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Proposed Improvement of Breaker Connection Quality 2 on Green Tire in PT UVW Building Machines Using SPC and FMEA Method

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***Abstract*: Green Tire is the half product of Tire (no cure) made by some materials which one of them named 2nd Breaker. This material has been explanation item in research about quality of 2nd Breaker splice in Green Tire by building machine using primary and secondary datas. Collecting the data has been done by a tool like Steel Roll Meter. Data is processed using quality tools, such as Flowchart, Fishbone Diagram, Matrik Diagram, FMEA Table, and Control Chart X and R. The result of this research are measurement of width material by machine has process capability index lower than the others, it has value 0,23 and 0,67 which mean there is still occur some process deviation out of control limits. The next result, process deviation as a dominant cause that affect quality of 2nd Breaker splice to use in priority item for improvement. Followed by stretch material when length measure process, slip on BT drum motor, and no SOP in material selection process yet.**

***Keywords*: Green Tire, Breaker 2, Indeks Kapabilitas Proses (Cpk), Failure Mode Effect and Analysis (FMEA)**

1. Introduction

Demand for products that conform to consumer specification against the company, is a matter that a company must fulfill in order to create customer satisfaction. Two key points to consider in meeting consumer demand for products, namely quality and quantity. In order to produce the quality of the product according to consumer demand, the company should set the specification standard for the materials and machinery as well as operator operating standards for the operator, starting from the beginning to the end of the production process. The quality products delivered to consumers will certainly have a lot of positive effects on the company. On the other hand, if a company sends low-quality products to consumers, then consumers will complain about the company in this regard.

Complaints from the Final Inspection Department as an internal user of the Building Department, which is the connection to the pile and below on the 2 sizes of the Green Tire (GT) breaker Manufacturer of the Original Equipment Manufacturer (OEM) WX123 ordered by the car assembly company, making the Building Department immediately detect when, where and who makes the product using the barcode system and also take corrective steps so that the same occurrence does not happen. The GT size is made using a new one-stage engine by combining several ingredients into one that produces a product called Green Tire (GT). The casting process of 2 materials on this machine can be done in three ways, manual, semiauto, and automatic. When the machine operates manually, the material connection process is operated by the operator. In this case, the operator plays a larger role than the machine in the process of connecting the casting material 2. However, this situation is rare as the machine's operating system is designed to work automatically in almost all processes. Next, the second method is semiauto. When the machine operates, the connection process is performed by the machine and the machine will not proceed before the operator checks and repairs the material connection if there is a connection not compatible with the standard (0-1mm) on the BT drum. If the connection result is standard, the Operator is allowed to continue the process by pressing the step button. Whereas when the engine is operating automatically, the engine plays a full role when the material is connected without operator checking TBM BT area. In all these conditions, in addition to checking the material connection during the installation process, the main task of other operators is to examine visual and non-visual Green Tires for material connection, product appearance, and foreign materials. In the process of securing partial Breaker 2 automatically and, if there is a variation of the length, width, and angle of material cutting, the machine will stop and notify the controller in the form of the message that appears on the monitor screen so that the operator checks the material connection. If there is an incorrect connection, the operator must immediately repair the connection before continuing the process. The results of improper connections or incompatible with these standards often occur at every shift with bad patterns either generating a full schedule for one size GT or while resizing the GT. In this case, the point of concern is the potential loss of connection occurs when the engine condition considers that the measurement value of the length, width, and angle of the material is within the limit of specifications. But the reality of the results is different from the actual value of the length, width and angle of the material at that time. If this happens, then there may be a broken connection to GT because no message appears on the monitor (HMI) that makes the engine stop and requires the operator to check the connection of the material. After the engine installs the GT from some material, the product will be inspected by the operator to find out whether there is a product defect or not. Defective products will be separated from other normal products so they are not processed to the next level. If there is a defective connection with GT, the defective product will be considered the same as another normal product by the machine. This is because the operator cannot visually detect or not visual because the composition of the casting material 2 is above 3 other materials, namely Tubeless, Ply 1, and Breaker 1 so that the thick material that covers the casting joint 2 is deactivated. Another case is that if there is a broken connection to the breaker 1 or Ply 1, the operator can detect it visually and not inadvertently because the GT is damaged so GT can be separated from other normal products so that it is not sent to the next process. At PT UVW, every OEM tire size must pass through the final inspection process in 4 machines, namely Pruning, Uniformity, Dynamic Balance, and X-Ray. The Green Taper Defects caused by the connection to or below the breaker 2 that surpass the selection of the Operator Building and is cooked into the tire, will go through the screening process on the X-Ray machine. This machine can detect defects caused by casting 1, casting 2, ply 1, ply 2 and preassembly (PA), and foreign materials in it. In this case, the size of the OEM detected by the variance on the 2-casting extension is a warning signal to the Building Department as a party that makes GT pay more attention to the quality of the product being made. To overcome this, the company must take firm action not to send tires ready to be delivered followed by further search related to the burden of 2 load in the one-stage Engine of the Building. If this case occurs in the hands of the user, this possibility may affect comfort and endanger the safety of the user in driving. This does not necessarily match the quality management system implemented by PT UVW, ISO T / S 16949, where the company prioritizes the comfort and safety of driving users. To follow up on this case, it is necessary to analyze the casting process of the two materials in the building machine. Starting from human factor, the material (variation length and width), the machine, to the method used. To realize this, we need tools that can maintain and control the quality of the casting material 2. The tool, Flowchart, Fish Diagram, Matrix Chart, FMEA Schedule, and Control Map X and R. This tool can be used to collect data which is needed such as the error that occurred during the process of connecting the material to the machine. The mistake is then analyzed to determine the root cause of the mistake and decide on the best way to eliminate these mistakes, so that the Building Department can reduce or even prevent the same problem from happening again.

2. Literature review

The following are the references and research results with the same theme used by the author as the basis for conducting research. These studies include:

- Research conducted by Mohd Nizam Ab Rahman, et al. With the title of the research, Statistical Process Control: Best Practices in Small and Medium Enterprises. The findings show that PKS - SPC is a tool used to implement SPC in helping operators and other employees overcome the quality problems in the product to improve efficiency in process improvement.
- Research conducted by Farzana Sultana, et al. With the title of the research, Implementation of Statistical Process Control for Improvement of Manufacturing Performance. The findings indicate that apart from being used to control product quality, SPC can also be used to improve engine performance with analyzer data or engine history data as a reference to prevent engine damage by performing maintenance and corrective maintenance on engines.
- Research conducted by Ajit Pal Singh with the title of research, Quality Improvement Using Statistical Process Control in Glass Bottle Making Company. The results show that the major contributors to defective products, ie blisters, double seams, stones, and pressure failures. The damaged product is caused by several factors, ie materials, machinery, and employees. For parts of raw materials, silica sand washing machines, marble (marble), and limestone, do not work properly. This can certainly affect the quality of raw materials. For glass smelting section, the machine is very old so it needs new parts so that the engine can operate optimally.
- Research conducted by Hayu Kartika with the title of investigation, Quality Monitoring of CPE Film Product Performance By Methods of Control of Statistical Process at PT MSI. The results of this study indicate that PT MSI has turned its products, which is a CPE film with wrinkles 39%, 24% thickness, 21% gross, 10% incorrect size, and 6% color fading for February. Based on the fish bone diagram, it is known as a problem, an operator error that controls the process of film work, workspace temperature, and machine age.
- Investigation conducted by Robertus Sidartawan with title inquiry, Quality Control Analysis of Process Expenditures Using Methods of Statistical Process Control at PT MSI. The production process results are based on charts of control charts that indicate that there are still many points that are beyond the control limits and very high volatility points. Unorganized. Second, the process capability ratio (Cp) = 0.263 <1, indicates that the process is elastic and must be corrected. Thirdly, the process capability index (Cpk) = 0.047 <1, shows that the process's accuracy is less, which means the process can still be improved on the basis of quality

3. Research methodology

Data collection or retrieval is done at the X Building level machine by observing the spending process and measuring the length of the Breaker 2 process to find any stem resulting in a standard failure or Breaker extension specification 2. The data obtained in the field will be processed using the aid and evaluation of some tests. The test equipment and evaluation used in processing this data, namely:

- Flow Chart
- Fish bone tattoo
- Matrix diagram
- Mod Failure and Impression Analysis (FMEA)
- Data Normality Test
- Uniform Data Exam
- Data sufficiency test
- Create and Estimate Maps Controls X and R
- Estimate Process Efficiency

4. Results and discussion

PT UVW Building Department now has 101 engines. The machine is divided into two types, two levels and one level. The two-stage engine is a building machine operated manually or semi-automated by 2 operators in 2 separate sections. The first part of the engine, the operator has the task of making the Green Case from the assembly of Sidewall and Tubeless (Preassembly) material assembled from the Department of Materials, and Ply, while the second part of the machine, the operator is assigned by installing the Green Case from the first process combined with the Breaker 1. Breaker 2, Joint less / NE / NF, and Tread to produce products in the form of Green Taper. For a one-stage engine, it is a building machine that can be operated manually, semi-automatic and automatically by 1 operator. The machine is divided into two areas, Tire Building Tire Machine (TBM CC) and Tire and Tire Building Machine (TBM BT). CC TBM is a gathering area for Sidewall and Tubeless materials into one called Preassembly (PA), and produces products in the form of Green Case. For BT TBM parts, materials are installed in this area, Breaker 1, Breaker 2, Joint less, and Tread. The results of assembly of materials in this area will be carried using tools in the form of Transmission to be installed with Green Case at TBM CC to produce the final product in this process, namely Green Tire.

A. Breaker server

Casting service is one of the BT servicer parts used as a service area for Breaker materials. Each one-stage machine has 2 Breaker Servers, namely Breaker Servicer Breaker 1 and Breaker Servicer for Breaker 2. Each Breaker has a truck as a place to install a roll roll roll that will be positioned to Let Off. In this area there are several processes before the Breaker connection in the BT drum occurs. The process, ie feeding, length measurement, cutting cycle, and transportation. Basically the area where the process occurs is divided into 2 parts ie roll conveyor and applicator. The roll conveyor is a place of eating, a measure of length, and a cut cycle occurs, while the applicator is the place where long processes and transport processes take place. Especially for the long-term process applies in both places. Here is an illustration of the long process of steps that apply in Building a single X-level machine.

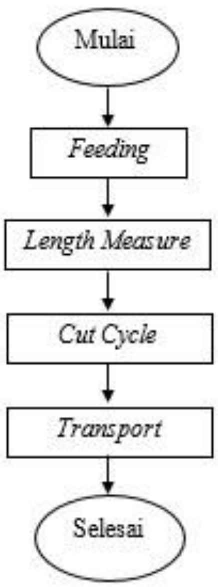

Fig. 1. Flowchart Length Measure Breaker

B. Radial Force Variation (RFV)

RFV is the radial vibration value parameter used if the test is caused by an abnormal connection of the material (PA, Ply, Breaker or flower). If screens with bad RFV values are used by users in guiding continuously, it will cause the screen to be evenly distributed. This can indeed have a negative impact on consumers, which interferes with the convenience and endanger the safety of consumers in guiding, especially on the smooth surface of the road. Server breaks. The polisher breaker is one of the BT servicer parts used as a service area for Breaker materials. Each one-stage machine has 2 service breaks, Breaker Servicer Breaker 1 and Breaker 2. Each Breaker has a lorry to place a roll that will be put on Let Off. In this area there are several processes before the Breaker connection in the BT drum is valid. The process, i.e. feeding, length, cutting cycle, and transportation. Basically, the area where the process is used is divided into 2 parts, i.e. roll conveyor and applicator. The roll conveyor is the place to eat, long, and cutting cuts applied, if the applicator is the place where the process is long and the transport process is imposed. Particularly for a long process takes place in both places. Here is an illustration of the long process of steps used in Building a single machine X.

C. Fishbone diagram

RFV is a radial vibration value parameter that is used if the test is caused by an abnormal connection of material (PA, Ply, Breaker or flower). If the screen with a bad RFV value is used, this tattoo aims to show the roots or root causes that come from

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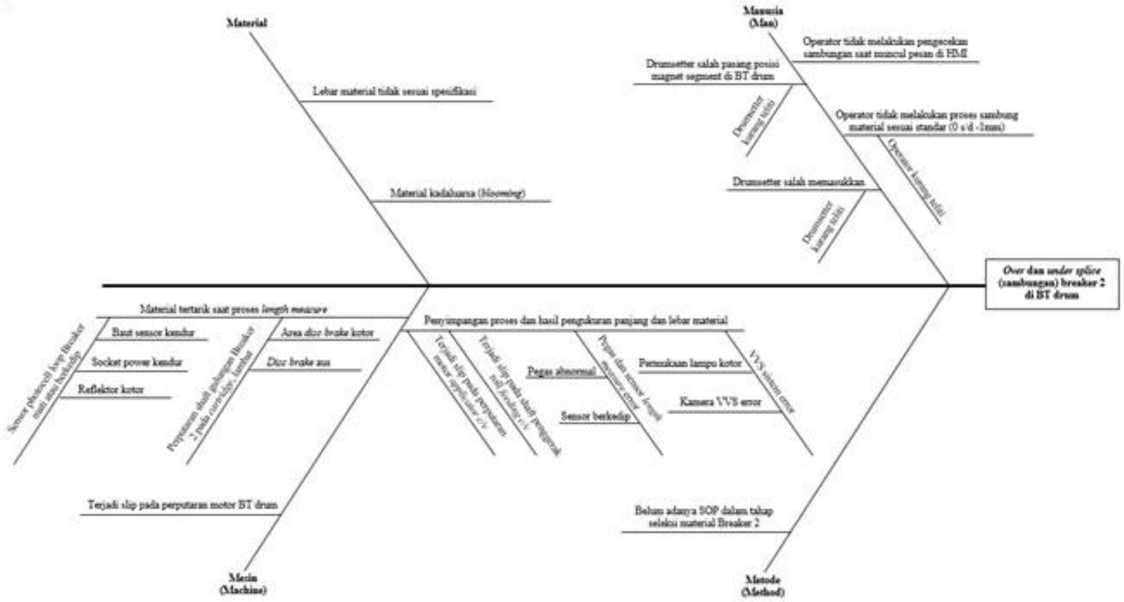

Fig. 2. Fishbone Diagram

humans, materials, methods, and machines and helps in analyzing the root of the problem to find the best solution that is useful for improving the continuous expenditure process. Making this tattoo is obtained through the results of conversations from several experts which involved two positions in it, namely Building Position and Technical Position. Building Position consists of a Leader, a Machine Supervisor, and a Tool Supervisor, when a Technical Position is represented by a Technical Supervisor. Following is an example of a Fishbone Diagram regarding the problem of investigation, which is above and below the splice (connection) Breaker 2 on the BT drum. If the user guides continuously, he will cause screens to improve. This may give a negative impression to the user, which easily interferes with user safety in guiding, especially on slippery road surfaces. Waiter breaker Polisher breakers are one part of the BT servicer that is used as a service area for Breaker materials. Each single rank engine has 2 maintenance breakers, namely Breaker Servicer Breaker 1 and Breaker servicer Breaker 2. Each Breaker has a lorry to put the roll to be placed on the Let Off. In this area there are several processes before the Breaker connection in BT drums is valid. The process, namely eating, length, cutting cycle, and transportation. Basically, the area where the process is used is divided into 2 parts which are roll conveyors and applicators. Conduit roll is a place to eat, length, and cut pieces are used, if the applicator is a place where a long process and transport process is used. Especially for the old process used in both of these places. Following is an illustration of the long process of the steps used in fostering a single rank X machine.

D. *Matrix diagram*

Based on the Fishbone Diagram identification, factors affecting the result of Breaker 2 connections will be processed in the form of Matrix Diagrams. This figure is aimed at finding Critical to Quality (CTQ) for each factor that causes breakdown of 2 connection results that are not in accordance with the standard. The advantages of using this Matrix Diagram are to know the priority scale of the cause of the most influential problem so that deeper analysis can be done on these causal factors. Prior to making this Matrix, things must be done first, ie collecting data using questionnaires to several related parties, such as Building Department (production) consisting of Machine Supervisor, Tool Supervisor, and Team Leader and Technical Department represented by Supervisor Technical. These parties are considered competent in their field as they are directly related to research problems in their work. The parties are then asked to answer the questionnaire according to the proportional value for each causal factor. The preparation of this questionnaire is aimed at gaining value based on the perspective, knowledge, and experience of each party in the research environment without disturbance from the other's opinion. The following is a proportionate value determined by the relevant party.

- Very influential
- No effect
- Influential
- Very influential

After gaining the value of proportion, it can be determined the total competitive value calculation of each factor. The greatest value calculation will be prioritized in this study. The causal factor with the greatest value and which requires a deeper analysis for improvement will be determined as CTQ based on the results of the discussion from the analysis team after viewing the collected data. This needs to be done to get the best results together as inputs for improvements in the next analysis. The following is the result of the recapitulation of the assessment value of competition in the Diagram Matrix.

Table 1
CTQ Value Recapitulation

Quality Matrix			Departemen Terkait					
			Production			Technical	Competitive Total	Critical To
			Machine Supervisor	Tooling Supervisor	Team Leader	Supervisor	Evaluation	Quality
Results of 2 over and under Breaker connections on the engine	Human	The operator does not connect material according to the standard (0-1mm)	3	3	4	2	12	CTQ
		The operator does not check the connection when a message appears on	3	4	4	4	15	CTQ
Results of 2 over and under Breaker connections on the engine	Human	Drumsetter incorrectly pairs the position of the magnet segment	3	4	4	4	15	CTQ
		Drumsetter incorrectly pairs the position of the magnet segment at BT drum	4	4	4	4	1	CT
		Drumsetter has entered the parameter value incorrectly	4	4	4	4	1	CT
	Material	Material width does not match specifications	2	3	3	2	10	
		Material expired	1	3	3	2	9	
	Machine	Material is attracted during the length measure process	3	4	4	4	15	CTQ
		The process deviation measures the length and width of the material	4	4	4	4	16	CTQ
	Method	There was a slip on the BT drum motor rotation	3	3	4	4	14	CTQ
		There is no SOP in the material selection stage	3	3	3	3	12	CTQ

Based on Table 1, it can be seen that the causal factor with the greatest value, which is derived from human and machine factors. In this case, the determination of the causal factor as CTQ is based on the percentage value, which is 75% of the total competitive evaluation which means a minimum value of 12. For human factors with the greatest value, the analysis team assesses that this can be overcome by socializing the drumsetter and Operators to be more focused, concentrated, and careful in installing the magnet segment, entering parameter values, and checking material connections. Whereas machine factors, the team assessed that the three items needed deeper analysis to get the best solution for improvement in the subsequent analysis, even though there were some items that had lower values compared to the greatest values on human factors. Apart from machine factors, the next factor determined as CTQ by the analysis team is a method factor, namely the absence of an SOP in the material selection stage. The factors that have been determined as CTQ will then be processed in the next analysis, namely FMEA.

E. SPC dan FMEA

In this stage, the factors that have been determined as CTQ will be analyzed more deeply to get the best solution by providing severity, assurance, and detection values in the Failure Mode and Effect Analysis (FMEA) table which is expected to be able to prevent process failures later. During the production process. The following is an explanation of the factors that will be analyzed using FMEA.

- Process irregularities and results of measuring length and width of material this factor is a causal factor with the largest value determined as CTQ by the analysis team because it has the greatest influence on the results of the Breaker 2 material connection in BT drum. To prove how much deviation occurs in the process and measurement results, further analysis is needed using Statistical Process Control (SPC) before entering FMEA analysis. In the analysis phase using SPC, a number of data samples are needed in conducting tests to determine the normality, adequacy, and uniformity of data before finally being presented in the form of a control map and calculation of process capability is carried out. Data collection is done on the X2 engine for material breakers
- By using Notebook connected to the Human Monitoring Interface (HMI) screen through the Ultra VNC Viewer application to collect data on the length and width of the material using one steel roll meter (meter) in the Breaker Servicer 2 area when full schedule (full size GT) and when changing the GT size (change size GT). The data is then divided into several measurement data. The division of groups in the measurement data will be presented in Table 2 below.

Based on Table 2, it can be seen that there are two differences in process conditions, namely full size GT and change size GT.

Table 2
Measurement Data

Kondisi Proses	Data	Keterangan
Full schedule (full size GT)	*Actual length*	The actual value of measuring the length of the material using the meter
	Length measure	Calculation value of material length by sensors in the machine
	Actual width	The actual value of measuring the width of the material using the meter
	Width measure	Material width calculation value by VVS camera on the machine
Change of GT size (change size GT)	*Actual length*	The actual value of measuring the length of the material using the meter
	Length measure	Calculation value of material length by sensors in the machine
	Actual width	The actual value of measuring the width of the material using the meter
	Width measure	Material width calculation value by VVS camera on the machine

The two process conditions certainly have different data values and data differences. Every machine has advantages and disadvantages in every operation. In terms of deficiencies, in general, each machine expects the ideal value in measurement to approach the actual value measured. But in fact, because of these shortcomings, the desired value is difficult to achieve. To find out how big the accuracy of the machine is in measuring, the difference value data is needed between the engine calculation data and the actual data that can be used as input for improvement. The data values and data differences during measurements will be shown in Table 3.

Based on the results of the data differences in Table 3 and Table 4., it can be seen that the range of values of the length of the material (length) of the material is between 0 and 7.6 mm and the difference in the value of the material width is between 0 and 1, 8 mm. The biggest difference in material length data is found at the 25th measurement, which is 7.6 mm, while the largest data difference in material width is found in the 43th measurement, which is 1.8mm. The biggest data difference value is obtained when the process conditions are Full Size GT.Setelah mendapatkan nilai selisih data material, maka langkah Next is to create a control map and obtain the value of process capability through a series of stages of data testing, such as normality test, adequacy test, and data uniformity test.

F. Data normality test

The normality test of this data is carried out on eight data

Table 3
Full Measurement Value and Difference

No.	Length Measure (Full Size GT)	Actual Length (Full Size GT)	Data Difference	Width Measure (Full Size GT)	Actual Width (Full Size GT)	Data Difference
1	1795,7	1798	2,3	133,8	135	1,2
2	1795,4	1798	2,6	134,9	134	0,9
3	1794,6	1799	4,4	134,3	134	0,3
4	1796,4	1799	2,6	135	135	0
5	1794,8	1796	1,2	135,1	135	0,1
6	1793,9	1796	2,1	133,8	134	0,2
7	1794,2	1799	4,8	134,6	134	0,6
8	1794,1	1796	1,9	134,2	134	0,2
9	1794,3	1797	2,7	134	135	1
10	1792,6	1797	4,4	135,1	135	0,1
11	1795,6	1797	1,4	134	134	0
12	1796,1	1798	1,9	133,6	134	0,4
13	1793,8	1795	1,2	135,7	135	0,7
14	1795,1	1797	1,9	134,4	134	0,4
15	1792,5	1799	6,5	134,6	135	0,4
16	1792,8	1797	4,2	134,2	135	0,8
17	1793,4	1796	2,6	134,9	134	0,9
18	1795,5	1797	1,5	133,9	134	0,1
19	1795,6	1801	5,4	133,9	134	0,1
20	1794,3	1797	2,7	134,6	135	0,4
21	1797,2	1797	0,2	135,8	134	1,8
22	1794,7	1795	0,3	134	135	1
23	1794,8	1798	3,2	134,4	135	0,6
24	1795,1	1795	0,1	134,8	134	0,8
25	1791,4	1799	7,6	134,5	134	0,5
26	1794,2	1800	5,8	133,5	134	0,5
27	1793,7	1798	4,3	135,6	135	0,6
28	1795	1795	0	133,6	135	1,4
29	1796,3	1802	5,7	133,8	134	0,2
30	1794,6	1795	0,4	134,7	135	0,3
31	1794,1	1796	1,9	134,4	135	0,6
32	1793,7	1796	2,3	134,1	135	0,9
33	1794,4	1796	1,6	134,8	134	0,8
34	1792,3	1796	3,7	135,2	134	1,2
35	1792,9	1797	4,1	134,2	135	0,8
36	1792,9	1797	4,1	135	134	1
37	1796,5	1800	3,5	133,7	134	0,3
38	1796,4	1798	1,6	133,7	134	0,3
39	1793,9	1798	4,1	134,9	135	0,1
40	1795,5	1799	3,5	134,6	134	0,6
41	1794,9	1798	3,1	134,1	134	0,1
42	1794,4	1799	4,6	134,1	135	0,9
43	1795,2	1797	1,8	134,8	133	1,8
44	1793,5	1796	2,5	134,3	134	0,3
45	1794,5	1796	1,5	133,9	135	1,1

breaker 2 materials that have been collected, namely length measure (full size GT), actual length (full size GT), width measure (full size GT), actual width (full size GT), length measure (change GT size), actual length (change size GT), measure width (change size GT), and actual width (change size GT). The full size GT data collection is carried out when the production process conditions are running full schedule one shift for one type of GT without changing parameters, while the change size GT data retrieval is carried out when changing the GT size schedule or changing the GT A size to GT B size in one shift with changes in parameters. Each type of data has 60 data which will be tested for normality using the SPSS 20 application (Liliefors Test) to obtain conclusions whether the data tested is normally distributed or not. The use of the Liliefors Test is based on the results of the data normality test conducted by Hun Myoung Park (2008) and Nornadiah Mohd Razali (2011) who concluded that the data normality test in the sample range of 51 to 200.

Table 3 (Contd.)

No.	Length Measure (Full Size GT)	Actual Length (Full Size GT)	Data Difference	Width Measure (Full Size GT)	Actual Width (Full Size GT)	Data Difference
46	1793,5	1795	1,5	135,2	135	0,2
47	1795,8	1797	1,2	134,2	134	0,2
48	1796,9	1798	1,1	134,7	134	0,7
49	1791,9	1795	3,1	133,8	134	0,2
50	1794,6	1798	3,4	134,2	135	0,8
51	1796,8	1799	2,2	134,2	134	0,2
52	1795,5	1795	0,5	134,8	134	0,8
53	1793,7	1797	3,3	134	134	0
54	1794,5	1798	3,5	134,1	134	0,1
55	1797,9	1798	0,1	133,7	134	0,3
56	1795	1796	1	134,3	135	0,7
57	1794,7	1796	1,3	134,3	134	0,3
58	1793,2	1794	0,8	135,1	134	1,1
59	1793,3	1796	2,7	135,4	135	0,4
60	1793,3	1796	2,7	134,6	134	0,6

With a significance level of 5% or 0.05, it means the opportunity for the examiner to make a mistake of 5% in concluding that H0 is rejected. Thus, the results are as follows:

- If it is known that a = 0.05, and N or df = 60, then the Liliefors table value is 0.886 / √60 = 0.114. With a statistical value of 0.045, it can be concluded that the statistical value (0.045) <Liliefors table value (0.114) means that H0 is accepted.
- If it is known that the value of a = 0.05 and the value of significance or P-value = 0.200, it can be concluded that the P-value (0.200)> value of a (0.05) means that H0 is accepted.

G. *Data adequacy test*

The data adequacy test is done by comparing the number of observations that have been made (N), which is 60 data with the required number of measurements (N '). Tests on the adequacy of data are needed to ensure that the data collected is objective enough.

The test results for the four data indicate that the amount of data taken in the measurement is sufficient or feasible to be used in further testing.

H. *Data uniformity test*

The data uniformity test aims to ensure the collected data comes from the same system. In addition, the test of data

Table 4
Value and Difference Measurement Data Change Size GT (in mm)

No.	Length Measure (Change Size GT)	Actual Length (Change Size GT)	Data Difference	Width Measure (Change Size GT)	Actual Width (Change Size GT)	Data Difference
1	1794,7	1800	5,3	134,9	135	0,1
2	1795,7	1800	4,3	135,2	135	0,2
3	1796,6	1797	0,4	134,5	135	0,5
4	1796,2	1799	2,8	135	135	0
5	1794,7	1797	2,3	135,1	136	0,9
6	1795,9	1798	2,1	135	135	0
7	1795,7	1798	2,3	134,4	135	0,6
8	1794,4	1795	0,6	135,5	135	0,5
9	1795	1796	1	134,9	135	0,1
10	1794,7	1797	2,3	135,4	135	0,4
11	1793,4	1797	3,6	135,4	135	0,4
12	1794,5	1798	3,5	134,8	135	0,2
13	1794,7	1797	2,3	134,8	135	0,2
14	1796,3	1801	4,7	135,3	136	0,7
15	1794,2	1796	1,8	135,4	135	0,4
16	1797,8	1798	0,2	135,1	135	0,1
17	1796,1	1798	1,9	135,5	134	1,5
18	1796,1	1799	2,9	134,7	135	0,3
19	1793,2	1797	3,8	135,7	135	0,7
20	1794,5	1797	2,5	135,4	135	0,4
21	1795,3	1798	2,7	134,6	135	0,4
22	1793,7	1797	3,3	135,5	135	0,5
23	1796,5	1797	0,5	134,4	135	0,6
24	1795,8	1799	3,2	134,6	135	0,4
25	1796,2	1799	2,8	134,9	135	0,1
26	1794,4	1795	0,6	135	134	1
27	1794,9	1797	2,1	134,6	135	0,4
28	1794,5	1797	2,5	135,1	135	0,1
29	1794,6	1797	2,4	134,5	135	0,5
30	1795,7	1800	4,3	134,4	135	0,6
31	1792,2	1792	0,2	135,3	135	0,3
32	1795,2	1798	2,8	135,1	136	0,9
33	1795,4	1796	0,6	134,7	135	0,3
34	1794,5	1798	3,5	134,5	135	0,5
35	1797,5	1799	1,5	134,8	135	0,2
36	1792,5	1795	2,5	135,6	135	0,6
37	1794,7	1797	2,3	135,3	135	0,3
38	1793,3	1797	3,7	135,3	135	0,3
39	1794,6	1795	0,4	134,8	135	0,2
40	1797,2	1800	2,8	134,6	135	0,4
41	1794,1	1797	2,9	134,9	135	0,1
42	1795,8	1797	1,2	134,8	135	0,2
43	1794,9	1796	1,1	135,2	135	0,2

Table 4 (Contd.)

No.	Length Measure (Change Size GT)	Actual Length (Change Size GT)	Data Difference	Width Measure (Change Size GT)	Actual Width (Change Size GT)	Data Difference
44	1794,6	1797	2,4	134,8	135	0,2
45	1798	1799	1	134,9	135	0,1
46	1794,6	1799	4,4	135,7	135	0,7
47	1794,4	1796	1,6	134,7	135	0,3
48	1794,3	1795	0,7	135,3	135	0,3
49	1796,5	1800	3,5	134,8	136	1,2
50	1798	1796	2	134,5	135	0,5
51	1793,9	1795	1,1	135,1	135	0,1
52	1796,4	1798	1,6	133,7	134	0,3
53	1797,8	1801	3,2	135,7	135	0,7
54	1794,9	1793	1,9	134,5	135	0,5
55	1795,1	1796	0,9	134,9	135	0,1
56	1796	1799	3	135,4	135	0,4
57	1792,6	1794	1,4	134	134	0
58	1792,8	1796	3,2	134,3	134	0,3
59	1792,8	1795	2,2	134,3	135	0,7
60	1796,6	1796	0,6	135	135	0

security is done to see whether the data collected by the researchers does not exceed the data control limit, both the upper control limit (BKA) and the lower control limit (BKB) of the sample taken so that it can be concluded that the data are uniform.

The test results for the four data show that the data taken in the measurement is uniform data and can be further tested.

I. Making control maps X and R

Sufficient and uniform data can be used in making Control Maps X and R. In making this control map will be created using the Minitab application 16. This control map aims to control the average process and range of data that occurs during the production process takes place in data retrieval. The final output, which is a proposed improvement that can be used for process control.

The results of the study show that two of the four data analyzed have several process variations that are outside the control limits so that it requires better process control for future improvements.

Table 5
Test the Normality of Data Length Measure (Full Size GT)

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Length Measure (Full Size GT)	,045	60	,200*	,996	60	1,000

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Table 6
Data Normality Test Results

No.	Tested Data	Test result
1.	*Length measure (full size GT)*	Berdistribusi normal
2.	*Actual length (full size GT)*	Not distributed normal
3.	*Width measure (full size GT)*	Normal distribution
4.	*Actual width (full size GT)*	Not distributed normal
5.	*Length measure (change size GT)*	Normal distribution
6.	*Actual length (change size GT)*	Not distributed normal
7.	*Width measure (change size GT)*	Normal distribution
8.	*Actual width (change size GT)*	Not distributed normal

Table 7
Data Adequacy Test Results

No.	Data Yang Diuji	Hasil Pengujian
1.	*Length measure (full size GT)*	Enough data
2.	*Width measure (full size GT)*	Enough data
3.	*Length measure (change size GT)*	Enough data
4.	*Width measure (change size GT)*	Enough data

Table 8
Data Uniformity Test Results

No.	Tested Data	Test result
1.	*Length measure (full size GT)*	Uniform data
2.	*Width measure (full size GT)*	Uniform data
3.	*Length measure (change size GT)*	Uniform data
4.	*Width measure (change size GT)*	Uniform data

Table 9
Status of Cpk and Ppk

No.	Data	Status Cpk	Status Ppk
1	*Length measure (full size GT)*	Variations in the process of each subgroup are controlled	The whole process variation is controlled
2	*Width measure (full size GT)*	Some process variations in each subgroup are out of bounds is controlled	Some overall process variations are out of bounds is controlled
3	*Length measure(change size GT)*	Variations in the process of each subgroup are controlled	The whole process variation is controlled
4	*Width measure(change size GT)*	Some process variations in each subgroup are out of control	Some overall process variations are out of bounds kendali

5. Conclusion and suggestions

Based on the results of the data analysis, the following conclusions are obtained.

- Factors that cause breaker connection 2 and below the BT drum caused by four factors, namely human, material, machine, and method.
- The cause of the human factor, the wrong drum setter is installed in magnetic position in the BT drum, the drum setter enters the incorrect parameter value, the operator does not check the connection when the message appears in HMI, and the operator does not perform the material extension process according to the standard.
- The cause of the material, ie the width of the material does not match the specification and the material expires.
- The causal factors of the machine, ie the material that is attracted during the long-term process, is slipping on the BT drum motor rotation, and the deviation of the process of measuring the length and width of the material
- The causal factor of the method used is the absence of SOP from the breaker selection 2.
- Based on these four causal factors, causal factors are used as CTQ, which are human factors, machinery, and methods. For human factor can be overcome by means of socialization of Controllers and Drumsetter accuracy related to doing things that affect the results of Breaker 2 connections, while machine and method factors can be processed in the next stage, namely making FMEA tables.
- The resulting data difference between the engine measurement data and the actual data shows that the range of data length (length) of the material is between 0 and 7.6 mm and the range of difference in the width of the material is between 0 and 1.8 mm. The biggest difference in material length data was found on the 25th measurement, 7.6 mm, while the largest data difference in material width was found in the 43rd size, which is 1.8 mm. Based on this decision, it is necessary to have a standard that must be set in determining the tolerance value of the material data difference between the engine data and the actual permissible data and the limit of the number of occurrences if the difference value is out of the tolerance value. This is to facilitate the decision-making process when the production process takes place, whether it needs to be calibrated or not. Berdasarkan hasil perhitungan, pengukuran lebar material menggunakan kamera VVS memiliki indeks kapabilitas proses yang lebih rendah dari pengukuran lainnya, yaitu senilai 0,23 (full size GT) dan 0,67 (change size GT). Hal ini berarti, masih terdapat beberapa variasi proses saat pengukuran, baik itu variasi proses di setiap subgrup ataupun variasi proses secara keseluruhan.
- Based on FMEA results, the cause of the machine, ie process aberrations, proposed improvements are CPU checks and VVS programs at HMI, if the offset is reset or homing cycle and maintains the cleanliness of the lamp tube per shift, check the mechanical function of the spring and check the material selection SOP if the sensor is error or blinking, and if it has enough cost and time, it can be changed 3-phase motor (induction) + slip ring for motor roll nutrition and conveyor applicator.
- For factors that cause the second machine, the material can be made to ensure that the bolts, sockets, and reflectors are not loose and dirty, change the position of the sensor and the reflector under the start of the position or edit the PLC program to set aside the breaker motorcycles Breaker 2, and brake offline releases check items in periodic preventive maintenance.
- For the third engine, the BT drum motor slip, the proposed upgrade is to keep the engine partially auto or manual and wait until the process is completed before passing the security sensor, and if it has enough cost and the time it can be switched induction motor + slip ring.
- For a causal factor of the method, ie no SOP can be made to keep the engine partially auto or manual and wait until the process is completed if you want to get

into the machine (pass the security sensor) and set the standard selection of SOP materials to Load men.

- Based on the multiplication results, drum drum slabs have the largest Risk Priority Value (RPN) compared to other causative factors 392. However, it does not mean that the item with the largest RPN value is to be done first in process improvement. In determining priorities in process improvement, things to consider are RPN multiplier factors, ie severity, guarantee, and sequential tracking. By looking at the value of the RPN multiplier in the table above, it can be concluded that the deviation process is a priority item in process improvement. Although this item has the same severity value as other items, but in other evaluations, that is, this item has a value greater than other items.

A. Suggestions

It is necessary to apply the proposed improvement so that further research can be done to find out the advantages and disadvantages of the proposal

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