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THE ROLE OF RISK MANAGEMENT IN MINIMIZING *BLACK STAIN* THROUGH THE FMEA APPROACH AT PT MPZ

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Quality products have a major influence on the company's image, and also very influential on the number of sales and profits to be gained. But f deed of the field stated that sometimes a lot of product failure that can not be sold and had to be discarded because they do not meet quality standards. This failed product was caused by various factors, including 4M (Man, Material, Machine & Method). PT MPZ is one of the manufacturers of tissue in Indonesia. The problem they face is the number of " Black Stain Defect " when the production process is running. To minimize the occurrence of Black Stain Defect , the author uses the concept of risk management assisted with the approach of FMEA (Failure Mode and Effect Analysis) to help resolve problems that occur. From the results of research and data collection, it is found that the highest RPN level occurs in grinder log saw with RPN 648 points and lower in seal bearings by 12 points. The risk management used is risk avoidance (avoiding risk) and risk mitigation (reducing the likelihood or impact), one of the recommendations for improvement is to replace thickness logsaw from 5 mm to 3.8 mm and timing grinding from 6 seconds to 3 seconds and several other proposed improvements to minimize the failure during the production process.

Keywords : *Black Stain Defect, FMEA, Risk Management*

1. INTRODUCTION

Every company would want a large profit and the product is in demand in the market . However, for produce quality products is not was easy, because many factors affect the quality of the product. One of the indicators of the declining quality of a product's performance is when it is found that many products fail during the manufacturing process of the product . Defect is a product defect that occurs outside the product quality standard , so that the product cannot be accepted by consumers [1]. In this study, based on the data obtained that the highest defect that occurred in PT MPZ was black stain like the graph below.

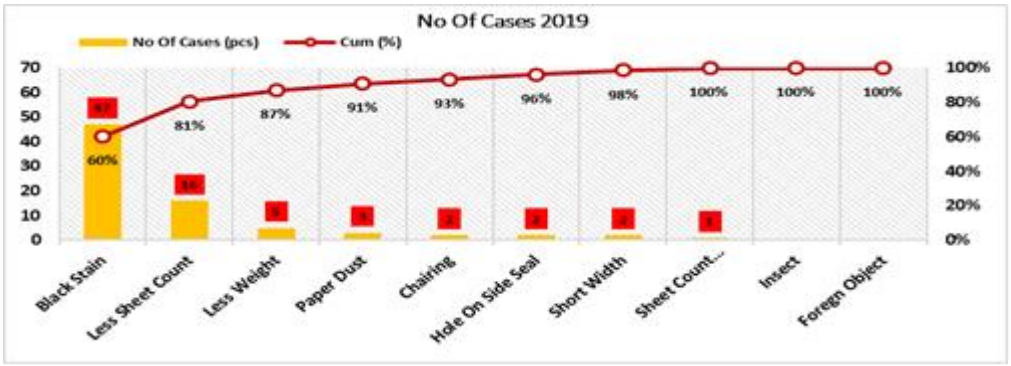

Figure 1. The number of defective products and and the percentage of it: the year 2019
Source: Production data record of PT MPZ (2019)

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The graph above shows the number of defect (defective products) which occurred during 2019. Total product defects for one year is as much as 78 cases , and his greatest contribution is the case of " *Black Stain Defect"* as many as 60% of total product defects for one year, or same with 47 cases.

Figure 2 . Black Stain Defect
Source: Production data record of PT MPZ (2019)

Then the second contribution is *"Less Sheet Count,* which is 16 cases. But that will be the focus of the research is *" Black Stain Defect"* as the greatest contribution to immediately be repaired and mas ne black stain can be resolved, or at least be minimized. The approach taken to overcome *black stain* is the FMEA approach. The FMEA approach is carried out by describing the causal factors in tabular form and then determining the ratings on the S *(severity),* O *(occurrence),* and D *(detection)* values. Then multiply the numbers on the 'S' *(severity),* 'O' *(occurrence)* and 'D' *(detection)* and the results right on the 'RPN' *(risk priority number).* The highest RPN value gets the highest priority scale for improvement. And it is hoped that this black stain problem can be resolved soon.

According to Mulyadi [2] defective product is product that do not meet the standards that have been determined, but at the cost rework to fix it, the product can be refined economically longer a good finished product. According to Horngren, Foster and Datar [3] defective products according to the type of damage can be classified into two groups namely Normal and Abnormal Disabilities. Normal defects are defects that can not be avoided in certain production processes that arise even under efficient operating conditions while Abnormal defects are defects that will not arise under efficient operating conditions . The factors that cause defective products stated by William K. Carter [4], namely: Product defects caused by customers, such as replacement of specifications after production begins or the need to produce within very tight tolerances and Product defects caused by internal failures, such as employee carelessness or machinery.

The objectives of this research are Identifying risk to know the magnitude of the potential impact during the production process and Providing recommendations (proposed improvements) to companies to minimize the presence of defect products by using risk management and assisted with the *FMEA (Failure Mode and Effect Analysis)* approach.

2. METHODE

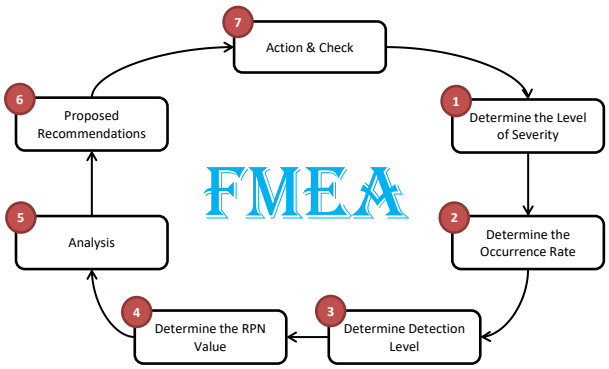

Figure 3. Process Flow Approach with FMEA

Failure mode and effects analysis (FMEA) is a methodology used to evaluate failure occurs in a system, the design process or service (*service*). Identification of potential failure is done by scoring or score each failure mode based on the incidence (*occurrence*), degree of severity (*severity*) and the level of detection (*detection*). Therefore, the FMEA method is one of the most recognized and widely used proactive risk assessment methods in the industry [5]. The assessment of each of these potentials can be assessed on a scale like the following (Figure 3)

1. Severity (*severity*) is an assessment of the severity of an effect or the result of a potential failure on a component that affects an engine's work being examined. *Severity* can be assessed on a scale of 1 to 10 .

Table 1. *Severity* Ranking Table

Severity level	**Severity of Impact**	**Ranking**
Dangerous without warning	Failure is not preceded by a warning	10
Dangerous with warnings	Failure is preceded by a warning	9
Very high	Product cannot be operated	8
High	The product can be operated with a much reduced level of performance	7
Is	The product can be operated but some additional items (secondary functions) cannot function	6
Low	The product can be operated with a slightly reduced level of performance	5
Very low	Defects realized by customers (> 75%)	4
Minor	Defects realized by customers (50%)	3
Very minor	Defects realized by customers (<25%)	2
There is no	Has no influence	1

2. An event (*occurrence* **)** is an assessment with a certain degree in which there is a cause of mechanical damage that occurs in the equipment. The value of the *occurrence* level can be seen the possibility of damage and the frequency of damage to equipment .

Table 2. *Occurrence* Assessment Criteria

Probability of Risk Occurrence	**Description**	**Ranking**
Very high	Often occurs	10
High	Repeated	9
		8
		7
Is	Rarely happening	6
		5
		4
Low	Very small happened	3
		2
Very low	Almost never happens	1

3. Detection (*detection*) is an assessment that also has levels as well as *severity* and *occurrence* . *Detection* level assessment is very important in finding potential mechanical causes that cause damage and its remedial action.

Table 3. *Occurrence* Assessment Criteria

Detection	**Possible Detection**	**Ranking**
Almost impossible	The controller cannot detect failure	10
Very rarely	Very far the possibility of the controller will find a potential failure	9
Rarely	It is rare that a controller will find a potential failure	8
Very low	The possibility of a controller to detect failure is very low	7
Low	The possibility of the controller to detect failure is low	6
Is	Possible controller to detect moderate failures	5
Rather high	The possibility of the controller to detect failure is rather high	4
High	The possibility of the controller to detect failure is high	3
Very high	The possibility of the controller to detect failure is very high	2
Almost certain	Failures in the process cannot occur because they have been prevented through solution design	1

4. Determining the value of the RPN , S fter scoring is done, each value will be multiplied to obtain the value of *risk priority number* (RPN). This value is used to compare the causes identified during the analysis

of each potential problem. Then do step calculation of the value *of r isk priority number* (RPN). The RPN calculation has the following formula:

RPN = *Severity* x *Occurence* x *Detection*

The RPN value is then used to determine the level of risk of the production process , then the biggest value will be priority for immediate repairs, with the hope that defective products can be reduced as soon as possible.

After knowing the level of risk, then the risk management is carried out where according [6, 7, 8, 9, 10, 11] there are 6 processes carried out in managing ISO 31000 based risks which are described in more detail. The ISO 31000 Risk Management Details are as follows : The stages of risk management are First Communication and consultation : There is consultation to discuss risk management in order to have responsibilities in carrying out risk management, and to have a basis on which decisions are made and the reasons why such actions should be carried out. The second is Establishing the context : When making context for the risk management process, detailed and clear consideration is needed specifically how it relates to the scope of a particular risk management process. Establishing this context includes setting goals, strategies, scope and other parameters related to the process of managing an organization's risk. Determination of this context shows the relationship between problems or things that are managed risk with the organizational environment (external & internal).

The Third is Risk assessment (risk subscription) : The processes in Risk Assessment namely Risk identification, Risk Analysis, Risk Evaluation, and Risk treatment. At risk assessment stage the risks will be classified into risks that can continue to increase, risks that can be prevented, and risks that can be overcome immediately or those risks can be reduced the level of seriousness of the risk. At risk analysis stage of development it is necessary to evaluate the risks that will be dealt with first and what will be dealt with later, by making a table of likehood and impact of all the risks that . At risk evaluation stage the risk analysis will prioritize which handlers should be prioritized and which risks can be dealt with later. At risk treatment stage is the stage of choosing whether the risk can be accepted or rejected, if the risk is accepted, then deeper handling is reviewed, whereas if the risk is rejected, then it is considered whether it will bring up new risks. How many alternatives can be considered for use : Share the risk (risk sharig), Reducing the likehood and / or reducing the consequences (risk sharing), Avoiding risks or canceling high-risk activities (risk avoidance), and Accept risk (risk acceptence)

Monitoring and review is Actual progress in implementing the action plan for risk provides a measure of performance and can be incorporated into company performance management, measurement and reporting of internal and external activities . Monitoring and review can involve regular examination or supervision of what already exists or can be periodic. KPIs are defined as strategic and measurable measurements that reflect critical business success factors [12]

f. Recording the risk management process

Risk management activities must be flawed, so that the notes can be made improvements from existing risks. From the analysis in determining the improvement of product quality and added value is expected to be known to the different conditions [13, 14, 15, 16, 17, 18].

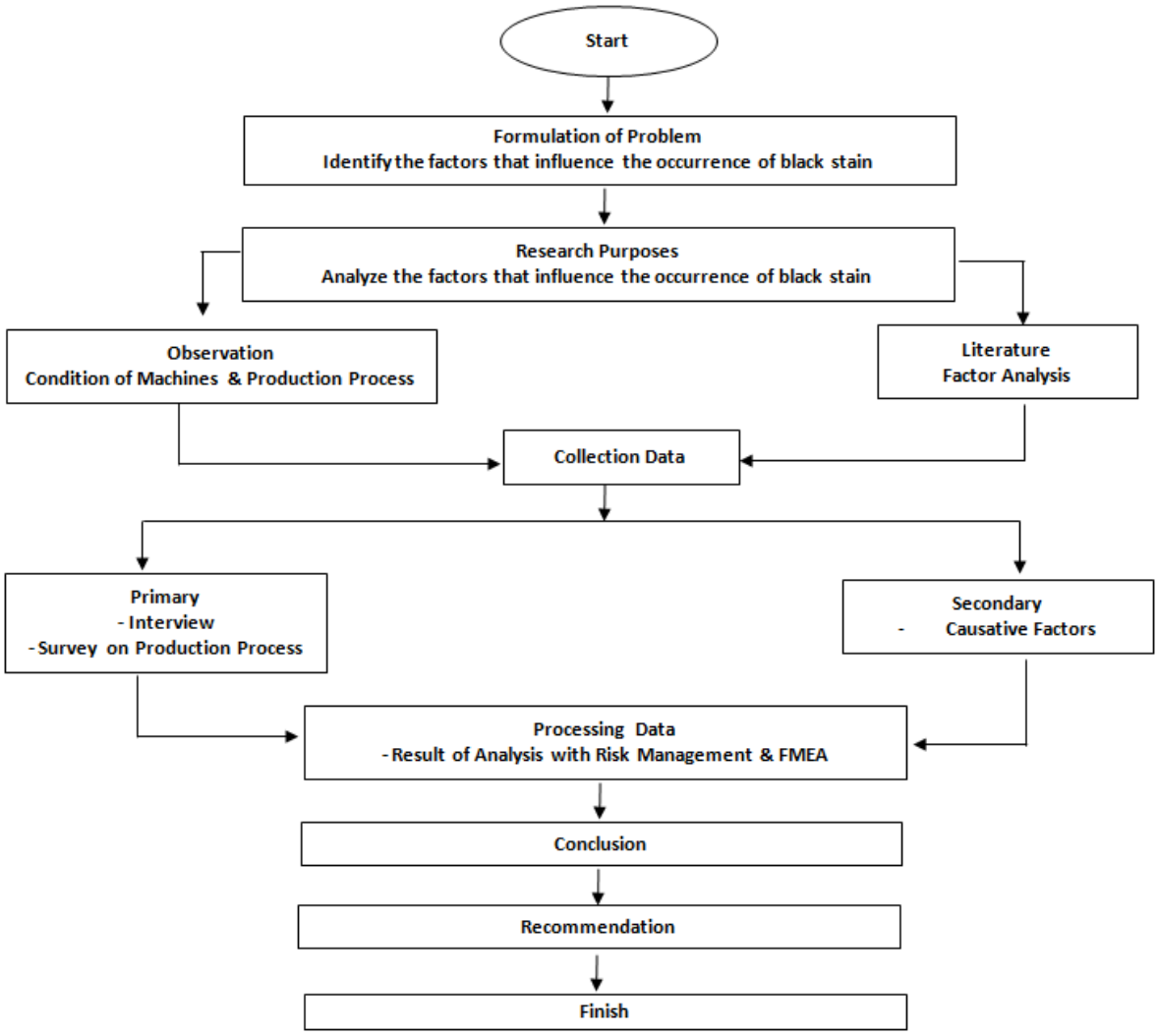

Figure 4. Framework (*Flow Cart*)
Source: Results of data processing 2021

3. RESULT AND DISCUSSION

Establishing Context

In this study, *black stain is* one of the *defects* that contributes the most compared to other *defects* . This happens due to abnormal conditions of the machine during the production process so that the quality of the product drops. To minimize the existence of black stain, improvements are made by determining in advance the causal factors based on the level of risk aided by the FMEA approach so that the repairs are carried out on target.

Risk Identification

The first step in analyzing a problem is to identify the factors causing the *black stain* from the production process . Once known, goes on to identify the causes of each stage of production for the specified *rating severity* , *occurance* , and *detection*. Based on the identification of hazards, risks [19], results survei and direct observation to the production area is found factors - factors that cause *a black stain* on the stages of the production process that can be seen in pictures and videos ar flow below:

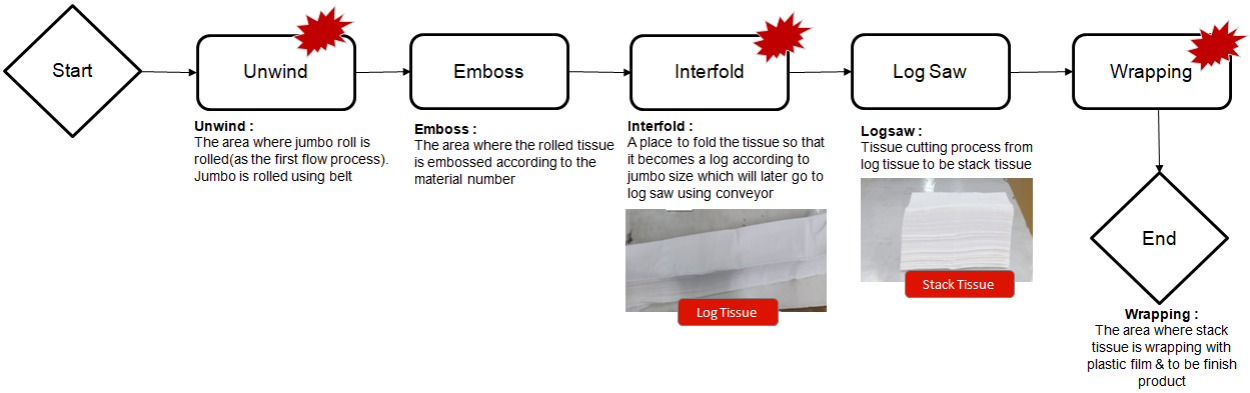

Figure 5 . Production Process Stages
Source: Production data Flow of PT MPZ

From the production process flow above , found 3 process areas that are factors causing *black stain* namely

1. Unwind , is an area where jumbo roll rolls are rolled using a belt. In the belt there are bearings that are located close to the belt so that when the seal bearing is damaged it causes grease (lubricant) on the bearing out of normal conditions and on the belt . This causes the black stain on the tissue

Figure 6 . Bearing
Source: PT MPZ's production record data

2. **Interfold**, is the process of folding tissue into log tissue .
At the main pulley interfold grease is given so that the process of bending becomes smooth. When applying grease, the main pulley does not have a cover on the bottom so that oil drops on the tissue passing under the main pulley can be seen in the image below:

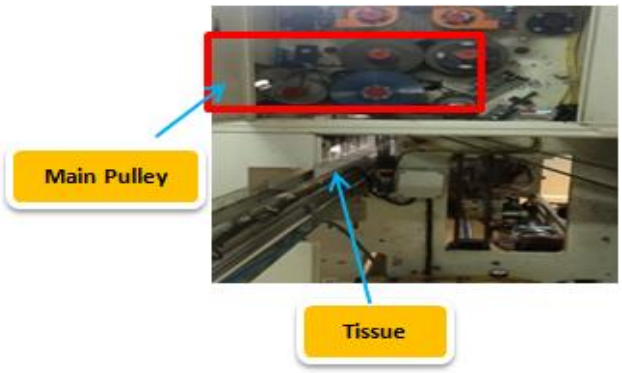

Figure 7 . Play Pulley
Source: PT MPZ's production record data

Apart from the *main pulley* , the area where the *vacuum* hole *folds up* when the engine turns off but the *vacuum* is still running for 10 minutes. This causes the *tissue is* still sucked up by the vacuum & the dirt in the vacuum sticks to the tissue .

3. ***Log saw*** , the area where *the log tissue* into pieces of *tissue* in a small size . In this process the *log saw* undergoes a grinding process (grinding). With a thick *logaw* diameter causes the grinding process to last a long time so that the debris from the process sticks to the logsaw so that it touches the *tissue* .

After finding 3 process areas that cause *black stain* , then described in the form of a *fishbone* diagram that aims to explain in more detail the reasons for the occurrence of *black stain* from the predetermined causal factors making it easier to analyze and make suggestions for improvement in each of these causative factors.

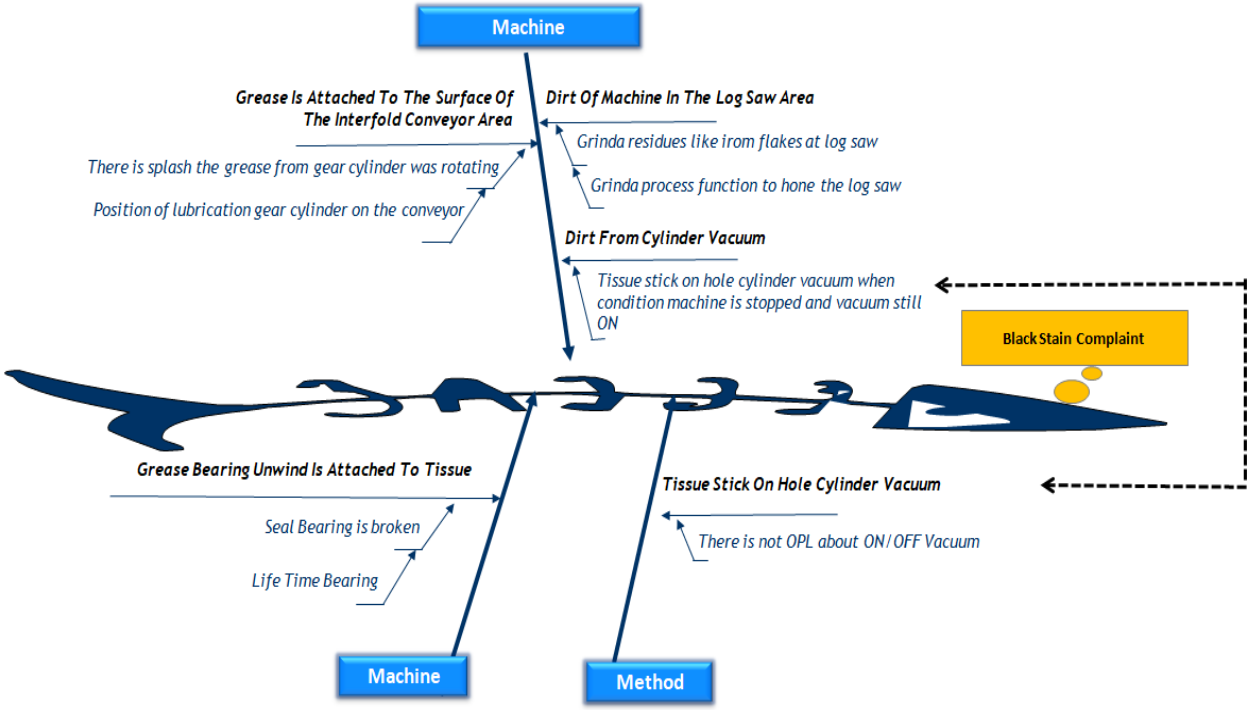

Figure 8. fishbone
Source: PT MPZ's *production record data*

Risk Analysis

Fishbone from the translation of the above, an analysis of the factors - these factors to determine the level of risk the *black stain* in terms of severity, occurrence and detection . For more details attached to the table as follows :

Tabel 4 : *FMEA* Analysis

Process	Failure mode	Effect of failure	Cause of failure	Current control	Existing Condition				Risk Level	Range
					S	O	D	RPN		
Interfold	Grease Is Attached To The Surface Of The Interfold Conveyor Area	Black stain	1. There is splash the grease from gear cylinder was rotating 2. Position of lubrication gear cylinder on the conveyor	Create cover gear cylinder	8	8	2	128	Low Risk	0-350
	Dirt From Cylinder Vacuum	Black stain	Tissue stick on hole cylinder vacuum when condition machine is stopped and vacuum still ON	1. Create SOP 2. Daily Cleaning	7	6	8	336	Medium Risk	351-650
Logsaw	Dirt Of Machine In The Log Saw Area	Black stain	Grinda residues like irom flakes at log saw	1. Change thickness of logsaw 2. Change timing grinda process	9	8	9	648	Medium Risk	351-650
Unwind	Grease Bearing Unwind Is Attached To Tissue	Black stain	Seal Bearing is broken	1. Change the seal bearing 2. Daily Cleaning	4	3	1	12	Low Risk	0-350

Process table above aims to rank the factors - factors the cause of the occurrence rate of black stains from the highest to the level of low. In this labeling process, we created a range to help us determine priorities. Low Risk is 0-350 points, Medium Risk is 351-650 points, and for High Risk is 650-800 points. For the order of the highest level of causative factors is in terms of engine impurities in the logsaw area with a severity level of 9, which means a high level of severity in the log saw machine that causes black stain then the rate of occurrence (occurrence)) of 8 which means it occurs repeatedly. Then from a detection level of 9 which means that it is very far away that the controller will find potential. This is because there is no control in the log saw grinding process so that the RPN value of 648 with a risk level is classified as medium risk, which indicates that the risk of black stain is highest in the log saw. As for the order of the causes of the low at seal bearing damaged by the level of severity for 4, level of incidence (occurrence) of 3 and a detection rate of 1 so that the value of the RPN to 12, shows that the causes of the seal bearing the broken is still relatively low risk and has high enough opportunities in controlling so chances are the black stain is not so great .

Risk Evaluation

Having analyzed the factors causes of the problem through the elaboration diagram *fishbone* and FMEA table , then do the proposed recommendation as a form of *action* / activity shortly angani t erjadinya *black stain defect* as follows:

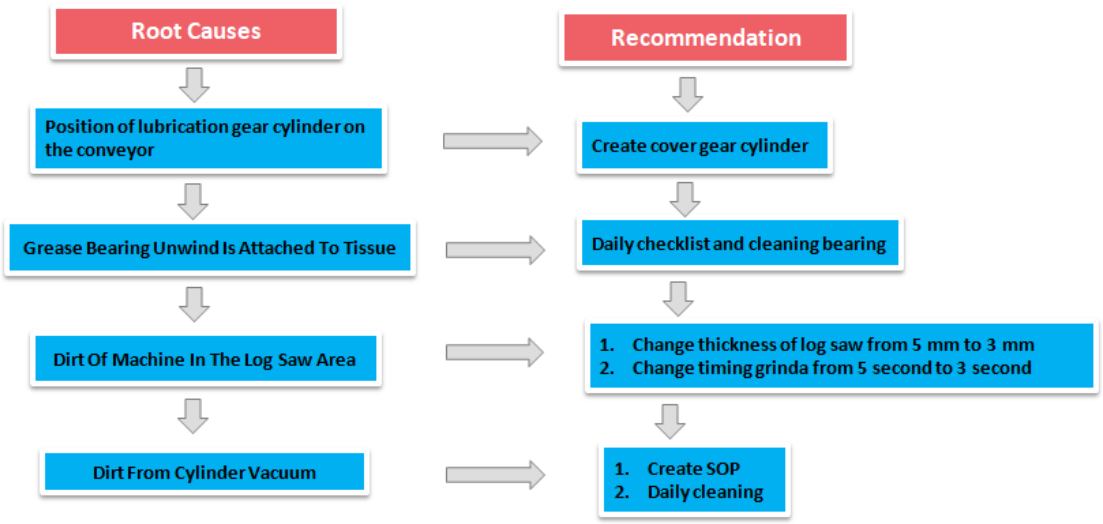

Figure 9 . Number of *Case Black Stain* Before and After Repair
Source: PT MPZ's production record data

After testing repair field, and then carried out the evaluation process to monitor and ensure that improvements are effective in addressing the problem *of black stain* to show the comparison of data *complain black stain* before and after improvement as follows:

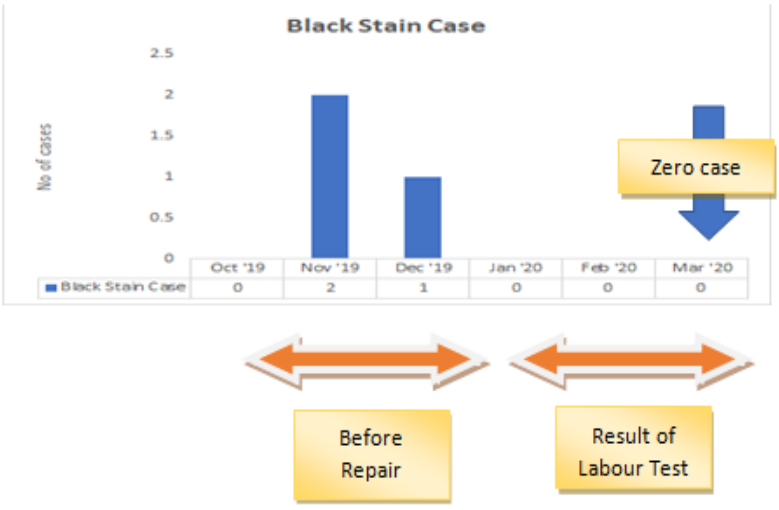

Figure 10 . Number of *Case Black Stain* Before and After Repair
Source: PT MPZ's production record data

From the data above show after the test fixes , the problem *of black stain* does not happen again natural span of 3 months ahead so that the proposed improvements are made effective in the *black stain* on the PT MPZ.

Risk Treatment

Based on the above RPN values, it can be seen the order of risk from highest to lowest, it is necessary to control risk (*risk treatment)* aimed at managing existing risks where *risk treatment* consists of *risk avoidance* (*risk avoidance*) and *risk mitigation* (reducing the likelihood or impact). The results of this *risk treatment* are obtained through *brainstorming* with production, *quality* and *engineering* after checking the condition of the machine so that risk control is obtained as follows:

Tabel 5 : Risk Treatment

No	Risk	*Risk Treatment*	
		Risk Aviodance	***Risk Mitigation***
		Recommendation	**Recommendation**
1	Grease Is Attached To The Surface Of The Interfold Conveyor Area	Create cover gear cylinder	Checking to production area before running
2	Dirt From Cylinder Vacuum	1. Create SOP	1. Put OPL / SOP near with machines
		2. Daily Cleaning	2. Briefing before working about Standard Of Operation (SOP) cleaning cylinder vacuum
3	Dirt Of Machine In The Log Saw Area	1. Change thickness of logsaw	Checking log saw every break time during 30 minutes
		2. Change timing grinda process	
4	Grease Bearing Unwind Is Attached To Tissue	1. Change the seal bearing	Cleaning every break time during 30 minutes
		2. Daily Cleaning	

Based on the above table, it is explained that each risk can be controlled by: First, For *grease* risk *attached to the* surface of the *conveyor area interfold* , control of *risk avoidance* by giving *cover* to the *gear cylinder* and *risk mitigation* by checking the production area before the engine operates in order to ensure that the *cover* mounted on the *gear cylinder is* in good condition. Second, To risk Dirt From Hole *Vacuum* Silinde r , control in terms of *risk avoidance* by way of making SOP making it easier for workers to handle if the problem occurs again while *risk mitigation* by conducting *briefings* before work related SOP *vacuum cleaning cylinder* which aims to remind workers during what conditions do the *cleaning* cylinder *vacuum* . Third, For the risk of engine impurities in the *Logsaw* Area , control in terms of *risk avoidance* by means of changing the thickness of the *log saw* and changes in grind *timing* while in terms of *risk mitigation* by checking the condition of the *log saw* during recess to ensure there are no iron flakes from the grinding process attached to the *log saw.* And the last, For the risk of *Grease* on *Unwind Bearings* Regarding *Tissue* , control in terms of *risk avoidance* by means of *bearing bearings* and regular *cleaning* while in terms of *risk mitigation* by *cleaning* during recess to ensure and maintain bearing conditions in normal conditions [20,21,22]

Standardization

This standardization is made with the aim to maintain and control so that the problem of *black stain* does not occur again. However, at the time this journal was made, the standardization process was still in the validation process [23,24]. But the steps that have been done is the coordination of *meetings* associated with this repair project, later n *issued* document standardization, the document has been *checked* by QC *head* , but has not reached the stage of *the approval document* by MBOS in Jakarta and can be seen in the image below:

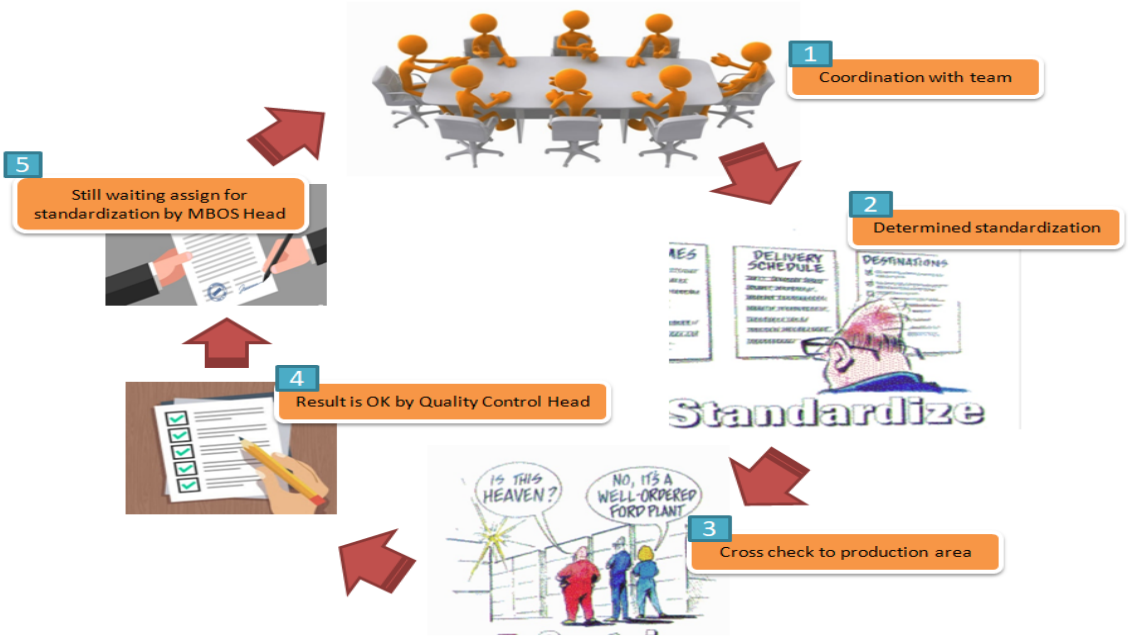

Figure 11. Standardization Regulation

4. CONCLUSION

1. Identifikasi factor - a factor of *black stain* using FMEA method with risk management approach , indicated by the value of the RPN of each - each process is considered to have respected contribution occurrence of product defects caused by abnormal conditions during the production process and categorize these risks in *r isk level of* the pitch is divided into two, namely *low risk* and *medium risk* .

2. The recommendations / proposed improvements given are as follow : Change thickness of *logsaw* and change the *timing* grinders to reduce the risks of dirt in the area *longsaw*, Replacement of *bearing seals* and do regular *cleaning* for the risk of *grease* on the *bearing unwind* on the *tissue*, Preparation of SOP and do *cleaning* regularly to risk dirt from hole *vacuum cylinder*, A gear cylinder cover is provided for the risk of grease sticking to the interface surface of the conveyor area, After the above improvements, the *quality* and production team checks to control and monitor the effectiveness of the repairs that have been made so that the improvement objectives can be achieved properly. By carrying out routine control, the results show that within a period of 3 months *black stain* cases are not found in the product so this proves that the proposed improvements can be recommended to companies to improve and maintain product quality.

5. REFERENCE

[1] RIYANTO., WAHYU. A., "Implementation of the QCC Method to Reduce Defective Rate of Alloy Wheel Products", *Wijaya Putra University Internal Journal*, v. 3, n. 2, 2015

[2] MULYADI, "Akuntansi Biaya, Edisi kelima, Cetakan kedelapan, Penerbit Sekolah Tinggi Ilmu Manajemen YKPN, Yogyakarta, 2007

[3] HORNGREN, CHARLES T., FOSTER, GEORGE., dan DATAR, SRIKANT M., "Cost Accounting : A Managerial Emphasis" *Upper Saddle River, New Jersey : Prentice-Hall*, v. 2, n. 4, pp. 35-45, Apr. 2013.

[4] CARTER, WILLIAM K., dan USRY, MILTON F., *Akuntansi Biaya*. Diterjemahkan oleh Krista. Buku 1. Edisi Keempat Belas. Jakarta: Salemba Empat, 2014.

[5] SANTOSO, S., PUTRO, S.S., FATMAWATI, A.A, PUTRI, C.G., SA'DILLAH, "Disain Mitigasi Risiko Penularan Covid-19 Di Lingkungan Industri Padat Karya Dengan Metode FMEA", *JKBM (Jurnal Konsep Bisnis Dan Manajemen)*, v. 7, n. 2, pp. 149-166, 2021 https://doi.org/10.31289/jkbm.v7i2.4674.

[6] SUSILO, LEO J. KAHO, VICTOR RIWU., Manajemen Risiko Berbasis ISO 31000, Jakarta : Penerbit PPM, 2014

[7] RAHAYU, N.R., SANTOSO. S., "Implementation of Six Sigma to Minimize Reject Gusset Difference and Fold in the Blowing Process", *European Journal of Business and Management Research*, v. 6, n. 4, pp. 1-6, 2021 DOI: 10.24018/ejbmr.2021.6.4.913

[8] SANTOSO, SUGENG., "Risk and Social Economic Factor as a Management Risk Revealing (Vegetables Farmer Decision Making Study in Pujon Sub District Malang Regency)", *International Journal of Science and Research (IJSR)*,v. 8, n. 10, pp. 35-49, 2019

[9] SANTOSO, S., AULIA. M.I., HARAHAP. R.S., SITORUS, R.S., WASKITA, D.S., "Improvement of cooling time performance in TAD® 20t mixing vessel using root cause analysis and PDCA cycle in TAD® 20t mixing vessel product maturity", *IOP Publishing, IOP Conf.Series: Materials Science and Engineering*, v. 10, n. 34, pp. 154-167, 2021 012126. doi:10.1088/1757-899X/1034/1/012126, 2021

[10] NURZAKI, A., SANTOSO. A., BENAWAN. C., WAHYUDIN. D., dan SANTOSO. S., "Improvement of DEET level of product X using Deming cycle (PDCA Method) in PT Z", *IOP Conf. Series: Materials Science and Engineering*, v. 10, n. 34, 2021 012110. doi:10.1088/1757-899X/1034/1/012110, 2021

[11] PUTRO, S, S., SANTOSO. S., "Desain Konseptual Digitalisasi Manajemen Mutu Pada Industri FMCG", *Jurnal Mix: Jurnal Ilmiah Manajemen*, v. 11, n. 2, pp. 147-162, 2021 DOI:10.22441/mix.2021.v11i2.001

[12] PEKIH, I.M., SEMBIRING. A., SANTOSO. S., "Key Performance Indicators Analysis for Quay Container Crane Performance Assessment (Case Study at Jakarta International Container Terminal)", *MECHTA: International Journal of Mechanical Engineering Technologies and Applications*, v. 2, n. 2, pp. 115-125, 2021 https://doi.org/10.21776/MECHTA.2021.002.02.5

[13] SANTOSO, S., MAYRIFKA, D., "Analysis Problem and Improvement of Appearance Aesthetics Product Model HC C5 / XT with Method of Plan-Do-Check-Action (PDCA) In Pt. XXXX", *International Journal of Innovative Science and Research Technology*, v. 4, n. 11, pp. 42-49, 2019.

[14] SANTOSO, S., SOEHARI, T. D., APRIANTO, Y., ANDREAN, D., & HENNY., "Value Creation In Fisheries Supply Chain As A Role Model For Fish Protein Hydrolyzate Cluster Development", *Jurnal Rekayasa Mesin,* v. 11, n. 3, pp. 401 – 407, 2020 doi:10.21776/ub.jrm.2020.011.03.12.

[15] SIMBOLON, R., SANTOSO, S., "Product and Service Quality Improvement In Manufacturing: A Study of Optical Lens Manufacturing in Indonesia", *Jurnal Media Ekonomi dan Manajemen*, v. 36, n. 1, pp. 76-88, 2021 htpps://doi.org/10.24856/mem.v36i1.1726

[16] SANTOSO, S., NUSRANINGRUM. D., HADIBRATA. B., WIDYANTY. W.; ISA, S. M., APRIYANTO, Y., HENNY, "Policy Recommendation for Food Security in Indonesia: Fish and Sea Cucumber Protein Hydrolysates Innovation Based", *European Journal of Business and Management,* v. 13, n. 7, pp. 71-79, 2021 doi:10.7176/EJBM/13-7-08

[17] YULIANA, V., SANTOSO., "Re-engineering and Technology Development on Reference Sample of Business Process (Case Study on Health Laboratory Service Company)", *Jurnal Ilmiah dan Manajemen*, v.7, n.2, 2021

[18] PUTRO, S, S., SANTOSO. S., "Desain Konseptual Digitalisasi Manajemen Mutu Pada Industri FMCG", *Jurnal Mix: Jurnal Ilmiah Manajemen*, v. 11, n. 2, pp. 147-162, 2021 DOI:10.22441/mix.2021.v11i2.001

[19] SANTOSO, S., ROCHMAN., FOURMARCH., PAWENARY., FITHRI, P., "Transformasi Digitalisasi Pelaporan HAZOB Untuk Meningkatkan Kinerja Keselamatan Kerja di Perusahaan", *Jurnal Sains, Teknologi dan Industri*, v. 18, n. 1, pp. 112-119, 2020, DOI : 10.24014/sitekin.v18i1.12062.

[20] ISWANTO, A., "Application of the Taguchi Analysis and Failure Mode And Effect Analysis (FMEA) Method to Improve Product Quality at PT. XYZ", *Industrial Engineering E-journal*, v. 2, pp. 13-18, 2013.

[21] ROSIH, A, R, CHOIRI. M. YUNIARTI, R., "Operational Risk Analysis in the Logistics Department using the FMEA method",*Journal 13 Industrial Engineering and Management Systems*, v. 3, n. 3, 2016

[22] SAMADHAN, DB., "Quality Improvement in Manufacturing Processes Using SQC Tools"., *International Journal of Engineering Research and Applications*, v. 3, n. 15, pp. 832-837, 2013

[23] SOKOVIC, M., JOVANOVIC, J., KRIVOKAPIC, Z., VUJOVIC, A., "Basic Quality Tools in Continuous Improvement Process". *Journal of Mechanical Engineering* , v. 55, n. 5, 2019

[24] SUSILO, LEO J. KAHO, VICTOR RIWU., Manajemen Risiko Berbasis ISO 31000, Jakarta : Penerbit PPM, 2014