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Increasing Quality Rate in Accommodation Machine D-Wolf using Infinity Loop Methods at XYZ Company

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Abstract*: XYZ company not be separated from issues related to the quality of the product. It can be seen from the highest defect occurs in the final product (Finish Good) in the period July 2016 - November 2016 with the final product defect percentage (Finish Good) caused by the engine by 82.63%, amounting to 10.48% of materials and methods at 6, 89%. Sachet filling machine that produces the biggest flaw is the sachet filling machine D-Wolf by 25.12%. One of the efforts was to implement a system of Total Productive Maintenance (TPM) by the method of OEE as a method for measuring the efficiency and effectiveness by observing the factors of availability, performance, and quality rate. Quality Achievement Rate value on sachet filling machine D-Wolf by 99.36% to 99.60%, which means the target defects for the equivalent of 0.24% or a total of 29 707 pieces of 4,668,839 pieces with pareto type of defect is sticky seal as many as 3829 pieces. Therefore, this study will seek to increase the value quality Pareto Rate by eliminating defects that happen. Repair methods that will be used to improve the Quality Rate (QR) is Infinity Loop in 7 steps, namely the Identify Existing Situation, Restore, Analyze Causes, Causes Eradicate, Establish Condition, Conditions Improve, Maintain Conditions. Through the stages of improvement from December 2016 to July 2017, the type of seal defects before 3829 pieces of sticky decreased to 0 pieces. In addition, the achievement rate increases earlier Quality Rate 99.36% to 99.46% and 81.93% previously OEE value becomes 82.00%.

***Keywords*: Total Productive Maintenance (TPM), Quality Rate, OEE, Infinity Loop, Seal defects**

1. Introduction

In today's globalization era, entrepreneurs compete to produce high quality products that can survive amid fierce competition and provide consumers with satisfaction. To get quality product of XYZ Company will maintain every production process to produce quality and flawless product.

XYZ Company is a food-based company. Examples of products produced by XYZ Company are Chilmil, Chilscholl, prenagen, Diabetasol, Fitbar, Benecol, and others. XYZ Company cannot be separated from problems related to product quality. This can be seen from the number of defective products in the final product (Finish Good) for 11 lines in July 2016 - November 2016 of 143,132 pcs from the total production of 37,823,543 pcs. The cause of defects in the final product (Finish Good) is caused by a machine of 82.63% or equivalent 118.272 pcs, material of 10.48% or equivalent 15.000 pcs, method of 6.89% or equivalent of 9.860 pcs and for humans and the environment does not there is a problem. From the data, it can be seen that the biggest cause of defect / disability is caused by the engine. Of the total 11 filling sachets owned by XYZ Company which resulted in the largest defect/defect percentage is the D-Wolf filling sachet machine with a total product defect of 25.12% or 29.707 pcs total of 4.668.839 pcs.

Therefore, one of the efforts to solve this problem is to use the Total Productive Maintenance (TPM) system. TPM is a system where one of its objectives is to improve product quality by preventing defective products [5]. In addition to preventing defective products, TPM aims to improve the efficiency of the production system by company optimizing the effectiveness of machines used in the production process.

Overall Equipment Effectiveness (OEE) evaluates how effectively a manufacturing operation is utilized and is expressed in terms of Performance, Availability and Quality. Performance is measured in terms of whether plant is operated as per expected speed, reduced speed or with minor stops. Availability is influenced by breakdowns and product changeover. Quality is determined in terms of acceptance and rejects in startup, during production runs and customer returns. Maintenance performance and its measure is an important part of reducing losses and productivity improvement [9].

To measure the success of the TPM system and measure the efficiency and effectiveness of the D-Wolf filling machine using the Overall Equipment Effectiveness (OEE) method by observing the three main factors affecting the value, availability, performance, and quality [5]. The number of defective products produced by D-Wolf filling machine can be seen from the achievement of Quality Rate (QR) on D-Wolf filling machine of 99.36%, the defective product produced by D-Wolf filling machine is 0.24%. If converted to number of pieces, the defective product produced is 29,707 pieces from a total of 4,668,839 pieces in July 2016 - November 2016.

This final project illustrates how to increase the Quality Rate (QR) value of the D-Wolf filling machine at XYZ Company to reduce the defective product by implementing Total Productive

Maintenance (TPM) and improvements to defective types using Infinity Loop (The Figure of Eight Method) in it. Infinity loop is one of the improvement tools in TPM used to solve defective products consisting of 7 steps in which the repairs will be performed after the process of return of the machine under standard conditions. And this method will continue to produce "zero defect". The principle of infinity loop method is not much different from DELTA (eight steps seven tools) [2], which differ only after the repair is done after the machine returns the standard condition. This is done because the engine has experienced a great deal of improvement from year to year regardless of the initial state of the machine first. Total Productive Maintenance (TPM) technique has been used by various organisations for business performance [10]. Significant research has been conducted for various sectors and used for improving equipment effectiveness, eliminating breakdowns, reducing costs and promoting autonomous maintenance [11].

2. Literature review

Early maintenance / maintenance is done because the equipment or machine is damaged or not working, which is called maintenance of damage. In 1970, a concern Company of Total Productive Maintenance (TPM), which is a concern Company of continuous improvement and has proven effective [3], developed by JIPM (Japanese Institute for Plant Maintenance). Maintenance is a combination of any action taken to store the item in or to fix it until a condition is accepted. The purpose of the maintenance or maintenance, among others [1]:

- To extend the useful life of an asset i.e. every part of the workplace, its buildings and its contents.
- To ensure the availability of Company minimum installed equipment for production and maximum return on investment.
- Ensure that human security is in such a way.
- Ensure the readiness of the operation of all care is required in emergency situations at all times [1].

A. Types of maintenance are

The planned maintenance is organized and carried out with forward thinking, control and record keeping according to the designated plan. The planned maintenance consists of 3 types:

- *Preventive Maintenance:* Preventive Maintenance is a maintenance carried out at predetermined time intervals or against other criteria described and aimed at reducing the possibility of other parts that do not meet acceCompanyable conditions.
- *Corrective Maintenance:* Corrective Maintenance is a maintenance repair done to repair a section including the preparation and repair of the machine that has ceased to measure the Companied condition.
- *Predictive Management:* Predictive maintenance is a precautionary maintenance designed to prevent the failure of a machine / equipment and be carried out by checking the machines at regular intervals and predetermined, subsequent further repairs depending on what was encountered during the inspection. [1]

B. Unplanned maintenance (Unplanned maintenance)

Unplanned maintenance is only one type of maintenance thatis an emergency maintenance is the maintenance done immediately when the machine fails to be detected before. Total Productive Maintenance (TPM) is a method for maintaining productive machinery / equipment. The increase in the use of industrial machinery is done through more maintenance to ensure the sustainability of production resources by measurement methodology is OEE [6]. The TPM has 8 pillars, which work to build a TPM system where eight pillars have their respective tasks and work together [1].

Total Productive Maintenance needs to consider how to maximize equipment effectiveness throughout its entire life using robust processes, safety culture, long term view and participation and motivation of the entire work force [12]. Body of knowledge shows TPM implementation reduces unexpected machine breakdowns for improving OEE [13]. OEE is the method used as a metric in the TPM application to ensure the equipment is ideal by eliminating the major loss of eight major equipment losses. This OEE measurement is based on the three major ratio sizes, Availability, Performance Rate, Quality Rate (QR) [6].

The formula for measuring availability is:

$$\text{Availability Rate} = \frac{\textit{Loading time - Downtime}}{\textit{Loading time}} \text{X } 100$$

The formula for measuring availability is:

$$\text{Performance Rate} = \frac{\textit{Standard cycle time x Processed}}{\textit{Utilization hours}} \text{ X } 100$$

The formula for measuring performance is:

$$\text{Quality Rate} = \frac{\textit{Processed units} - \textit{Defect units units}}{\textit{Processed units}} \text{ X } 100$$

OEE = Avability Rate x Performance Rate x Quality Rate

One step of improvement to increase OEE value is to use the Infinity loop method which is a method of improvement introduced by Japanese TPM consultant JIPM (Japan Institute for Maintenance Plant). The advantages of infinity loop method compared to the method that has been done so far at XYZ Company is the 8-step method used for QCC (Circle Control Quality) is an important point in the infinity loop in the second step is to restore the engine condition which must be returned to initial conditions refers to QM-Matrix [3]. While 8 steps if

there is a direct problem done continuous improvement. The first of these losses, breakdown, is the most obvious when it occurs. Immediate efforts will be applied to fix the problem but attention to solve the cause is also essential to prevent reoccurrence. A less obvious but equally likely cause of lost availability is set-up and adjustment losses.

These occur during the period between making the last good piece of one batch to the first good piece of the next. When the actual speed of a machine is lower than its designed speed can cause significant losses. Loss also occurs through the production of defective items. This may be due to sporadic incidents and also during the start-up of a process until it becomes stable [14]. The infrared loop of steps looks like the number 8 which means the measures will continue if at the time of monitoring the defective product repeats again to get a "zero defect". Although 8 steps are not sustainable [2].

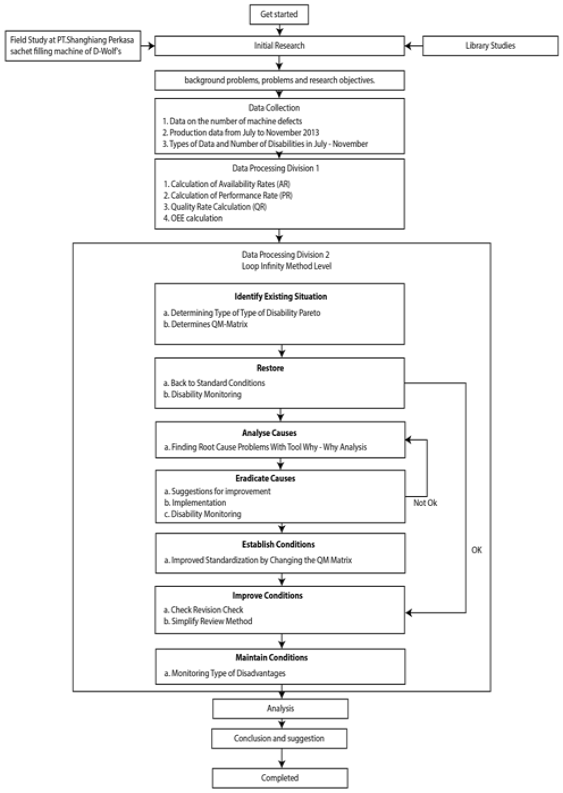

Fig. 1. Methodology of flowchart research methodology

Quality Assurance runs a quality system, monitors the product and evaluates it from the product. And one of the goals of a critical evaluation program to improve the effectiveness, cost saving, efficiency, and sustainability of EHDI (Early Hearing Detection and Intervention) is a program to detect the detection of an abnormal condition and quickly provide feedback from the problem [8]. "The usual problem arises when we do not qualify activities on important work or do quality activities on unimportant jobs, the key is doing quality activities on important jobs" [7]. Here are some quality control tools which will also be used as research analysis tools.

- Check sheet
- Problem separator (Stratification)
- Histogram
- Pareto diagram (Pareto Diagram)
- Fish bone diagram
- Scatter Diagram (Scatter Diagram)
- Map Control (control chart)

Of the above quality control tools are highly recommended and should be implemented for each manufacturing industry of many functions in order to facilitate the analysis phase [6].

3. Processing and results

A. Availability Rate, Performance Rate, Quality Score, OEE

OEE's achievement for D-Wolf sachet filling machine from July 2016 to November 2016 was 81.93% and was unable to reach 85.00% target. One factor is the achievement of Quality Score (QR) on the D-Wolf filling machine of 99.36% with a target of 99.60% until there is a gap of 0.24% which means the defective product produced by D-Wolf filling machine is from 0.24% or equivalent to 29,707 production volume of 4,668,839 pieces.

B. Identify existing situation

At this stage the main thing to do is identify the highest defect type on the D-Wolf filling sachet machine, mapping the defects and flow process to the D-Wolf filling sachet machine and make QM-Matrix a matrix containing important points and procedures which have been standardized from the side of the machine, materials, methods, humans, environments based on the type of defective occurring and process on the machine. The first type of disability is the QC inspection (Quality Control) with a total of 18196 pcs or 61.25%. However this type of defect will not be a priority in the study because the QC check is a product recruitment conducted by the Quality Control team that analyzes the quality of the product but according to the management decision of XYZ Company, this QC check should still be counted and put in broken product category though it is not a defective product. Genba then went to the field on January 21, 2017 until January 24, 2017 and from Genba's results to the field there were six non-standard check items that were:

- The front and rear jaw states are polymer combs attached to the front & rear jaws that should not be dirty / clean.
- The front and back jaws of backbone or chips that should not be damaged.
- Cross jaw front temperature for products weighing below 200 grams is 162 OC - 165 OC which should be 150 OC - 160 OC.
- Back jaw temperature for products weighing below 200 grams is 158 OC - 161 OC which should be 150 OC - 160 OC.
- The discharge of the front and back of the jaw is not

performed periodically.

- The operator does not do some things from the set procedures.

C. Restore

This recovery level is to restore the machine to a standard state. Six non-standard-time discoveries to the field were returned according to the standards that existed on February 3, 2017. From the monitoring results after the restoration in February, data showed that the type of defective seal attached still occurred in February 2017 of 367 pcs, but fell to pareto -3 compared to data from July 2016 - November 2016 which became to pareto -1.

Things to do are:

- Cross jaw front & back condition there is polyroll residue attached to cross jaw front & back which should be condition is not dirty / clean.

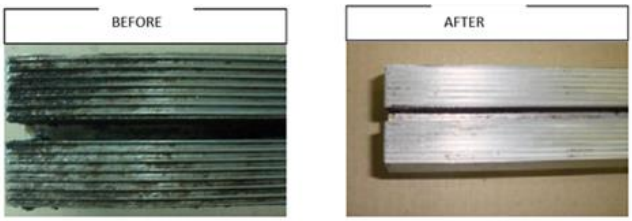

Fig. 2. Front and rear condition before and after repair

- The front and back jaws of backbone or chips that should not be damaged. Action: replace foam.

Fig. 3. Condition of foam before and after repair

- Temperature cross jaw front for products weighing below 200 grams is 162 OC - 165 OC which should be 150 OC - 160 OC. Action: returns the temperature to the standard.
- Temperature cross jaw back for products weighing below 200 grams is 158 OC - 161 OC which should be 150 OC - 160 OC. Action: returns the temperature to the standard.
- Cross jaw front & back clearance is not done periodically, per-batch. Action: cleaning is performed periodically every batch.

D. Analyze Causes

The cause of analyzing the phase is to find the main cause which causes the type of defect to be valid where the process of recovery was previously performed [4]. The results obtained in the second genre still have check items that still do not conform to the cross-standard front & back side there is a polyol sticking side that should be clean or not dirty with the root of the problem:

- The cleaning brush material is too hard and not soft that causes the teflon layer to erode.
- The cleaning interval per batch or every 20 minutes causes teflon coating to erode.
- The front and back cross jaw is not the center that causes the inner layer of polyol, i.e. LLDPE out and is attached to the front of the jaw and back.
- There is no way to validate the front and back of the cross jaw that leads to the jaw front and centerless.

E. Eradicate Causes

This level is the level of improvement based on the root cause of the problem that has been found. Improvements made in March 2017, action plans used using the 5W + 2H method (What, Why, Who, Where, When, How and How Many). The corrective measures are:

- The main plan for the root of the first problem is that the toothbrush is too hard and not soft that causes the teflon coating eroded to replace the type of teflon brush with the softer material of the previously used brush material is the steel material and replaced with a brush as hardness is less than steel which means softer. For the second improvement is the re-layer of the Teflon layer in front of the jaw & back as the teflon layer in the jaw is lost. Coating is done by machine vendor.

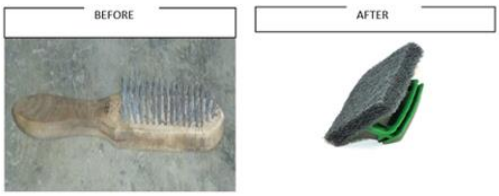

Fig. 4. Brush condition before and after repair

- The mitigation plan for the root cause of the batch or every cleaning interval for 20 minutes which causes teflon coating to erode is to extend the release time of the front and back of the jaw of the cross. Before cleaning done each group or 20 minutes once a week (start of production). Because the result of removal causes where before every 20 minutes / each batch becomes per 480 minutes / per shift the result is a seal attached to 0 PC. After that step increases the interval of clearing time to widening from each shift to once in a week (early withdrawal) and the result of a sealing seal impairment is still outdated.
- Plans for a third root problem that crawls front and back is not the center that causes the inner layer of polyol, i.e. LLDPE to come out and attach to the front of the jaw and the back of the jaw to the middle position.

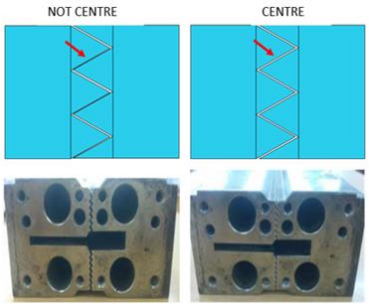

Fig. 5. Front and rear front jaw center and not center

- The operating plan for the root of the fourth problem is that there is no way to verify the front of the jaw and the rear position that causes the front and back jaws to be centerless. The result of the discussion with the machine vendor is not a measurement method to determine whether the front and back of the jaw front is either center or not.

Then the reaction steps performed were to create a method to verify the setting of the front and rear crossing of the jaw position by using a carbon paper layer. This carbon layer is prolonged by the jaw cross so carbon ink will be printed on the second paper layer. The front & rear jaw is said to be centered if the carbon ink printed on the paper layer has the same thickness. This method is visually measured.

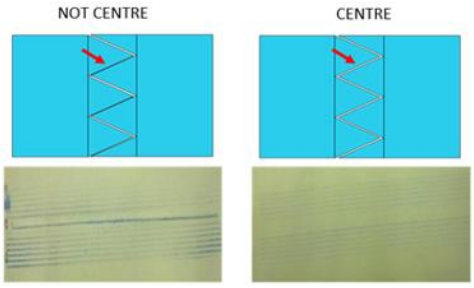

Fig. 6. Results confirm the position of the front and back jaws

F. Establish conditions

After improvements to the cause causes and the monitoring of the results is no longer a defective seal attached, the next step is to revise QM-Matrix by adding new revision item after repair. Then there are four check items added in QM-Matrix namely:

- Teflon layer in front and back of the jaw cross
- Center jaw front & rear
- Clean the face of the jaws & the back
- Confirm the result of fixing the jaw & back jaw

G. Improve Conditions

This level is to make improvements to existing inspection methods [4], i.e. by minimizing the review intervals to facilitate the inspection of the operators who perform. Of the four extra regular check-ups that can be done is the increased jaw front & back by reducing the cleaning process that was previously performed every shift to a week.

H. Maintain conditions

The level to maintain the condition is to monitor only the defective tendency after improvement, i.e. reducing the front & rear jaw cleansing process before shifting every week. And as a result, in May - June 2017, the type of defective sealing seal is no longer occurring i.e. 0 pieces.

I. Quality Score and OEE After Repair

After the increase in the sealed seal, there was an increase in the value of Gross Value previously in July 2016 - November 2016 by 99.36% to 99.46%. Additionally, it also affects the overall value of Overall Equipment Efficiency (OEE), which is 81.93% up to 82.00%.

Table 1
Comparison of QR, OEE before and after repair

	Before Repair	After Repair
Quality Rate	99,36%	99,46%
OEE	81,93%	82,00%

4. Conclusion

Here are some conclusions from the research that will be answered from the purpose of this study:

1. Overall equipment effectiveness (OEE) for D-Wolf soap filling machine in July 2016 - November 2016 is 81.93 %% with QR is 99.36%.
2. Pareto high defect in D-Wolf sachet filling machine in July 2016 - November 2016 check QC (Quality Control) with a total of 18196 pcs or 61.25% and pareto second defect is sticky seal with a total of 3,829 pcs or 12.89%. For the purpose of this final investigation, the focus on the second pareto's disability is to examine QC is the product taking by the Quality Supervisory team which functions to analyze the quality of the product but according to management decision of XYZ Company, check this QC should still be counted and included in the product category damaged although it is not a defective product.
3. The main reason for the problem that causes the type of disability to occur is:
   a) The cleaning brush material is too hard and not soft that causes the teflon layer to erode.
   b) The cleaning interval per batch or every 20 minutes causes teflon coating to erode.
   c) The front and back cross jaw is not the center that causes the inner layer of polyol, i.e. LLDPE out and is attached to the front of the jaw and back.
   d) There is no way to validate the front and back of the cross jaw that leads to the jaw front and centerless.
4. Improvements made to address the cause of the problem include:
   a) The mitigation plan for the root of the first problem i.e. brushing material is too hard and not soft which causes the teflon layer to erode is to change the type of teflon brush with the softer material before the brush material

used is steel material and replaced with scotch brite brush because the hardness is smaller than steel which means softer. For the second improvement is the re-layer of the Teflon layer in front of the jaw & back as the teflon layer in the jaw is lost. Coating is done by machine vendor.

b) The mitigation plan for the second root of the problem is the cleaning interval per batch or per 20 minutes which causes the corrosive teflon layer to widen the cross jaw front & back clearance time. Before cleaning done each group or 20 minutes once a week (start of production). Because the result of removal causes where before every 20 minutes / each batch becomes per 480 minutes / per shift the result is a seal attached to 0 PC. After that step in step improvements the cleaning houses are further developed from per shift to once per week (initial expenditure) and the result of sticky seal flaws is still deprecated.

c) The mitigation plan for the root of the third problem is the cross jaw front and the non-center back which causes the inner layer of polyroll, which is LLDPE out and attached to the cross jaw front and back is the setting of the cross jaw front back to the center position.

d) The operating plan for the root of the fourth problem is that there is no way to verify the front of the jaw and the rear position that causes the front and back jaws to be centerless. The result of the discussion with the machine vendor is not a measurement method to determine whether the front and back of the jaw front is either center or not.

e) Then the reaction steps performed were to create a method to verify the setting of the front and rear crossing of the jaw position by using a carbon paper layer. The carbon layer is prolonged by the jaw cross so carbon ink will be printed on the second paper layer. The front & rear jaw is said to be centered if the carbon ink printed on the paper layer has the same thickness. This method is visually measured.

5. Of the improvements that have been made then the Quality Score is 99.46% of the Quality Score before the 99.36% improvement. In addition, the OEE value achievement after improvement improved from 81.93% to 82.00%.

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