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Evaluation of Set-Up Time using the SMED (Single Minutes Exchange of Dies) Method
(Case Study: Finger Replacement in Building Two Stage Machines in PT Z)

Andi Setyawan, Versi Harga Riksa, Marinus Halawa, Erry Rimawan
Industrial Engineering, Mercu Buana University
Jakarta Indonesia

Abstract: PT Z is a multinational company that processes rubber and chemical materials into tire products. In the process of making tires, several machines are needed, starting from a mixing machine that will process rubber and chemical materials to building, which functions to process the material to become a raw tire. The building two stage machine has several important components, one of which is finger. In the use of finger must be replaced according to the lifetime. The usual set-up is done to install and release the finger too long which can reach 149 minutes. One evaluation to reduce set-up time is by implementing the SMED system at PT. Z on the building two stage machine. Before the implementation of SMED the time for replacing the finger was 149 minutes, with loss due to set-up of 450 Pcs / day, after the implementation of the SMED system the set-up time could be reduced by 2 conditions, namely; a) the condition of a breakdown condition finger change is 71.88 minutes with loss due to 219 Pcs set-up / day and a loss green tire decreases 231 pcs / day from 450 pcs / day, b) finger replacement b conditions based on a predetermined lifetime that is to be 30.04 minutes with loss due to 90 Pcs / day set-up, so that the loss green tire is reduced by 360 pcs / day from 450 pcs / day.

Keywords:- *SMED, set-up time, internal setup, and external set-up Off.*

I. INTRODUCTION

PT Z is a company engaged in tire manufacturing which one of its products is car tires, PT Z manufactures car tires more than 80% of its products are sold overseas and has positioned itself as the leading and largest tire manufacturer in Indonesia with proven quality . Along with the increase in consumer confidence in the tires produced, bringing these tire products to become Original Equipment Manufactures (OEM) for several existing car companies. A product if it is believed to be one part of the official material of a company, in the end the demand for quality products becomes an obligation that must be fulfilled in every production process.

PT Z Plant D, especially in the building department, has a large number of machines and product sizes so it requires preparation time for production, especially for the large number of building two stage machines, there are 76 machines with the same engine characteristics. Machine building two stage is a type of building machine with a material assembly process carried out in two stages, for the first stage carried out on a first building machine and the second stage carried out on a second building machine. In the building two stage machine there is a set-up time which actually takes a long time and varies especially during the finger change process so that it slows down the production rate in the building machine. The problem faced today is in replacing the finger set-up is the set-up time of the process where currently the required set-up time is 149 minutes so that the loss caused for this set-up finger is quite large, namely 450 Pcs. Therefore, the right method is needed to reduce the set-up time to replace the finger with the SMED method (*Single Minutes Exchange of Dies*).

The SMED method is used to change set-up times to below the same and more effective set-up time. This is a theory to change the setup time to below the usual setup time. The SMED method separates set-up activities into two, namely internal setup and external set-up. Internal set-up is a set-up activity that can only be done when the engine stops. External set-up is a set-up activity that can be carried out when the engine is running or operating. By changing the internal set-up to an external set-up, set-up activities are carried out when the engine stops being carried out when the engine is running so the set-up time can be reduced.

II. LITERATURE REVIEW

According to the journal entitled "Proposed Reduction of Setup Time Using the SMED Method and Reducing Production and Assembly Process Times Using the Most Methods at PT Panasonic Manufacturing Indonesia" by Rizki Nurul Fathia, Sumiharni Batubara, and Dian Mardi Safitri. The length of time the evaporator is made by the method of moving the operator that is less standard and the layout that is not close between work stations. SMED (Single Minute Exchange of Dies) is one of the improvement methods from Lean Manufacturing which is used to accelerate the time needed to make a replacement setup from producing one type of product to another product model. This method is used to reduce the length of the machine setup Fin Press FIX 18. From the proposed improvements using the SMED method, the machine setup time is obtained Fin Press Fix 18 for 931.15 seconds which is a reduction in setup time by 54.27%. Method MOST (Maynard Operation Sequence Technique) is one of the predetermined time system techniques for time measurement arranged in the order of sub-activities or movements. Method this is used to reduce the evaporator

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and assembly process time Air Conditioner Model CS-YN9RKJ. Proposed improvements that perform for movement and posture change operator. In addition, the proposed improvement for the evaporator manufacturing process is to make changes to the layout of the work station, while the assembly process is to reduce the working elements of the operator. From the proposed improvements using the method MOST obtained the evaporator manufacturing process time for 1082.42 seconds which is a reduction in time by 19.47%. While , the time to execute this assembly during 393.27 seconds of a reduction in the time as many as 29 %. The results of the proposed fixes uses the method SMED and MOST is a reduction in Manufacturing Lead Time for 423415 seconds or a reduction in Manufacturing Lead Time by 23%. (Rizki Nurul Fathia, Sumiharni Batubara, and Dian Mardi Safitri, 2016).

A. Theoretical Basis

➢ *Technical Procedures For Working*

Work procedures are a science that consists of techniques and principles to get the best design from a work system. These techniques and principles are used to regulate the components of a work system that consists of humans with their properties and abilities, materials, equipment and work equipment, and work environment in such a way that it is achieved a high level of efficiency and productivity as measured by time spent, energy used and the psychological and sociological consequences it causes. (Sutalaksana et al. 1979).

➢ *Waste*

Extravagance according to Fujio Cho, extravagance is all things who waste by outside a minimum of nine years demand instead of continuing to device, the prices of staples pushed, the largest component in, a place, and work time absolutely necessary for the process of the levels of value added a product. While Henry Ford have a simpler formulation of extravagance, if something not be valued at added, that is what is called extravagance. (Suzaki. 1987).

➢ *Simplification, Merging and Deletion*

The main difficulty in eliminating waste is because most of us have never been directed to try to identify that waste and eliminate it. But with the awareness to try, everyone can certainly do it. It is said that 90% of improvements come from common sense. The greatness of the improvement is very simple. Even when an improvement is realized, many people are surprised with curiosity, why they didn't think there before. But to get the skills to make improvements, some principles can be very helpful so we no longer have to do too many trials.

Various techniques in the field of industrial engineering can be the foundation for process improvement programs. Some people feel that various improvements were made by industrial engineering engineers because "they were paid to do it," but this thought is out of place. In principle, we can all contribute to the improvement effort. Who knows best about the ins and outs of a job? The answer is the operator who does it. The basic idea of each improvement is very simple. We want a simpler, faster, cheaper, better and safer way of working. For this reason, the basic approach to improving processes is to simplify, combine and eliminate. (Suzaki. 1987).

➢ *Work Map*

A work map is a tool that describes work activities systematically and clearly (generally production work activities). Through work maps we can find out in full the stages or events experienced by a workpiece from the start into the factory (in the form of raw materials), then describe all the steps in nature, such as transportation, operations, inspection and assembly, to finally become finished products , either complete products, or parts of complete products. (Niebel, and Freivalds, 2003).

➢ *Time Measurement*

Time measurement is the work of observing and recording time - the time it works both for each element or cycle by using the tools prepared above. When the operator is ready at the front of the machine or at another work place where the working time will be measured, the measurement chooses the position where he stands observing and taking notes. The first thing to do is a preliminary measurement. The purpose of the preliminary measurement is to find out how many times the measurement must be done for the levels of accuracy and desired beliefs (Niebel, and Freivalds, 2003).

➢ *Data Uniformity Testing*

This test is useful to find out whether the measurement results performed are quite uniform. If the results of measurements carried out are outside certain control limits, then the measurement results are said to be not uniform. The formula used to test the uniformity of data on direct measurements is

- Calculate the average value of the subgroup value with the following equation.
- After that, calculate the standard deviation from the completion time with the following equation :
- Calculates the standard deviation of the average price distribution of subgroups with equations.
- Determine the upper control limit (UCL) and lower control limits (LCL) with the equation as follows :

➢ *Data Adequacy Test*

Work measurement activity is a sampling process, the greater the number of work cycles observed, the closer it will be to the time data obtained. Because of the limited time for sampling, a method is needed to determine the amount of sampling that is sufficient to be used in determining the standard time of the process.

This is done to test the adequacy of the data, that the data that has been collected is quite objective. Testing the adequacy of data is carried out by referring to statistical concepts, namely the degree of accuracy and the level of confidence / trust. The degree of accuracy and confidence is reflecting the level of certainty that the gauge wants after deciding not to take a large number of measurements.

In an activity the measurement of employment usually has will be taken away 95 % , then degrees meticulous detail express its strongest there were any irregularities involved maksimumhasil of measurement from period of completion actually. The level of confidence shows the amount of confidence measuring the accuracy of the time data that has been observed and collected, so that the formula used to find the amount of data needed is needed by using the general formula :

➢ *Accuracy Level and Confidence Level*

The level of accuracy is the maximum deviation resulting from the actual completion time. The level of confidence is the amount of confidence that the results obtained meet the requirements of accuracy. For example, the level of accuracy of 10% and 95% confidence level means that the gauge allows the average measurement results to deviate as far as 10% of the actual average, and the possibility of succeeding in getting this is 95%. (Sutalaksana dkk. 1979).

III. RESEARCH METHODOLOGY

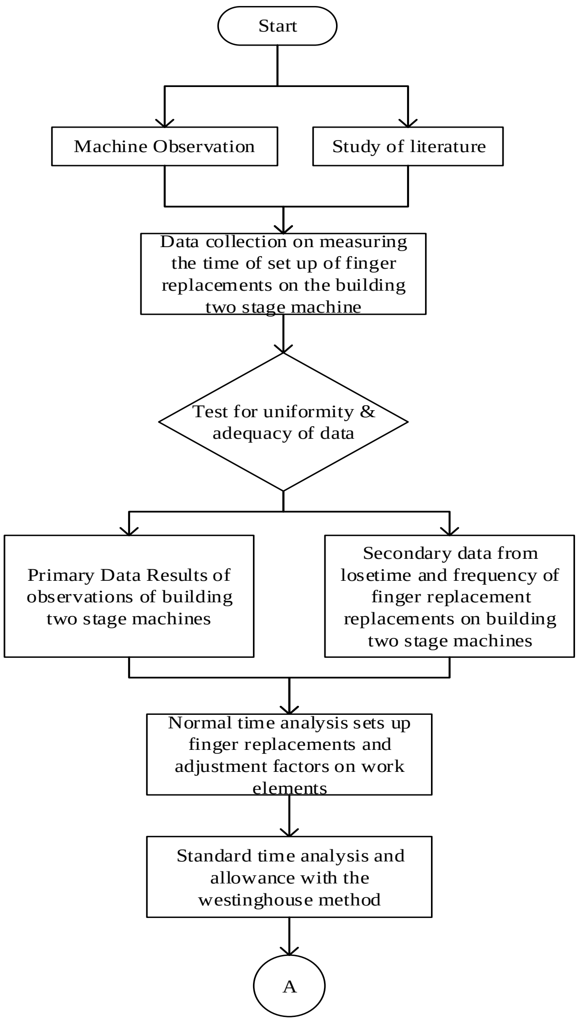

Fig 1:- Research Flowchart

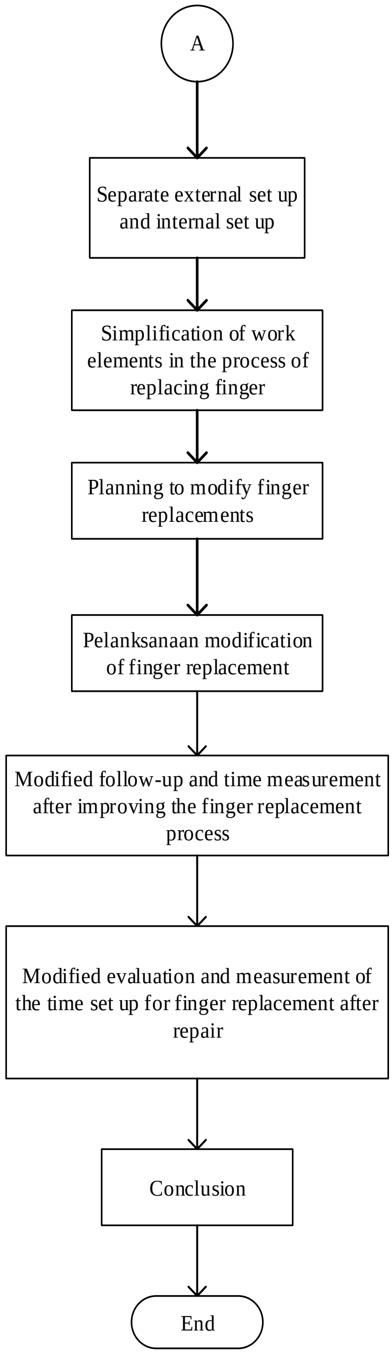

Fig 2:- Research Flowchart (2)

Data collection is done at PT. Z by using the method as follows:

➢ *Field Research Method (Field Research)*

Data collection by means of hold direct observation towards an object research.And in its implementation be conducted by:

- *Interview*

Namely by conducting interviews with the parties concerned.

- *Observation*

That is by observing directly the object being investigated so that the required data can be completed.

➢ *Library Research*

Data collection is done by reading literature that has something to do with SMED.

IV. RESULTS AND DISCUSSION

Building is a process that processes several materials, namely : tubelles, ply, bead, sidewall, steel, jointless, and tread which is then assembled into a greentire. In this section the things that must be prepared include:

➢ *Tubeless / Inner Linner*

One of the materials located at the very bottom of the green tire, has a function as a substitute for inner tubes and is made of an airtight rubber mixture.

➢ *Body Ply*

Body ply is a material from the green tire in the form of layered sheets consisting of polyester or nylon with a layer of rubber. Its function is to hold wind pressure from inside the tire and absorb the vibrations on the road.

➢ *Bead*

In the form of carbon steel wire ties which are hard rubber coated then formed in a circle in layers and then given a layer called apex which is a material made from compound. Its function is as adhesive body ply so that it is attached to the rim (velg).

➢ *Sidewall*

Rubber compound material that functions to protect body ply (carcass) on the side of the tire and also functions as the place where important information is printed from the tire.

➢ *Steel*

A layer of steel fiber that has been laminated with rubber and arranged in cross. Belts provide tire strength (reinforcement) and has a more stable and flexible physical character.

➢ *Joinless (capstrip)*

A textile yarn material with 0 rubber coated angle. Used to wrap the steel belt so that the steel belt does not change its angle and diameter due to centrifugal force when the tire is used at high speed.

➢ *Tread*

Tread is a material in the form of a compound located at the outermost part of the green tire if it becomes a tire this material will come in direct contact with the road surface. Its function can determine the age of the tire, giving an appearance to the tire and making traction which is good on wet road surfaces.

At PT Z a building with a two stage type consists of 2 types, namely type, namely two stage building and one stage building.

- *Two Stage Building Machine*

In this machine the preparation of the greentire is done twice, first the first building machine, functions to make the green case consisting of tubeless, bead finish, ply and side wall. Then the second building machine functions to arrange steel belt 1, steel belt 2, edge cover (optional), edge cover (optional), joint less (optional) and tread which will then be combined with a green case from a first building machine. The result is called green tire.

Fig 3:- Two Stage Building Machine

- *One Stage Building Machine*

On this machine the green tire preparation is only done with one machine. All materials are arranged with only one machine and one process, this makes it more efficient.

➢ *Finger*

One tooling on a building two stage machine that plays an important role for the green tire assembly process, this finger is in the engine of the two stage type.

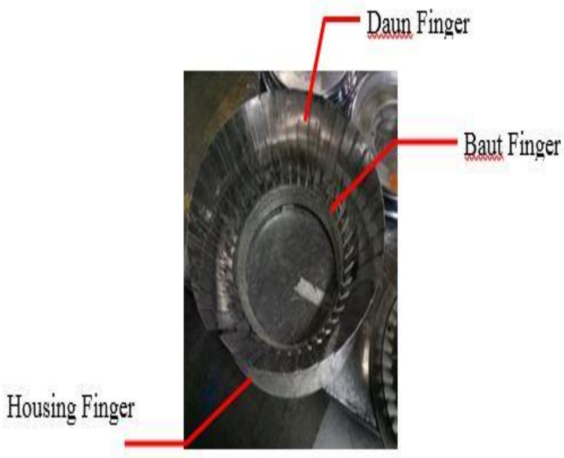

Fig 4:- Finger

The picture above is a finger that has been installed on a finger plate and a finger clip which is then connected to the top ring.

Finger has a life time of 4200 pcs or 84 shifts or 28 days with an average production per shift of 150 green tire pcs. Finger is used for building two stage machines. The number of building two stage machines has 76 engines. To replace this finger, it is determined by taking into account the life time of the finger. But for a time when there is a breakdown, one or several finger leaves are broken and bent, and even then it becomes one of the things that must be considered for finger replacement. If we know the average replacement of finger takes 149.40 minutes and the average building process is 2.5 minutes, it can be calculated the green tire loss caused by changing the finger is 149.40 minutes: 2.5 minutes = 59.7 the building process is rounded 60, while in one building process can produce 1 pcs of green tire, it means the resulting loss is 60 x 1 pcs = 60 pcs of green tire per Replacement finger. Then you can find a loss green tire in 1 day if there are 10 finger replacements for each shift:

$$Loss\ per\ shift = 2{,}5 \times 60 = 150\ pcs\ green\ tire$$

$$Loss\ per\ hari = 150 \times 3 = 450\ pcs\ green\ tire$$

➢ *Data Processing*

Before calculating cycle times from finger replacements, a test of the adequacy of the data is carried out on operating time data. Time measurement using the stop clock tool. The amount of data taken is 30 data, this refers to opinion *Gay* and *Diehl 1992*, i.e.: "That the sample taken for a minimum observation is 30 samples for each data".

➢ *The Time of a Cycle each Elements Work*

The cycle time or the average value of the sub groups of each work element can be calculated by grouping the data obtained into 3 sub groups, each of which contains 10 measurement data obtained in a row and calculates the average. The following are the results of the cycle times of each element of the finger release work before any changes:

No	Working Elements	Ws (detik)
1	Press the 4M menu "Change Finger"	4,49
2	Drum setter prepares set up tools	493,42
3	Remove the bladder with a spanner 10	39,04
4	Place the bladder in a safe area	4,00
5	Take off the ring turn up on the engine	61,03
6	Place the ring turn up in a safe area	4,02
7	Removing BSR (Bead Setting Ring)	172,02
8	Place the BSR (Bead Setting Ring) in a safe area	4,01
9	Remove the old finger leaves with the L key	2621,23

Table 1:- Finger Release Element Work Cycle Time Data Before

Then the following results from the cycle time of each element of the finger release work prior to the change:

No	Working Elements	Ws (detik)
1	Guaranteeing new finger leaves	12,08
2	Replace the new finger leaf with L key	2621,32
3	Attach BSR (Bead Setting Ring) to the machine	167,05
4	Installing a ring appears on the machine	67,10
5	Install the bladder with a spanner 10	28,00
6	Position the finger and do the test	83,02
7	Experiment on making the first product	121,25
8	Close the 4M "Change Finger" menu	5,04

Table 2:- Work Element Cycle Time Data Installing Finger Before

➢ *Data Uniformity Test*

The data uniformity test is done in order to obtain uniform data. Uniform data is data that is still in the Upper Control Limit (UCL) and Lower Control Limit (LCL). UCL and LCL can be calculated by first looking for the standard deviation value of the completion time and the standard deviation of the subgroup average value distribution. The following is an example of the calculation performed.

Calculates the actual standard deviation from completion time :

$$\sigma = \sqrt{\frac{\Sigma\,(x_i - \bar{\bar{x}})2}{N-1}}$$

$$= \sqrt{\frac{(61-61{,}03)2 + (60-61{,}03)2 + \cdots + (61-61{,}03)2}{30-1}}$$

$$= 0{,}78$$

Calculates the standard deviation of the average distribution of subgroups :

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

$$\sigma_{\bar{x}} = \frac{0{,}78}{1.73}$$

$$= 0{,}45$$

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Sehingga:

$$BKA = \bar{\bar{x}} + 3\ \sigma_{\bar{x}} \qquad BKB = \bar{\bar{x}} - 3\ \sigma_{\bar{x}}$$

$$= 61{,}03 + 3\ (0{,}45) \qquad = 61{,}03 - 3\ (0{,}45)$$

$$= 62{,}40 \qquad = 59{,}67$$

Based on the example calculation above, it can be seen that there is no data on the time of the operation that came out of UCL and LCL, so it is concluded that the data is uniform.

➢ *Data Adequacy Test*

The following is an example of calculating the data adequacy test on the work element, releasing the ring turn up on the machine in the process of removing the finger on a building two stage machine with the assumption that the confidence level is 95% and the accuracy level is 5%. Operating time data on the work element process removing ring turn up can be seen in table 4.3. The example of calculating the data adequacy test is :

$$N' = \left[\frac{40\sqrt{N\,(\sum x_1^2) - (\sum x_1)\,2}}{\sum x_1}\right]^2$$

$$N' = \left[\frac{40\sqrt{30\,(111767) - 3352561}}{1831}\right]^2$$

$$= 22{,}47$$

N' < N = 22,47 < 30, so that the amount of sampling data is sufficient.

➢ *Calculation of Normal Time and standard time*

Cycle time data of work elements that have passed the test are observational data on the work process carried out, not yet paying attention to the reasonableness of the work shown by the operator. While the standard time to be sought is the time needed by the operator in completing his work in reasonable conditions. Therefore, to get the fairness value from a cycle time data, adjustment factors are used Westinghouse. In the calculation of standard time, Westinghouse adjustments are used to obtain the normal time of a process.

The standard time calculation is done by using the cycle time of the average operating elements obtained from the data that has been tested. The first step in calculating standard time is to determine the adjustment factors and allowance factors.

The following is a table of calculation of normal time and standard time in each element of work :

No	Working Elements	Ws (detik)	p	Wn (detik)	Kelonggaran (%)	Wb (detik)	Internal	Eksternal
1	Guaranteeing new finger leaves	12,08	1,05	2752,39	0,30	16,43		Eksternal
2	Replace the new finger leaf with L key	2621,32	1,05	693,65	0,31	3591,86	Internal	
3	Attach BSR (Bead Setting Ring) to the machine	167,05	1,08	180,42	0,40	251,68	Internal	
4	Installing a ring appears on the machine	67,10	1,08	72,47	0,40	101,09	Internal	
5	Install the bladder with a spanner 10	28,00	1,05	39,94	0,40	55,72	Internal	
6	Position the finger and do the test	83,02	1,05	87,17	0,27	110,27	Internal	
7	Experiment on making the first product	121,25	1,08	130,95	0,25	163,69	Internal	
8	Close the 4M "Change Finger" menu	5,04	1,08	5,44	0,24	6,75		Eksternal
	Total detik					4297,48		
	Total menit					71,62		

Table 3:- Normal Time and Raw Time Finger Release Elements Before Change

And the following Time Normal Time Finger Installation Elements Before Change

No	Working Elements	Ws (detik)	p	Wn (detik)	Kelonggaran (%)	Wb (detik)	Internal	Eksternal
1	Press the 4M menu "Change Finger"	4,49	1,08	4,85	0,23	5,96		Eksternal
2	Drum setter prepares set up tools	493,42	1,05	518,10	0,36	702,02		Eksternal
3	Remove the bladder with a spanner 10	39,04	1,08	42,16	0,36	57,13	Internal	
4	Place the bladder in a safe area	4,00	1,08	4,32	0,36	5,85	Internal	
5	Take off the ring turn up on the engine	61,03	1,08	65,92	0,27	83,38	Internal	
6	Place the ring turn up in a safe area	4,02	1,08	4,34	0,26	5,45	Internal	
7	Removing BSR (Bead Setting Ring)	172,02	1,08	185,78	0,34	248,01	Internal	
8	Place the BSR (Bead Setting Ring) in a safe area	4,01	1,08	4,33	0,36	5,87	Internal	
9	Remove the old finger leaves with the L key	2621,23	1,05	2752,29	0,31	3591,74	Internal	
	Total detik					4705,41		
	Total menit					78,42		

Table 4:- Normal Time and Standard Time of Finger Installation Elements Before Change

➢ *Time Change Analysis After Process Changes*

- *Finger Removal and Installation at the Two Stage Building Machine*

After changing the time in the process of releasing and installing the finger, the difference between the process before and after the implementation of changes in internal and external setup is obtained. These differences include:

✓ *Differences In The Process Of Finger Release Before And After.*

Internal setup or work element processes are usually carried out when the building machine is turned off before a change is made at 78.42 minutes. Whereas after the application is made the changes in the internal release process are setup with 2 conditions namely

Breakdown conditions or finger releases are carried out before a predetermined lifetime such as finger leaves are broken and bent at 22.25 minutes. The total internal setup time is 28.88 minutes.

Finger coating conditions were carried out according to the lifetime determined by replacing the work element removing the old finger leaf to release 1 set of housing finger which was found to be 1.45 minutes long. The total internal setup time is 7.95 minutes.

So that the time reduction that occurs during the internal setup process with condition a is 78.42 minutes - 28.88 minutes = 49.54 minutes while for other conditions it is 78.42 minutes - 7.95 minutes = 70.47 minutes.

External setup or work element processes that are usually done when the building machine is in a state of life before the change is made is 11.79 minutes. Whereas after the application was made the change in the external release process setup was 8.9 minutes. So that the time reduction that occurs during the internal release process setup is 11.79 minutes - 8.9 minutes = 2.89 minutes.

According to the calculation of the differences above, the total overall time of finger removal both internally and externally before the change was 66.62 minutes + 11.79 minutes = 78.42 minutes. Whereas after the change with 2 conditions, namely condition a is 28.88 minutes + 8.9 minutes = 37.78 minutes then condition b is 7.95 minutes + 8.9 minutes = 16.86 minutes. Then the time reduction is obtained, i.e. :

A condition is 78.42 minutes (time before change) - 37.78 minutes (time after change) = 40.64 minutes, then The condition of b was 78.42 minutes (time before change) - 16.86 minutes (time after change) = 61.57 minutes. Then the efficiency obtained after a change is :

Condition a :

$$Efisiensi = \frac{40,64}{78,42} \ x\ 100\ \%$$

$$= 51,82\ \%$$

Condition b :

$$Efisiensi = \frac{61,57}{78,42} \ x\ 100\ \%$$

$$= 78,51\ \%$$

So that changes to the internal and external improvements of the finger release set can minimize the time with a condition of 40.39 minutes and the condition of b as much as 61.72 minutes. Then also increase efficiency for a condition of 51.82% and as many conditions as b

- *Differences in the Finger Installation Process Before and After Change*

Internal setup or work element processes are usually done when the building machine is turned off before the change is made at 71.62 minutes. Whereas after making changes to the installation process internal setup with 2 conditions, namely :

Breakdown conditions or finger installations are carried out before a specified lifetime such as finger leaves are broken and bent at 22.65 minutes. The total internal setup time is 33.78 minutes.

The condition of the finger installation was carried out according to the lifetime determined by replacing the work element removing the old finger leaf to release 1 set of old housing finger, which took 1.47 minutes. The total internal setup time is 12.92 minutes.

So that the time reduction obtained during the internal setup process with condition a is 71.62 minutes - 33.78 minutes = 37.84 minutes while for condition b is 71.62 minutes - 12.92 minutes = 58.7 minutes.

External setup or work element process which is usually done when the building machine is in a state of life before the change is made is equal to 0.38 minutes. Whereas after the application is made the change in the external installation process is 0.32 minutes. So that the time reduction that occurs during the internal release process is 0.38 minutes - 0.32 minutes = 0.06 minutes.

According to the calculation of the differences above, the total time of finger installation both internally and externally before the change is 71.62 minutes + 0.38 minutes = 71.24 minutes.

Where as after the change with 2 conditions, namely condition a is 33.78 minutes + 0.32 minutes = 34.1 minutes then condition b is 12.6 minutes + 0.32 minutes = 12.92 minutes. Then the time reduction is obtained, i.e. :

Condition a was 71.62 minutes (time before change) - 34.1 minutes (time after change) = 37.52 minutes.
The condition of b was 71.62 minutes (time before change) - 12.92 minutes (time after change) = 58.7 minutes.

Condition a

$$Efisiensi = \frac{37,52}{71,62} \ x\ 100\ \%$$

$$= 52,38\ \%$$

Condition b

$$Efisiensi = \frac{58,7}{71,62} \ x\ 100\ \%$$

$$= 81,96\ \%$$

So that changes to the internal and external improvements of the finger set up can minimize the time with a condition of 37.52 minutes and the condition of b as much as 58.7 minutes. Then also increase efficiency for condition a as much as 52.38% and condition b as much as 81.96%.

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- *Differences in Set Up Finger Replacement Before and After Change*

According to the calculation of the differences above, the total release time and finger installation before change is 78.42 minutes + 71.62 minutes = 150.04 minutes. Whereas after changes with 2 conditions, namely condition a is 37.78 minutes + 34.1 minutes = 71.88 minutes and conditions b 16.86 minutes + 12.92 minutes = 29.78 minutes. Then obtained a reduction in time a condition of 150.04 minutes (time before change) - 71.88 minutes (time after change) = 78.16 minutes and condition b as much as 150.04 minutes (time before change) - 29.78 minutes (time after change) = 120.26 minutes.

Then the efficiency obtained after a change is :
Condition a

$$Efisiensi = \frac{78,16}{150,04} \; x \; 100\ \%$$

$$= 52,09\ \%$$

Condition b

$$Efisiensi = \frac{120,26}{150,04} \; x \; 100\ \%$$

$$= 80,15\ \%$$

So that by making changes to the internal and external improvements, the set up of finger release can minimize the time for condition a as much as 93.05 minutes and the condition of b as much as 135.41 minutes then increase the efficiency of condition a as much as 52.09% and condition b as much as 80,15 %.

With this change, we found a green tire loss due to the replacement of the finger which was also reduced where previously it was able to reach 17 pcs of green tire per finger change while after a change in the time of loss green tire produced with 2 conditions. For conditions a 71.88 minutes: 2.5 minutes = 28.75 green tire rounded 29 and b conditions 29.78 minutes: 2.5 minutes = 12.01 green tire rounded 12 green tires, because in each building process produces 1 green tire pcs then the loss green tire after the change is a condition a 6 x 1 = 6 green tire pcs, condition b 12 x 1 = 12 pcs green tire. Then you can know the loss green tire in 1 day if there are 10 finger replacements per shift after the change is:

Condition a

$$Loss\ per\ shift = 2{,}5 \times 29 = 72{,}5\ pcs\ green\ tire\ dibulatkan\ 73$$

$$Loss\ per\ hari = 73 \times 3 = 219\ pcs\ green\ tire$$

Condition b

$$Loss\ per\ shift = 2{,}5 \times 12 = 30\ pcs\ green\ tire$$

$$Loss\ per\ hari = 30 \times 3 = 90\ pcs\ green\ tire$$

The green tire loss that can be eliminated after a change is for a condition 450 pcs (loss before change) - 219 pcs (loss after change) = 231 pcs for each day for conditions b 450 pcs (loss before change) - 90 pcs (loss after change) = 360 pcs for every day. So if it is refined by taking the average price for each pcs green tire Rp.300,000 - then the company can benefit for a condition of 231 x 300,000 = Rp. 69,300,000 / day, condition b is 360 x 300,000 = Rp. 108,000,000 / day.

V. CONCLUSION

After the SMED system was applied to the release and installation of finger on building two stages with condition a can be reduced by 52.01% and condition b 79.94%, the number of lost green tire due to finger change for a condition was 219 pcs / day and condition b was 90 pcs / day which means reduced for conditions a 231 pcs / day from 450 pcs / day and conditions b 360 pcs / day from 450 pcs / day.

Comparisons before the study and after the study include pre-research, namely in February 2018 the average time for finger / shift / engine replacement is 149.3 minutes, then in March 2018 149.4 minutes, April 2018 149.5 minute. After repairs in May 2018 with 2 conditions, namely the replacement of finger conditions a is 71.89 minutes and conditions b 30.63 minutes. Then for finger replacements in June 2018 a condition is 71.87 minutes and conditions b 29.54 minutes.

The following is the modified finger that changes from 3 bolt holes to one bolt.

Fig 5:- Before and After the Finger Machine Building Modification

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