Root Cause Analysis in Integrated Tire Manufacturing using Shainin Group Comparison Method

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ABSTRACT

Mass production condition in the manufacturing has high speed and high amount of product quantity. It needs fasterr and appropriate problem solving (PS) to handling a quality problem in order to minimize the losses. Many method of PS can be chosen by manufacture base on the conditions of each process and type of quality problem . The PS method like 8D, DMAIC (six sigma), or Shainin group comparison method (SGCM) is popular to be used in the manufacturing to solve quality problem. The SGCM is simpler and fasterr method to find out the root causes of quality problems. These research was conducted in the tire manufacturing which aims to find out the root causes of repair tire problem. Blister on the Bead Base area (BBB) is the highest defect of tire repair and selected as a case on this research. Using the SGCM method, analysis of PS begins with generating the clue of problem. It compares hierarchically step by step of processes level until the components level and then focus on worst of the worst product group (WOW) and best of the best product group (BOB) comparison. Three main differences are founded as the root problem (Red X) of BBB repaire problem, namely: inner linner width, strand and forming type. To know the effect of component differences, a further experiment was conducted by exchange the three components of BOB group against the WOW group. After implement the corrective action on the WOW group, BBB repair was reduced by 87%. The SGCM method proved as simpler , faster and effective to be used in problem solving for the tire manufacturing.

Keywords: Problem solving, Shainin group comparison method, Repair tire.

Introduction

Many of current mass production industries operate at high speed with a massive amount and 24 hours a day. However, not all of the result products quality are meet the specified requirements, some of the quality products are out of the specification In high-volume and high-speed industries like this need necessary the simpler and faster in problem solving (PS) against non-standardized products so that the losses can be minimized.

On the other hand, the current manufacturing industry is also required to work flexible enough to respond the various customer needs. At the moment the complexity of the product and process is increasing, this situation requires a real-time and effective PS method. Some studies (Kadam, Virupakshappa, & Kini, 2018; Vahist, Kumar, &

Narender, 2014)have shown that the Shainin group comparison method (SGCM) is effective to use in the manufacturing industry in determining the root cause of problem. The unique stage in SGCM is an easy and inexpensive technique in determining the dominant factors in the problem. It is known as Generating Clue process. The level increases the survey observation so that factors can focus on the dominant factors (Steiner, Mackay, & Ramberg, 2008). This method is easier and cheaper compared to experimental filtering attempts on the Six Sigma method(Sharma & Chetiya, 2009).

The Clue generating process can be done using brainstorming or fish bone analysis but this will generate list with a large number of possible causes. SGCM method is a process to eliminate the non-related area by focusing on the dominant causes. Today the manufacturing process has been highly integrated with the use of information technology such as barcode or RFID so it is possible to do traceability on the condition of the process through which the product. With such infrastructure it is possible to conduct the clue generating process easily. This study aims to determine the PS model that integrates the manufacturing environment condition to SGCM by utilizing the historical data of process and product to divided of a large possible causes area into area of the home of dominant causes.

Literature Review

Problem solving has various approaches and techniques in solving quality problems, such as 8D, DMAIC, Six Sigma and so on. But application of these techniques in the industry sometimes will be constrained by analytical techniques knowledge, time to do experiments or costs to experiment. From some researchers (Mittal 2017; Kadam, Virupakshappa, and Kini 2018; Sunil Sharma; Anuradha R Chetiya 2009; Sagar Vashist 2014) states that problem solving using the SGCM is more practical in the manufacturing environment. With the following advantages:
1. Using simple statistics calculation
2. There is no need for deep statistical understanding
3. The analysis process does not interfere with the running process
4. Compare the best of the best products (BOB) with worst the worst of products (WOW) that can bring to the home of root cause problem faster
5. Involve all levels of workers in solving problems

In general, the problem solving using SGCM is divided into two main parts, they are diagnostic journey and remedial journey (Steiner, Mackay, and Ramberg 2008). In the first stage is determine the root cause of the problem or the main factor (referred to as Red X) that begins with generating clue, by specifying variables that are supposed to be related to the existing problem doing the experiment so that the root cause can be confirmed correctly. While the second stage is to determine the action on root causes issues, implement and monitor the results.

In determining the possible cause can use many techniques. Brainstorming techniques was used as research of Rofiudin and Santoso (2018) in DMAIC method. Five Why and fish bones was used in 8D method (Kumar & Adaveesh, 2017). Booths can generate thousands of possible causes and it will take time-consuming to confirm the dominant causes. Fault Tree Analysis (Saptaaji and Rimawan 2017) was used in the specific function also can generate a large possible causes. Therefore the stage of generating clue is helpful to guide direct to the dominant factor that becomes as a root cause of the problem.

The emergence of information technology in manufacturing can make an integrated system between process and product information. A complete information as genetic of the product can be retrieve easily. This condition can be utilized as a model of PS in manufacturing combined by Shainin methodology. The observing investigations to generating clue can be done easily and quickly (Figure 1) without having to conduct experimental screening factors (Steiner et al., 2008). By increasing the observations will be make a better and fasterr in determining the dominant factors and also speed up the overall PS process.

Research Methodology

For a case study on the concept of usage information technology as a part of SGCM in generating clue, tire manufacturing that already have a barcode system selected as area to implement these concept. Tire production has a characteristic as a mass process and complex. A tire is consisting from several components that assembly into a composite product. In the product development step will determine construction of tire and create as product database. For manufacturing data that will be incorporate to product is identification of man, machine, material and time as process database. Booth database is integrated in the barcode system.. Process tire manufacturing mainly consists of preparation materials of component c tires, assembly process, curing process and final inspection processes. In each process use a common machine which means that one machine can be used to produce several types product. The purpose of this study is to reduce the repair products in tires manufacturing with the shainin method by utilize the advantage of integrated system.

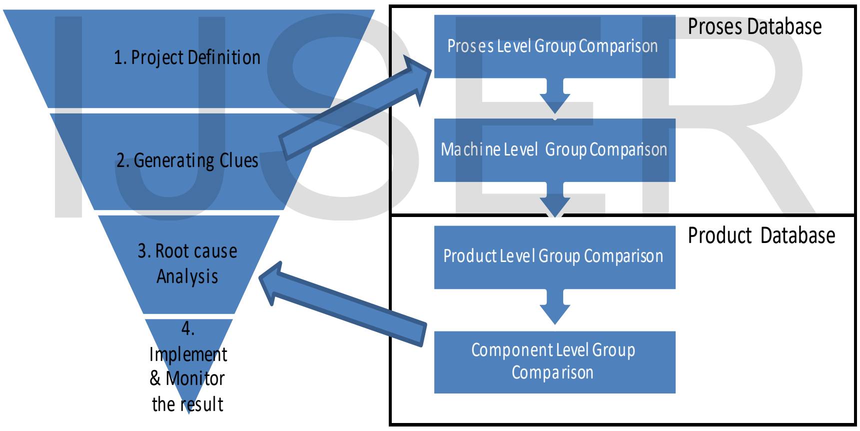

Figure 1 Research framework

Improvement of the determination project was done on the highest item in the pareto repair tires diagram that occurred during the 3 month period. In order to determine the dominant factor that occurs, the analysis of the process globally begins from the comparison phase of the assembly process, then hierarchically in the select area based on the assembly machine in the dominant type by comparing machine to machine level. This process was done by using the data production process in database process. Calculate in general the percentage of defect that occurs on each production machine.

Comparison at the product level will be done on the most machines that generate defect by select the dominant product repair rate (WOW) and the least product repair rate (BOB). For the selected products group then followed by comparing product at the component level to identify the differences factor as a candidate of possible causes. To confirm the root causes, the experiment was performed using a component search method, by changing the components between the WOW and BOB parts.

Results and Discussion

Base on data collection obtained from the quality report of the problem that occurred and after the processing of data obtained the repair of stratification (Figure 2).

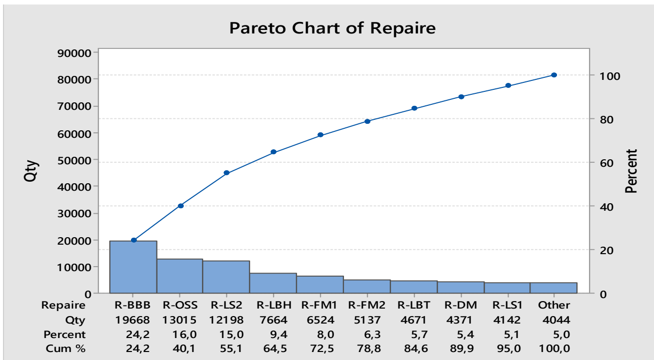

Figure 2 Pareto chart of repair tire.

Base on Pareto analysis, the most problematic repair tire is the blister on bead base (R-BBB) with a percentage of 24.2% of the overall repairs. This defect is the air trapped in the bead part of the tire (Figure 3a, 3b). If the tire cut horizontally on the blister bead base then it will be seen that the air is trapped (Figure 3c).

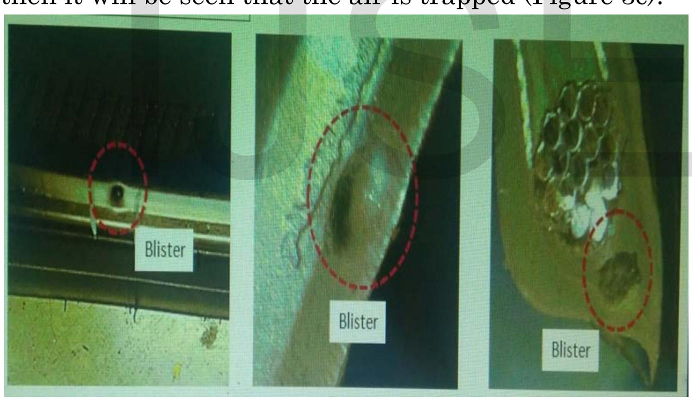

Figure 3. Visual defect blistered bead base.

Green Y (effects on the product) in this case is the blister on bead beads. Further analysis is to compare the type of process. At the process level comparison, it can be seen that the dominant BBB repairs were found 85% for assembly two stage type, and further investigation was forwarded to the machine to the machine level (Figure 4). It searches continuous until component level.

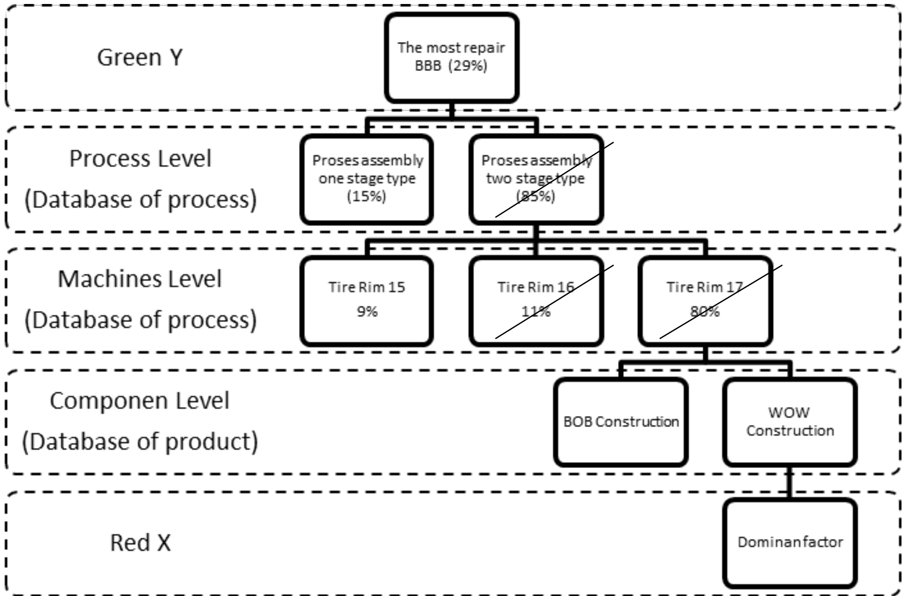

Figure 4. Stages of determining the root cause of the problem (Red X)

In the comparing the BOB product with WOW then selected 5 products with the category of most BBB and the lowest 5 BBB products. The average BBB repair rate on the WOW product is 27% and 0% of the BOB group. Then comparing the components from each group in the bead area which is the area of BBB repaire. In terms of constructions that differences between BOB and WOW groups are: the number of strands in the BOB group shows all using strand number 3 while the number of strands in the WOW group 5. The number of stand is the number of the base part of the bead. While being banned from forming type in BOB group using Single type and in WOW Square type group (Table 1)

Table 1. BOB and WOW product construction comparison

BOB product

Product code	Repaire blidter bead base(%)	Forming contruction	Forming type	Strand	IL width – DW width (mm)
B1	0.01	3+4+5+4+3	Single	3	46
B2	0.00	3+4+5+4+3	Single	3	58
B3	0.01	3+4+5+4+3	Single	3	42
B4	0.01	3+4+5+4+3	Single	3	42
B5	0.01	3+4+5+4	Single	3	46

WOW product

Product code	Repaire blidter bead base(%)	Forming contruction	Forming type	Strand	IL width – DW width (mm)
W1	30	5 x 6	Square	5	32
W2	14	5 x 6	Square	5	42
W3	37	5 x 6	Square	5	48
W4	33	5 x 6	Square	5	44
W5	23	5 x 6	Square	5	38

In addition to shaping construction, nets and types of shaping are components of rubber under the bead of the inner liner. Table comparisons indicate that the broader internal layers of the BOB group are higher than the WOW group (Figure 5).

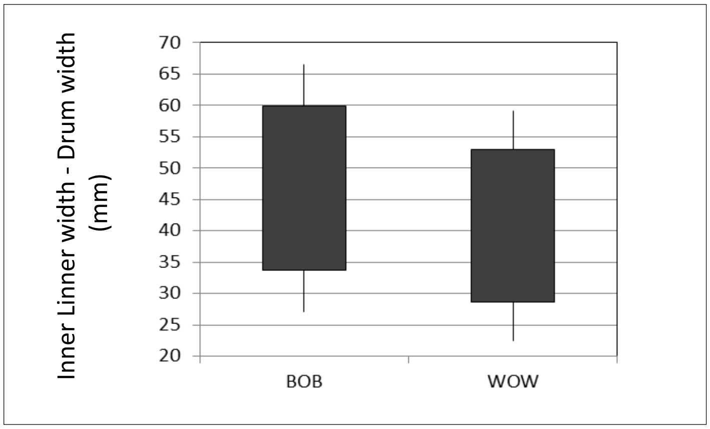

Figure 5. Inner liner width of BOB and WOW products

Based on the observation of the investigation result , there are three different variables that become the candidate factor that causes the BBB problem, that is the width of inner liner under the bead, the number of base wire from bead (strand) and forming type. Tire is a product that can not be assembled again but we can do a small experiment by changing the shape tires. This experiment characteristic is destructive test characteristic because when we try to change the component tires then such a thorough validation should be done such as performing endurance test through drum or field test. Therefore small experiments in limited quantities are limited to 30 pieces to represent each treatment. In the first attempt was to increase the width of the field in the WOW section and to reduce the width of the BOB portion with the result almost the same as the previous condition. While for the second experiments, strand and forming type conversion between WOW and BOB group indicate that there was a change also in BBB repair rate. This test confirms that the root cause of BBB repair is stand and forming type as dominant factor or Red X (figure 6)

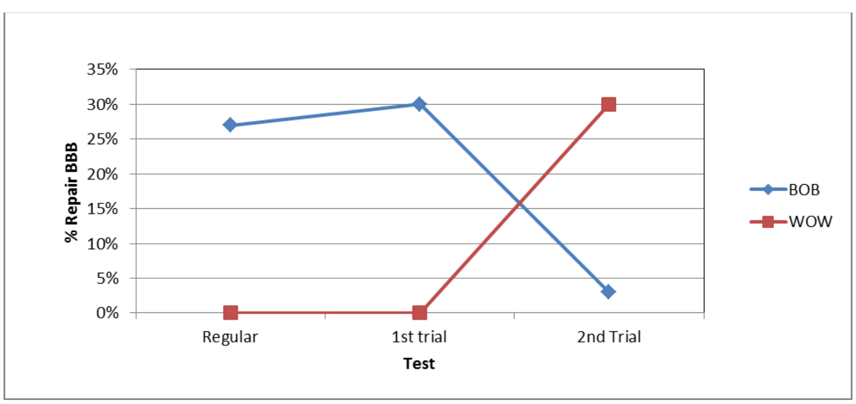

Figure 6. Progress trial component

A range of studies on quality aspects of experimental results impact such as laboratory testing are done before the changes implement to the WOW products.

After the component of WOW product changed using 2nd trial condition, the effectiveness of the changes was evaluated by comparison of the percentage BBB repairs and the results of the experiment. It shows that the BBB repair rate can be decreased by 87% compared to before (Table 2).

Table 2. Precented comparison of repaire regular and experimental results

Product code	% Repaire BBB	
	Regular	Experiment
W1	29.9	3.6
W2	14.2	3.6
W3	37.4	5.5
W4	33.0	3.0
W5	23.0	2.6
Average	23.0	3.7

Conclusion

By using the shainin group comparation method (SGCM) combined with integrated manufacturing system in tire manufacturing can be utilized as problem solving tools in order to find out the dominant factor of quality problem. The search of factor is dominant doing by investigation observations on the databases processes and database products using simple calculation and comparison. It can filter many parameters or factors into a narrow possible dominant factor in problem.
This method is effective to find the dominant root cause but not explaining the variation process and mechanism of defect reduction. For further research this method should be combined with others technique to find out the optimum parameter of component.

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