Reducing tyre scrap blister under tread with PDCA approach: a case study in manufacturing industry

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Abstract. Productivity by economists determines productivity as "output ratio" relative to "physical input". It is usually associated with the industry as a whole in the sector within the economy. One of the decreasing productivity factors is the value of scrap products. The purpose of this study is to reduce the amount of scrap that occurs to increase productivity. The value of the tire produced by the company is high enough and the highest value percentage due to Scrap Blister Under Tread (BL / UT), and this process occurs in TBM (Tire Building Machine). This study will analyze both the actual data and the data with the PDCA concept (Plan Do Check Action). The result of this study is that the BL / UT scrap tire decreased from 0.141% (January - April 2017) to 0.016% (Sept 2017) or down by 86% and the average after - repair output increased 8.5% from baseline (January - April 2017) besides giving an impression on QCDSM (Quality, Cost, Delivery, Safety, Morale).

1. Introduction
Manufacturing industry is closely related to productivity, this has an effect on the profitability of the company, but many things that affect the decline in the value of productivity both machine, material, process, and human factors. The one that affects productivity is product quality. Quality is important for the company, in addition to emphasizing the quality of the product, the company also needs to pay attention to the quality of the production process [2]. PT XYZ is a manufacturing company in the produce tyre manufacturing. The types of tires produced are tires of cars, motorbikes, and truck. In the production process, there is a TBM (Tire Building Machine) process, TBM is an assembly process of several materials such as tread, sidewall, under tread, bead. The results of the production which have been assembled have found that there are a number of scrap and things due to blister under tread. Blister U/T is the air that settles on the tire or under tread so that the tire becomes bubbly. The highest scrap scrap is scrap due to BL/UT having the highest percentage compared to other causes of scrap which causes the tire product to bubble and impact the next process, namely curing, shortage in the TBM (Tire Building Machine) process. Therefore, it is necessary to analyze the causes of the scrap because it affects productivity. This research project has chosen to study the PDCA method because it is highly recommended as continuous improvement method in the automotive industry, outlined in the quality standard, ISO/TS16949[3]. The PDCA cycle is targeted on the prevention of error repetition by creation standards and the ongoing modification of current standards. Using of the PDCA cycle means continuously improving process/product [4]. The PDCA method suggests that once the action is planned they must do the plan and then examine and take action based on the results and in addition PDCA has...
a positive effect on the worker's learning [5]. The Japanese developed it further to be applied in all problem solving situation and called it PDCA [6]. Although many “kaizen” or continuous improvement initiatives are started, the failure rate is high[7]. Reported that two out of three continuous improvement initiatives fail to deliver the desired improvement[8]. The PDCA method has been used ever since by the Japanese industry as a systematic continuous problem solving approach. Western industry started to focus on development and implementation of continuous improvement processes in the beginning of the 1980s [9]. The thing that is limiting in this study is that the research is carried out in the TBM (Tire Building Machine) process, which is selected based on the highest percentage value. Research data includes production and scrap data for the period January-April 2017.

2. Cause Analyzing
The first step is planning which is concerned with setting up quality objectives and monitoring the process. In the second step, data are collected and problems are recognized. In the third step, the problems are examined and analyzed. Finally, steps are followed to eliminate the problems to attain quality objectives. It is also referred to as the Shewart cycle, Deming circle cycle wheel, control circle cycle or PDCA[10], [11]. Seven Tools is very easy but effective to use as an improvement tool or graphical problem solving method that generally helps the process between design and delivery process [12], [13]. In analyzing the causes of Tire Scrap Blister Under Tread (BL/UT), the analysis uses a fishbone diagram, this is related to several aspects that cause scrap tire such as human aspects, material, methods and engines. Based on the results of the analysis there are several aspects reviewed, including:
(i) Material: Based on the analysis and analysis, the material aspect also triggers a tread blister, this is because the materials dimension or material length exceeds the standard,
(ii) Humans: Based on data and analysis it turns out that the material also triggered the tread blister, at the beginning of the shift the operator did not check the standard specifications and actual long tread which caused tread joint over,
(iii) Method: the aspect of the roll center was not pressing middle tread this was triggered by the pressure center roll varies and the putran center roll varies, (iv) Machine: based on the analysis and analysis, the material aspect also triggers the tread blister, namely the blister area center tread, this is because the center roll does not press tread.

2.1. Test and Determine Dominant Causes
- Possible causes: Tread Length over (more Tread length)
  Analysis of causes: Test the freq correlation. Tread length over per day against BL / UT
  Result: "Weak Positive" correlation
- Possible causes: Tread Joint over (more Tread connections)
  Analysis of causes: Test the freq correlation. Joint over tread per day against BL / UT
  Result: "Weak Positive" correlation
- Possible causes: Center roll does not press Tread
  Analysis of causes: Test the freq correlation. Center roll does not press Tread per day against BL / UT
  Result: "Positive Positive" correlation
- Possible causes: Pressure (bar) Center roll varies
  Analysis of the causes: Test the Pressure Center roll against BL / UT
  Result: "Positive Positive" correlation
- Possible causes: Center roll varies
  Analysis of causes: Test Center roll rotation against BL / UT
  Result: "Positive Positive" correlation

Based on the results of the correlation test shows there are three that have a strong correlation, namely center roll does not press Tread, pressure roll (bar) Center varies, Center roll degree varies. The data needed in this study is the production data for the period (January-April 2017), and the scrap (pcs) data for the period (January-April 2017), besides the data required is data from the results of interviews with operators. Then the data is processed and analyzed for the factors causing the occurrence of scrap tire,
besides that the data is used as a basis for determining the target this is done so that the achievement target can be calculated.

Figure 1. Pareto Scrap Tire Building Diagram Jan-April 2017

Based on the Pareto diagram above shows the highest scrap tire is scrap due to BL/UT, for this reason the focus is on scrap blister under tread (BL/UT) that Pareto chart is “a tool that arranges items in the order of the magnitude of their contribution[13],[14] noted that an uncomplicated rule is that Pareto 20% problems lead to 80% outcomes. This means 80% of problems come from 20 of causes, 80% of outcomes come from 20% of work, 80% of cost comes from 20% of spent area, and so forth[15].

2.2. Planning for repairs
After analyzing the factors causing the occurrence of scrap blister under tread and conducting a correlation test and knowing the strongest aspects of the cause of the occurrence, an improvement plan will be made, namely

- Dominant cause: Center roll does not press Tread
  Why: Center roll order presses Tread so that the air between JLB and the Tread is wasted
  What: Changes the Center roll contact profile
  Where: Workshop and Tire Building Machine (TBM)
  When: July 12-14, 2017
  How: Drawing profile center roll-change profile radius of contact R 2688 to 227 mm Material Center roll from "Teflon"

- Dominant cause: Pressure Center roll varies
  Why: Center roll order presses Tread so that the air between JLB and the Tread is wasted
  What: Looking for the best Center roll pressure setting
  Where: Tire Building Machine (TBM)
  When: July 13 2017
  How: Making a correlation between Centerrol's pressure setting (from 0.5-3.5 bar) to BL/UT

- Dominant cause: Center roll round varies
  Why: Center roll order presses Tread so that the air between JLB and the Tread is wasted
  What: Looking for the best Center roll round setting
  Where: Tire Building Machine (TBM)
  When: July 14, 2017
2.3. Carry out repairs
The improvements carried out are as follows:

- Dominant cause: Center roll does not press Tread
  Repair solution: Change the Center roll contact profile from Radius (R) 2688 - 227 mm
- Dominant cause: Pressure Center roll varies
  Repair solution: Setting product parameter pressure center roll all TBM into 2.0 ± 0.5 bar
- Dominant cause: Center roll round varies
  Repair solution: Setting the product parameters of the Center roll round of all TBMs to 2520 ± 360 degrees

3. Result and Discussion
Based on the results of the improvement seen in the graph shows a significant change, the decline in scrap tire percentage to 0.370% based on the average scrap in May-August 2017, and in September decreased to 0.226%. The impact that occurs after the improvement is the quality, cost and delivery.

| IMPACT | BEFORE | AFTER |
|--------|--------|-------|
| Q (Quality) | BL / UT Scrap: 0.140% (January-April 2017 period) | Scrap BL / UT: 0.0.16% (August-September 2017 period) |
| | Tyre scrap (Pcs/month) : 646pcs/month :Rp 226,100,000/ month | A. Improve Cost (Center roll price x 12 Machines: Rp. 300,000 X 12 = 3,600,000) |
| | | B Tyre Scrap (pcs/month) : 90 Pcs/month : Rp.31,500,000 |
| C (Cost) | Note : Tyre Price : Rp 350,000 | Reduce Cost : (Cost Improve - Cost Scrap After)= Rp 226,100,000 - (Rp.3,600,000+ Rp 31,500,000)= Rp 191,000,000/month |
| D (Delivery) | Due to the BUT problem, the GT was processed previously, so the green tire shipment to Curing was slow and caused shortage delivery from finishing to the tire warehouse (finish good). | Reducing the shortage of green tire shipment to curing and from finishing to warehouse because it is not resistant due to problem building |

After making improvements, a spec spec is made so that after the repair is carried out, the process will remain stable so that the scrap tire value does not increase again, the following standards are made.

| No | Dominant Causes | Improvement | Frekuensi check | PIC |
|----|----------------|-------------|----------------|-----|
| 1 | Center roll does not press Tread | Change the Center roll contact profile from R: 2688 227 mm | Every start of shift work | Building Production Mechanics |
| 2 | Pressure Center roll varies | Setting the Center pressure roll TBM to 2.0 0.5 | Every start of shift work and change size | Building Operators |
| 3 | Center roll rounds vary | Setting TBM Center roll rounds to 2520 ±360 degrees | Every start of shift work and change size | Building Operators |
The selection of scrap values obtained by scrap tire blister under tread is due to having the highest percentage value compared to other scrap factors. Determination of critical components is done using a Pareto diagram. Based on the analysis of the causes of scrap tire blister under tread using fishbone diagrams, this is because all aspects that affect the production process can be analyzed, there are six items that cause the blister under tread to occur, but based on the correlation test results only 3 items are selected namely centerroll does not press Tread, pressure centerroll varies, centerroll rotation varies. Based on the results of the improvement seen in the graph shows a significant change, the decline in scrap tire percentage to 0.370% based on the average scrap in May-August 2017, and in September decreased to 0.226%, this decline occurred because the improvements made were more process focused that occurs in the TBM (Tire Building Machine) engine and is affected by the engine and human aspect.

4. Conclusion
The cause of scrap tire blister under tread namely center roll does not press Tread, pressure center roll varies, center roll rotation varies. As a result of improvements, Tire Scrap BL/UT fell from an average of 0.141% (January-April 2017) 0.016% (Sept 2017) or decreased by 86%. The results of the implementation of SGA improvements have a positive impact in terms of QCDSM. After repairs, scrap blisters under tread (BL/UT) maximum 0.02% of production per day. The average production after repair increased 8.5% from the baseline (January-April 2017). After achieved this objective Company will further explore how to maintain and care for pasting machine through the implementation of total productive maintenance to maintain and improve the improvement that has been done and will continue the kaizen activity.

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