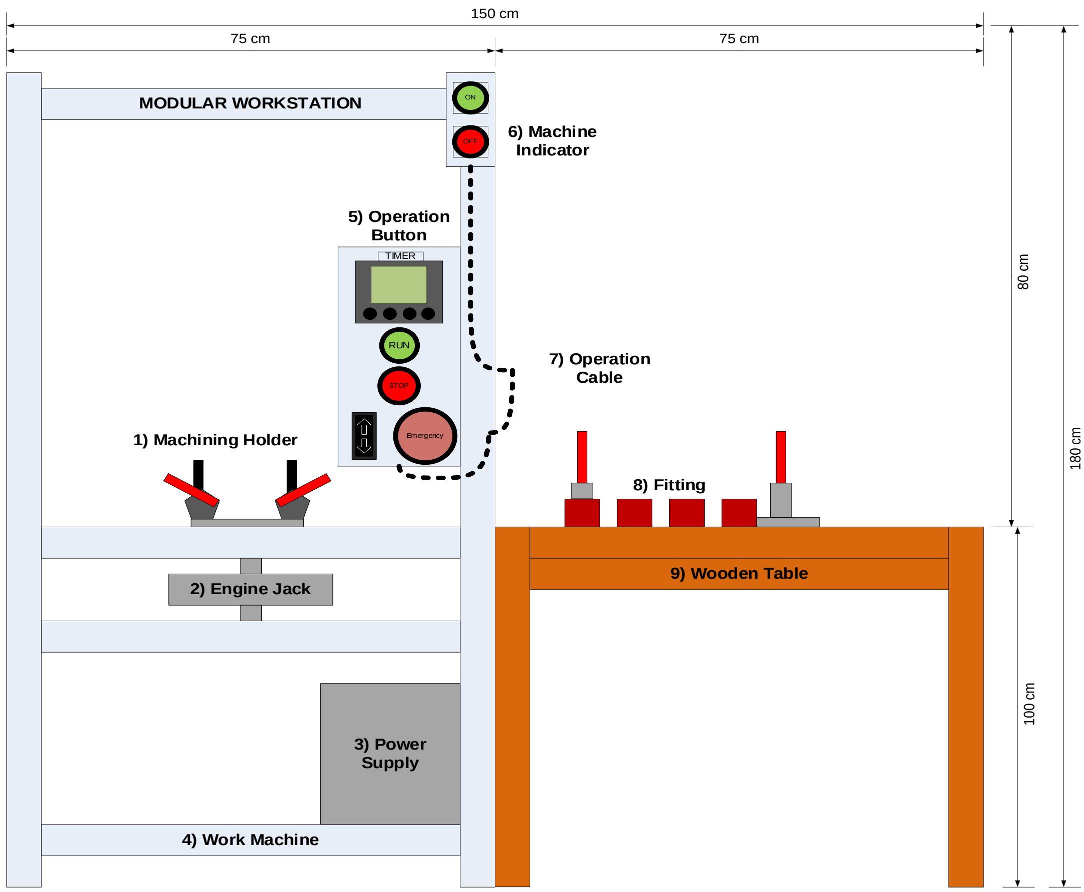

Figure 4 Workstation Design

Determination of the value of the adjustment factor is carried out when there is an abnormality at work, such as working without seriousness, very quickly as if being rushed for time or because you encounter difficulties such as bad room conditions. In this assembly the adjustment used is the Westinghouse adjustment. The skill factor is categorized in the Fair class with an adjustment value of -0.08. This is because operators are still new to the product to be assembled. The next factor is the business factor, this factor is categorized into the excellent class with an adjustment value of +0.07. This is because the operator is trying hard to carry out the assembly process which is basically new to him. Furthermore, namely the working conditions factor, this factor is considered insignificant because of the good work space and also not too bad. The last factor is the consistency factor. The consistency factor is categorized as fair with an adjustment value of -0.02. this can be seen from the length of time it takes the operator to complete 1 assembly activity. At the beginning of assembly, the operator takes a longer time when compared to the time after repeated work. Operators are familiar with these activities.

The determination of the value of the allowance factor is given for three things, namely for personal needs, eliminating feelings of fatigue, and unavoidable obstacles. These three are things that are actually needed by workers, and during which measurements are not observed, measured, recorded or calculated. Therefore, according to the measurement and after obtaining the normal time, the allowance needs to be added. The energy expended can be ignored because workers work at the table in a sitting position. So that the percent leeway is obtained by 4%. The second factor is work attitude. The operator performs the job in a sitting condition so that the percent leeway obtained is 1%. The third factor is the work movement factor. The operator performs the assembly with normal movements. The fourth factor is the eye fatigue factor. In this factor the operator takes an almost continuous view so that they find a factor of 6.5%. The next factor is the state of the workplace temperature which is considered high based on the results of temperature measurements taken. So that we found a percentage of 22.15%. The next factor is the factor of the state of the atmosphere. In this condition, the operator works in a place that has good ventilation so that the air in and out is also good. The last factor is a good condition and environment. Due to the operator doing work in the classroom, the situation is considered extraordinary so that the percentage found is 11%. And what should not be overlooked is his personal needs because the operator is a man so that the percent lease is 2%. The total percentage of looseness that was received in this assembly process was 46.65%.

The design of a CNC machine workstation is done by changing the location where the ON / OFF, run, stop, emergency and up / down buttons are lower than before. This is because the location of the buttons is too high so that operators who are not too tall will find it difficult to reach the buttons. If this machining work is done in a small frequency, it is not a problem, but the frequency of this work is quite a lot so that if it is done over a long period of time, it will be difficult for operators and can hamper the machining process. The location of the recommended buttons uses anthropometric data on eye height, forward hand reach and upward hand reach. Anthropometric data on eye height is used so that the operator is comfortable seeing the display of the buttons, the reach of the forward hand is used so that it is not too far to reach the buttons, and the reach of the hand up is used so that it is not too high to reach the buttons. From the three anthropometric data, the 5th percentile was chosen because it was to accommodate operators who were not too tall, so that with the 5th percentile, operators with tall bodies could adjust and operators who were less tall could reach the buttons.

The workstation design for the overall layout was also changed because it made it easier for operators to move from one machine to another. The placement of machines must be considered, in addition to facilitating the movement of operators, it must also be able to accelerate production. Therefore, the distance between machines needs to be considered, the distance from one machine to another is considered through hand-stretched anthropometric data. The percentile used is the 95th percentile because it can accommodate wide-bodied operators and operators who are slimmer can adjust.

The results of improvements to the layout of the machine that have been carried out by adding a wooden table work tool, moving the vise tool to the wooden table and decreasing the location of the operation buttons. This is useful for making it easier for the operator to operate the jack part making machine according to the concept of Poka Yoke (avoiding mistakes) and 5S, namely Seiri (Compact), Seiton (Neat), Seiso (Resik), Seiketsu (Rawat) and Shitsuke (Diligent). In addition, the production time for jack parts is faster with improvements to the engine layout in accordance with the SMED (Single Minute Exchange Dies) concept.

5. Conclusion

Measurement of working time can be done directly and indirectly. Measurement of working time is carried out directly at the workplace, for example by using downtime or sampling methods. Meanwhile, indirect measurement of working time is carried out without being in the workplace, for example by using standard time data from the same job in the past or using movement time data. The advantages of direct time measurement are practical, but the disadvantages are that it requires a longer time and is relatively more expensive. While the advantages of indirect time measurement are relatively short time and lower cost, however, the movement time data is incomplete, it must be adjusted to work environment conditions, and the standard time data used in Indonesia is only a few, while Indonesia and Europe standard time cannot be equated.

Measure uptime using downtime hours, and select elements of the effective operation with various considerations. The measurement of cycle time is done by first testing the normality, uniformity and adequacy. Standard time data processing is carried out by considering allowance adjustments.

The design of the machining workstation considers the operator does not need to take raw material and vise down because the work station is added a table so that the placement of raw material and vise is right to the right of the operator to make their movement more effective.

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