Application of Autonomous Maintenance to Reduce Failure Rate of Bearings in Food Production Line: A Case Study

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List of Abbreviations

TPM	Total Productive Maintenance
OEE	Overall Effective Equipment
AM	Autonomous Maintenance
C, I, L	Cleaning, Inspecting, Lubricating
JIPM	Japan Institute of Plant Maintenance
GMP	Good Manufacturing Practice

ABSTRAK

Industri pembuatan kini semakin meningkat di seluruh dunia dimana ia boleh dikatakan setiap negara berharap kepada industri ini untuk menjana ekonomi. Di era modenisasi ini, syarikat-syarikat akan bersaing sesama sendiri untuk menjadi syarikat pertama dalam dunia. Untuk memastikan sesebuah syarikat itu berada pada kedudukan yang baik, faktor yang paling utama yang perlu dititikberatkan adalah keupayaan sesebuah syarikat itu untuk memenuhi kehendak pelanggan. Perkara ini boleh dicapai dengan mempunyai kondisi pengeluaran yang lancar tanpa sebarang kerosakan mesin berlaku. Dalam hal ini, sistem penyenggalaraan memainkan peranan yang signifikan untuk membantu syarikat mencapai keinginan pasaran. Di dalam projek ini, satu tiang daripada Total Productive Maintenance (TPM) dipilih untuk dikaji tentang kepentingannya dalam penambahbaikan. Tiang yang dipilih adalah tiang Autonomous Maintenance (AM) yang membawa makna pekerja operator akan menjalankan penyenggalaraan keatas mesin. Projek ini adalah tentang kajian terhadap sebuah syarikat pemprosesan makanan di Enstek, Negeri Sembilan. Kajian yang dilakukan adalah berkaitan tentang penggunaan Autonomous Maintenance dalam mengurangkan kerosakan mesin yang disebabkan oleh galas. Hasil daripada kajian ini adalah terciptanya sebuah sistem pelincir yang mampu mengurangkan kadar kerosakan galas di dalam sistem pembuatannya.

ABSTRACT

The current manufacturing industries are blooming in the whole world where it can be said that every country mostly depend on this industry to generate economy. As in this modern world, industries are competing between each other. To ensure the company is performing well, one of the most important factors is the company can meet all the customer demand. To make this happen, the production of the company should in a smooth condition without any breakdown occurred. In this case, maintenance play a very significant role to fulfill the company desire. In this project, a single pillar of Total Productive Maintenance (TPM) is being study on its significant improvement that it can make. The pillar is the Autonomous Maintenance (AM) where AM is the pillar for the operators to do maintaining task in order to keep machine sustainability. This project is a case study done at a food manufacturing company at Enstek, Negeri Sembilan. The case study is about the application of Autonomous Maintenance to reduce machine downtime caused by bearing failure. The outcome from this case study is a lubrication system that improved the bearing failure rate at the production line.

CHAPTER 1

INTRODUCTION

In Oxford dictionary, maintenance is translated as a process of keeping something in a good condition. Maintenance can be in all equipment such as car, machine, house and tools. In industry as such manufacturing industry, maintenance is one of the most important part to ensure the company run smoothly. Maintenance in industry can be divided into three major categories which are mechanical, process control and facility [1]. Mechanical maintenance will involve in maintaining the machine at the production area from start to the end. They will focus on the mechanical part of the machine such as the gear system, bearing, conveyor, piston and rotary part. Process control maintenance also involve with the machine at the production line but only focus on the process control of the machine such as the HMI panel, sensor, and wiring system. Lastly, for the facility maintenance, they will focus on the facility of the factory such as the air conditioner, lighting, and other facilities.

One of the important of having a maintenance system in a factory is to prevent machine breakdown. Machine can be full of mechanical parts such as bearing, gear, piston, shaft, sprocket, chain and motor, all these part or component are the source of the machine breakdown. Sometimes, the bearing wear causing the rotary part cannot move and this will cause stoppage to the machine. When the maintenance at the factory is poor, it will result on increase of machine breakdown thus it will affect the Overall Equipment Effectiveness where the efficiency and availability of the machine will decrease [2]. This also can cause a failure to meet the customer demand.

In a big company where there is already a good maintenance system for the production machine, such machine breakdown can still happen due to several causes

and one of it is the human factor. What is meant by human factor is the people in charge to do the maintenance does not fulfil their job correctly or never done it.

Nowadays, the industrial world is growing and growing from day to day. The competitions between the companies are growing as the increasing in demand also increased rapidly from time to time. To become the number one company in the competition, one of the important criteria is that the company must be able to supply their product according to the demand of all the customers in the market. To achieve this, one of the important factors is to make sure that the production is running smoothly without any problems. From this, Total Productive Maintenance was introduced to the world of industries. Total Productive Maintenance or more known as "TPM" have its own formula to make sure the company running smoothly from all kind of aspects. TPM is a resource-based maintenance management system where improvement on equipment effectiveness, productivity, workplace safety and environmental issues, and eliminating production losses were being focused into [3]. Seiichi Nakajima, the founder of Total Productive Maintenance was one of the biggest contributors towards the improvement of the manufacturing industry for the whole world [4].

From the Figure 1.1, there are eight pillars of Total Productive Maintenance which are Autonomous Maintenance, Kaizen, Planned Maintenance, Quality Maintenance, Training, Office TPM and lastly the Safety, Health and Environment. All pillars are equally important to ensure the TPM goals will be achieved. Seiichi Nakajima was the one that contribute towards these pillars. The history of TPM is that it was started in Japan where an automotive electrical parts manufacturing company, Nippodenso start to implement TPM in their company in the year of 1960s [4]. Nakajima was a senior official of the Japan Institute of Plant Maintenance (JIPM) where

he is the one that defined the concept of TPM and the one that responsible on the implementation of it to hundreds of company in Japan at that time.

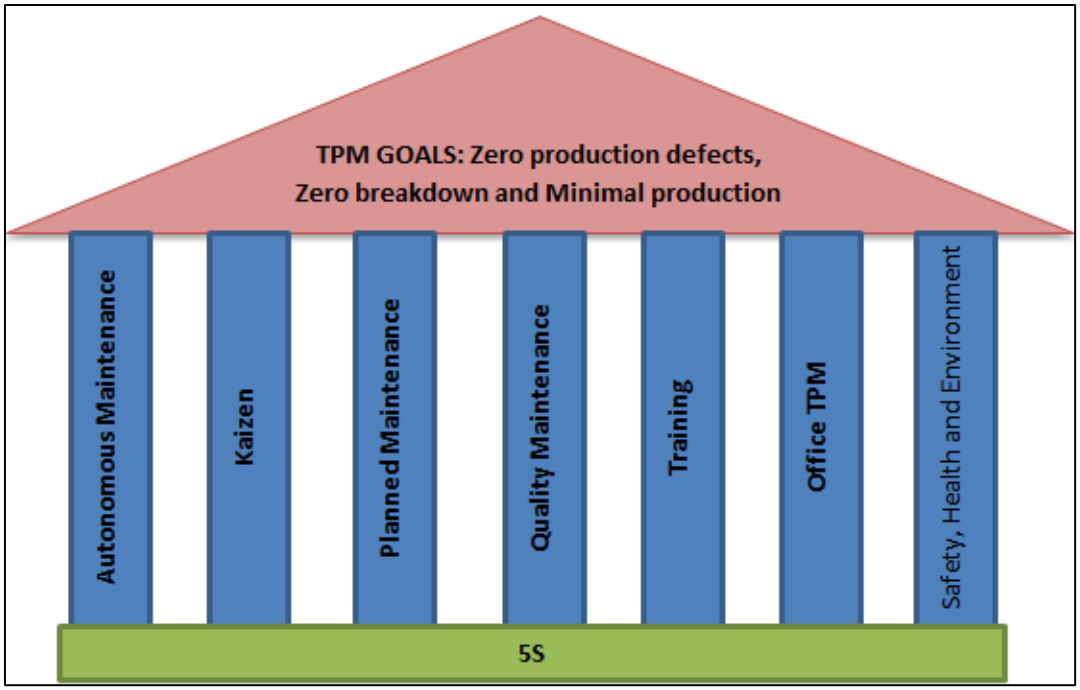

Figure 1.1: Eight Pillar of TPM [5]

One of the important pillars of Total Productive Maintenance is the Autonomous Maintenance (AM), where it places responsibility for routine maintenance, commonly is cleaning, inspecting and lubricating (C, I, L) in the hand of the operators. This is because the one that spend most of the time with the machine is the operators, so this is the main reason for autonomous maintenance is a responsibility of the operator. By doing this, it give the psychological ownership to the operator towards the machine where psychological of ownership is the feeling of belonging toward something as in this context is the machine that is responsible to the operator [6].

1.1 Project Background

Autonomous Maintenance is one of the important pillars in the house of Total Productive Maintenance (TPM). Each pillar in the house of TPM has its own people that responsible to ensure that the goal of TPM is achieved. The history of Autonomous Maintenance is that it started from the 5S activities of the production teams when they found the way to handle with the barriers to quality, delivery and cost performance they used to do improvement on the equipment condition , all that by applying the principles of 5S and QC circles [7]. AM is basically the result of production team (operators) to control and improve their own equipment. AM have the relationship with the Overall Equipment Effectiveness (OEE) where AM has the responsible on preventing from stoppage to occur in the production. OEE take account on three major factors which are availability, performance and output quality of the equipment. Although the job of the operator is just a simple task, but they play a major rolled in the context of preventing minor breakdown that will affect the three factors of OEE. By reducing the number of breakdowns, it will increase the percentage of OEE so as the production and this will result in achieving the customer demand of product. By doing this, the company automatically will be known as one of the main suppliers of their product in the market worldwide.

For AM, the responsible is on the hand of the operator where their job is to do routine maintenance to the machine that they are handled. In this case, by giving the responsibility to the operator, it create a psychological of ownership where it make the operator feels like the machine belongs to them [6]. It is found that people tend to develop a positive feelings for tangible or intangible objects for which they feel belonging [6]. By having this feeling, it will be a lot of initiatives from the operator to ensure their machine is in a perfect condition.

1.2 Problem Statement

It is well known that the autonomous maintenance is a strong element in TPM that can increase the productivity of the production, but it is only well known by the upper position, so the main problem here is to change the way of thinking, habit and the culture of the operators. There is a problem where operator not giving a full commitment to the task given. Next, the downtime in the production line is high due to minor maintenance. This meant that the problem that happen at the production line is come from a simple problem.

1.3 Scope of Work

For this project, a case study will be done on a food industry company that supply its product worldwide. The study that will be done is on the downtime of the machine that is causing from the bearing failure. The reason why this case study is focusing on the downtime causing from bearing failure is that the responsible of maintaining the bearing is on the hand of the operator. The machine that will be focusing on is the production area machines.

1.4 Objectives

1. To study on the benefit of Autonomous Maintenance
2. To define cause of downtime in company
3. To investigate Autonomous Maintenance case study in company

CHAPTER 2

LITERATURE REVIEW

2.1 Importance of Maintenance in Industry

After many years of manufacturing industry have been started since the Industrial Revolution 1.0 until Industrial Revolution 4.0, maintenance in industry is one of the huge contributors towards the productivity of the company. Nowadays, in the era of modernisation, to become the best manufacturing company, the rapid change of customer demand must be fulfill on any circumstances. The change in the manufacturing industry is too rapid that it cannot be change and that is the most challenging part for all the company [3]. As a modern manufacturing industry, all the company should be supported by the maintenance practices and procedures with efficiently and effectively [4]. Without a proper maintenance, it will be a hectic situation in the factory, many machines will breakdown and all the customer demand cannot be fulfill. Result from this, the company will lost a lot in order to do major service for all the machines. In order to make the maintenance system become more effective in the industry, the focus must not only be in the technical advancement but all the aspect which is safety, environmental care, quality and availability also need to be increased [8]. This mean all the factor need to be take a close look because sometime the root cause of the problem is not from the maintenance team or maintenance system.

2.2 Total Productive Maintenance (TPM)

Maintenance is a huge scope in industry and every industry implement different kind of maintenance system or maintenance culture. One of the most known maintenance cultures in the big industry is called Total Productive Maintenance. As a

global manufacturing industry where the market involve is worldwide, proactive lean manufacturing is a must do in the company in order to enhance the competitive between all the manufacturing industry in the whole world [4]. That is when Total Productive Maintenance (TPM) come over. It is all started by Nagajima from Japan where he is the major contributor in TPM [5]. The purpose of Total Productive Maintenance (TPM) is to maximize the effectiveness of usage of the equipment in the company such as the machines and equipment [5]. Total Productive Maintenance(TPM) have 8 pillars which is the systematic approach to gain the benefit of TPM [5]. As shown in Figure 1.1, the 8 pillars are Autonomous Maintenance (AM), Kaizen, Planned Maintenance, Quality Maintenance, Training, Office TPM and Safety, Health and Environment pillars.

Table 2.1: Description of Eight Pillar[5]

No	Pillar	Description
1	5S	5S act as the foundation of the pillars which means it is a disciplined that all the worker needs to do.
2	Autonomous Maintenance	AM is the pillar that is specially dedicated to the operators that work with the machine where small maintenance job need to be done by them.
3	Kaizen	Kaizen is the continuous improvement pillar where a lot of improvement will be done by this team.
4	Planned Maintenance	This is for the maintenance team where method to prevent equipment failure is done
5	Quality Maintenance	It is aimed for quality good produced with maintaining the equipment to be in a perfect condition and without breakdown.
6	Training	Training is important to educate worker to perform their job with the function of the equipment
7	Office TPM	Improve the efficiency and productivity in the administrative role.
8	Safety, Health and Environment	To predict and prevent damage on work in surrounding area to make sure that Zero accident, Zero health damage and Zero fires campaigns to be achieved.

2.3 Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) play a huge role in Total Productive Maintenance (TPM). OEE is the measure of how success it is the implementation of TPM in a company or industry [9]. In a technical word, OEE represent the performance and reliability of production in a company, and also the efficiency and effectiveness of the equipment [5, 10, 11]. An increasing percentage of OEE indicate that there is an improvement occurred from the source of data [12]. OEE represent three items which are time, speed and availability. Overall Equipment Effectiveness were introduced by S. Nakajima in the year of 1970s. where at that era, OEE was already become the KPI at the Maintenance department [2]. To calculate OEE, the availability, speed and time were multiplied each other and the result of the multiplication is the OEE. OEE is a common tool used in all manufacturing industries where if someone is searching for a career especially as continuous improvement team, OEE knowledge should be in their head before coming for the interview with the company [2].

2.4 Responsibility of Autonomous Maintenance

Autonomous Maintenance is a worldwide culture as it brings a lot of improvement towards the productivity in the manufacturing company. Autonomous maintenance is where the production team or the operator done the routine maintenance themselves. So, the biggest responsible of taking a good care for the machines in the production is in the hand of the operators. The company need to involve everyone in order to achieve their big goal including the operator where they will initiated daily maintenance which is consist of Cleaning, Adjustment and Inspection and also to conduct a minor improvement to the equipment [13]. The task of the operator in AM also involved the maintenance activities of preventive, predictive or light breakdown

event of machine that conducted directly by the operators [14]. It is also stated that the job for continuous maintenance for the machine is on the hand of the operators [15]. By giving them this big responsible, it create a psychological ownership which means the operator will have the feeling for the machine as their own belongings [6]. It will create a positive feeling in the mind of the operator thus the operator will tend to initiated more on the improvement of their machines [6].

2.5 Advantages of Autonomous Maintenance

There are a lot of advantages only for Autonomous Maintenance pillar in TPM. Although as we know that the task of the operator in AM is not that big compared to the maintenance department team where they involved in major maintenance, AM give the first defensive strategy to make sure the production is running smoothly. One of the advantages of AM written by a journalist in his writing is that, AM contribute increased the number of Overall Equipment Effectiveness (OEE) [15]. Overall Equipment Effectiveness included the machine availability, rate of production and quality. In the context of OEE, one journalist state in his writing where Autonomous Maintenance help in increasing the number of operational availability and the operator also will understand their key role in the company [16]. Furthermore, AM also will create a competitive advantages in the organization because it makes the operator to give more effort in the organization when the sense of belonging are already in their mind [6].

2.6 Implementation of Autonomous Maintenance

For the implementation of Autonomous Maintenance, there are a few methods and challenges in order to start the culture of AM in the company. As for the method to implement of the AM culture in the company, a writer said that it needs to be in four

stages which are AM initial preparation, AM training and motivation, AM five-step execution and lastly AM audit [9]. Also, in order to make sure that the autonomous maintenance is successful in the company, an effective and thorough training and education programmes should be done [17]. For whatever task that we ask people to do should be to have a training session so that the worker will not make mistakes. In the latest approach, it is also said that an associated training of machine tool should be done for the operator to ensure their co-operation [15]. Next, for the challenge to implement the Autonomous Maintenance is that to change the way of thinking, habit and their culture in term of take the responsibility when they are assigned for a certain task [9]. This is because it is not easy to change a habit in a short term of time. Thus, sustainability is one of important thing to be take note to make sure the old habit is not repeated.

After implementing the autonomous maintenance, most of the result were positive which mean Autonomous Maintenance is a good culture to be implemented in company. Shin Min et al. (2011) conducted a case study on the development of Autonomous Maintenance in a semiconductor company where the implementation is based on the four systematic stages. The result of the AM practice shows a significant improvement in production performance, minimising machine breakdown [9]. Guariente et al. (2017) conduct a case study in an automotive company where Autonomous Maintenance is used for air-conditioning tubes manufacturing lines and the result were also shows an improvement on reducing the machine breakdown. The implementation of Autonomous Maintenance in the company is by using the application of AM seven stages which are initial cleaning, elimination of dirt, standardisation of cleaning and inspection, general inspection, overall inspection, systematic autonomous maintenance and autonomous maintenance [12]. Rosimat et al. (2015) who conduct a

case study at the ICT Network company stated that the implementation of Autonomous Maintenance result in reduce of maintenance cost and thus increase the chance of earning higher profit [14].

2.7 Literature Findings

From the literature review, the major finding for the application of the Autonomous Maintenance in industry are overall shows a positive result. As firstly, the Autonomous Maintenance culture will automatically set the mind of the operator to care about the machine they are in charge. This will make the task given to them on the improvement of their machine will be easily done. Next, the Autonomous Maintenance result are all positive. Every company that implement AM will get the improvement on the OEE, rate of downtime, availability, efficiency, performance and quality.

Lastly, the step on implementing Autonomous Maintenance are almost the same in every company. But the most systematic ways are the four stages of implementation.

CHAPTER 3
METHODOLOGY

3.1 Autonomous Maintenance Development

Autonomous maintenance is an approach to give the responsibility to the operator to take care of their own machine, which is to be clear they need to do cleaning, lubricating and inspecting to the machine they are responsible at. When the problem arise is from the operator that does not do the task given, it is not a machine fault or technical fault, it is a human problem. Human problem may cause from many things.

The solution for the human problem is to investigate how they do the task given. To solve the problem, implementation of autonomous maintenance should be done in the company. From the literature review, one of the scholar have stated there are four stages of implementing Autonomous Maintenance in the industry which are [9]:

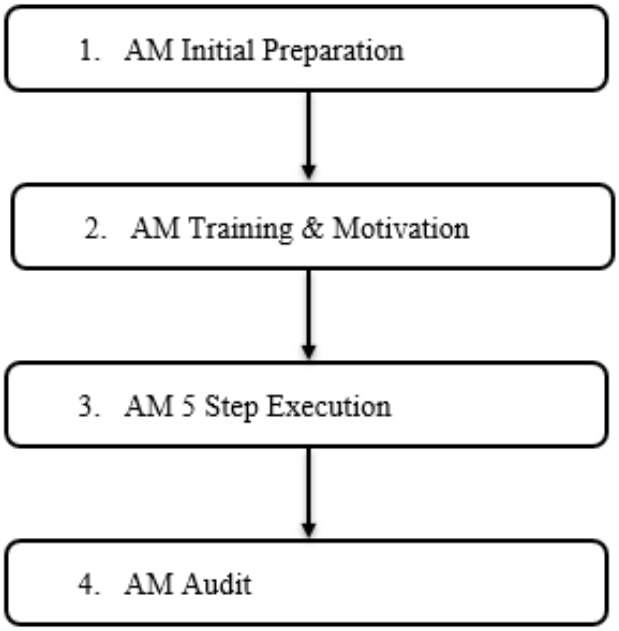

Figure 3.1**:** 4 Stages of implementing Autonomous Maintenance

3.2 AM Initial Preparation

AM initial preparation is the first phase in implementing Autonomous Maintenance in a company. In this phase, what should be done? For this phase, it is good to study the Autonomous Maintenance culture condition in the company. What condition should be study? The most important thing to be investigated is the frequency of machine downtime in the production line. The reason why frequency of machine downtime being investigated is to find what is the most critical part that always have problem and need a proper improvement.

After find the critical part of the machine in the production line, the team that specialize in that area should do an improvement in the way of autonomous maintenance which mean the operator will involve in the task. For example, if the problem is screw missing, the maintenance team should design a proper checklist to the operator's team for them to inspect whether the screw is enough or not. If the problem is complex, the maintenance team should discuss with their team on how to do improvement on that area.

3.3 AM Training & Motivation

AM training & motivation is the next phase which is phase two after the initial preparation. In this phase, there will be three steps to make it done

Firstly, the most importing thing is to create awarene**ss** to the operator on their responsibility to the company to make sure all the production line is operating smoothly and able to achieve the target. Their responsibility is in the Autonomous Maintenance pillar, one of the big pillars in Total Productive Maintenance to ensure the company run smoothly. They should keep in their mind that their role as an operator is one of the most important things in the company because they are the one that ensure whether the

production target of the day able to achieve or not, and it will affect the loss or profit of the company.

Secondly, after create awareness, training should be done for the operator's team. This training should involve the specialist of the task to make sure the operator gained the correct knowledge to do the task. During the training session, it would be great if there is also a hands-on practical being done for the operator. By doing this, the operator will get the full view in the real situation on how to do the new task for them correctly.

Lastly, after done with the training, to gain the worker's spirit, motivation should be given to them. Many motivations can be makes as example, Best Team Award to the production line that have the least problem for the month or the most common motivation for the worker is the Bonus Reward where bonus will be gained to the operator's if there is no problem regarding the task they were given. By doing this, it will make sure that the operator done the task eagerly to gain the reward.

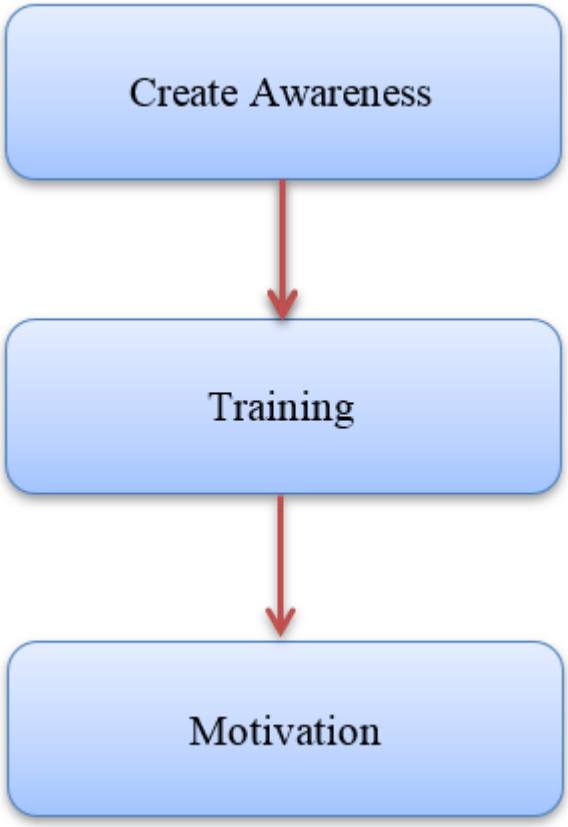

Figure 3.2: AM Training & Motivation flowchart

3.4 AM 5 step execution

For the Stage 3, there are five steps for execution which are shown in Figure 3.3.

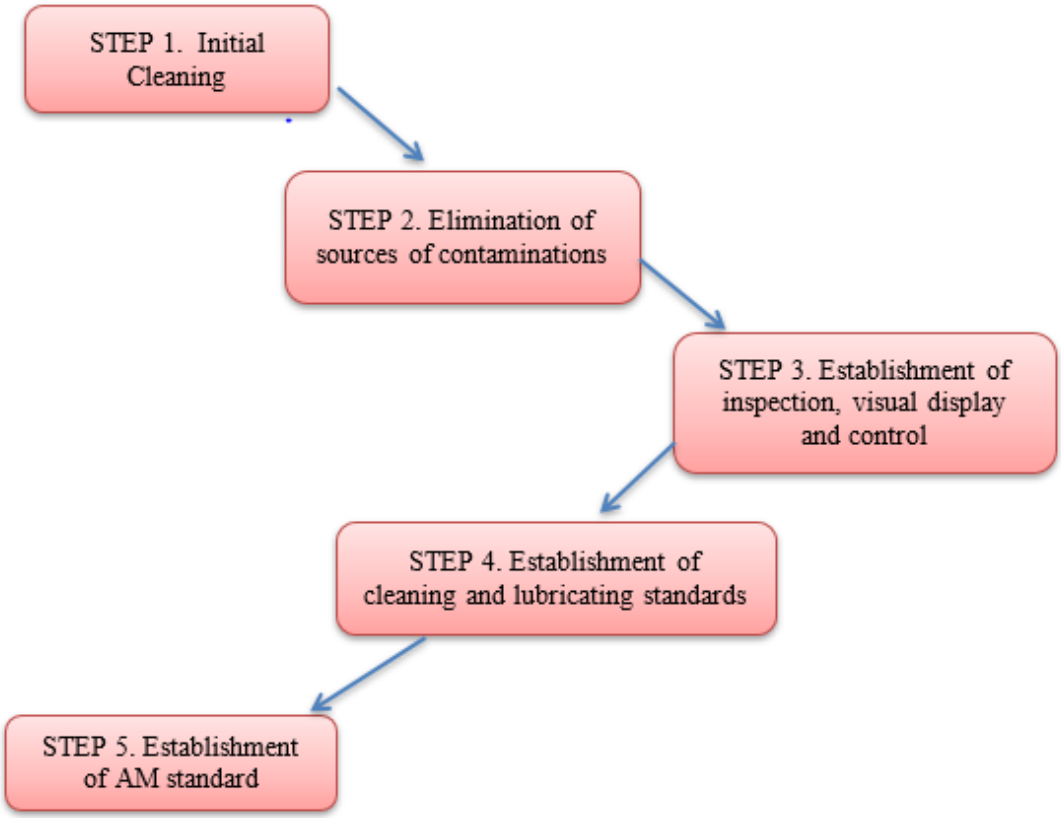

Figure 3.3: AM 5 step execution flow charts

3.4.1 STEP 1. Initial Cleaning

The goal is to maintain equipment cleanliness and detect hidden defects [9]. Hidden defects is being detect by removing contaminants and restore the defective areas of equipment [9].The initial cleaning is done by the operator with the supervise from the technician, supervisors and engineers. This stage played a very significant role because sometimes, dirtiness can cause machine or part failure. If bearing is taken as an example, there are some root cause of a bearing failure which is dust, water, hardened grease and high vibration. So, for this initial cleaning stage, the main purpose is to remove all the possible dust at the part or machine area to prevent machine breakdown.

3.4.2 STEP 2. Elimination of sources of contaminations

The goal in this phase is to maintain the cleanliness achieved from the earlier initial cleaning. The objectives are to identify the source of contamination and gain ways to control or eliminate the source of contamination. It is always important to eliminate the source of contamination because by doing this, there will be no same failure happen again in the future. As an example, dirt in a factory can be cause from many things such as air ventilation, air condition, opened window and human. So, all of these sources of dirt need to be eliminated by doing improvement.

3.4.3 STEP 3. Establishment of inspection, visual display and control

Inspection is the common task that the operators need to do. The goal is to gain the current condition of the machine. Visual display and control are established by the engineering team. Its main objective is to make it easy for the operator to perform the task. The control part is meant that the engineering team need to release a control culture to the operator to make sure the improvement is sustained. As an example, if bolt and nut issue is taken into consider, a checklist to tightening all the bolt and nut need to be done in order to make sure the operator do their job inspection job.

3.4.4 STEP 4. Establishment of cleaning, tightening and lubricating standards

The main goal is to prevent machine failure by inspecting the lubricating system and tightening point of the machine. The task will be standardized by the engineers. The development of the standard is done by doing the why-why analysis. The ‘why-why’ analysis is to determine the root cause of the problem. By gaining the root cause, the standard can prevent the same cause of failure to occur again.

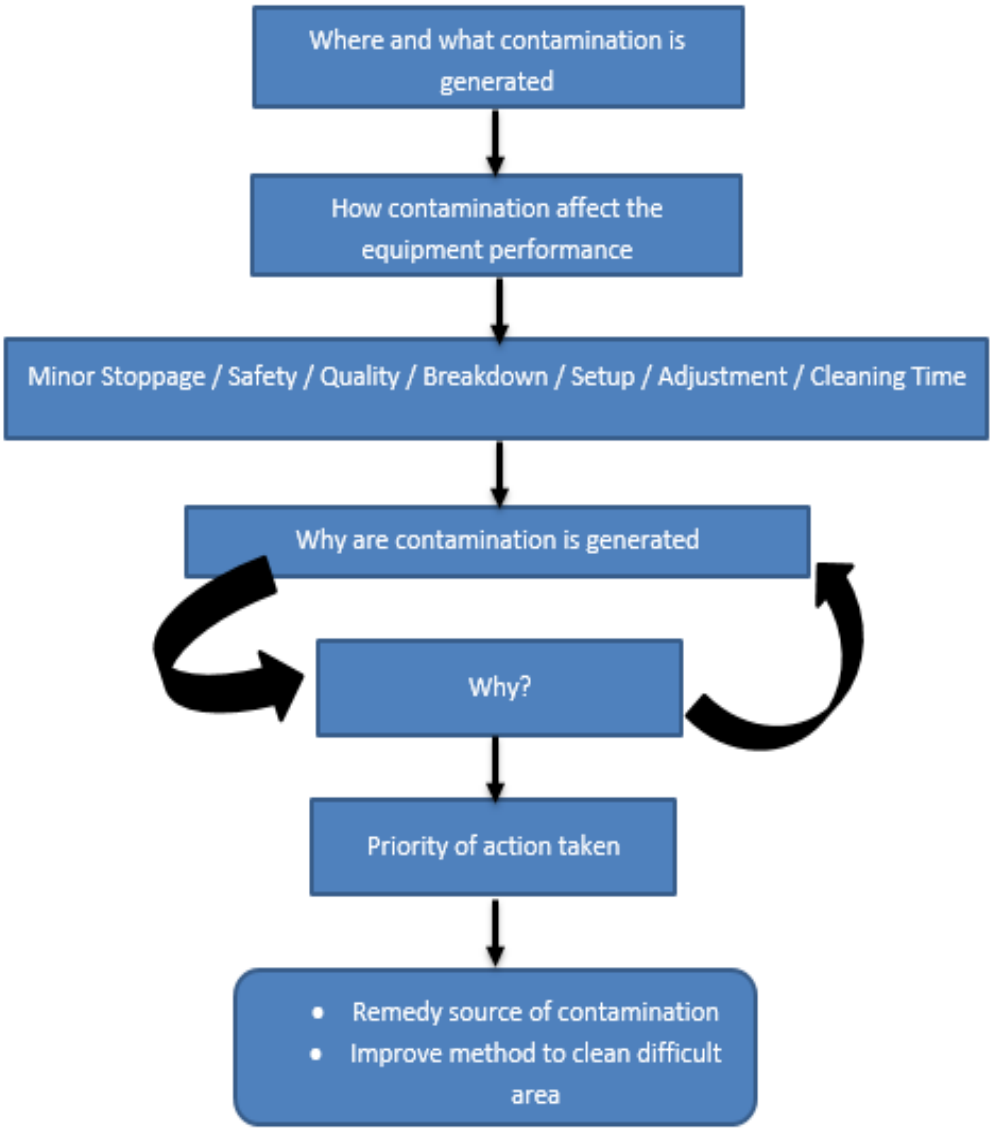

Figure 3.4: Step in conducting 'why-why' analysis to determine the root cause of problem

3.4.5 STEP 5. Establishment of AM standard

Establishment of AM standard consist of 2 part (inspection, visual display & control), and (cleaning, tightening and lubricating standard). By combining these two standards, it will create the total standard called AM Standards. AM standard prescribe the routine task of the operator which is the Cleaning, Inspecting, Lubricating (CIL). The procedure of developing AM standard is divided into 4 steps:

a. **Cleaning, Inspecting and Lubricating Standards**
b. **Compare AM standard with full time maintenance's standard**
c. **Set the tentative AM's standard**
d. **Establish the AM standard**

3.5 AM Audit

AM audit will be focus on the audit task and also continuous improvement of the Autonomous Maintenance. The main objective is to enhance Autonomous Maintenance practice in the company for all the operator whether senior or junior.

For the audit, the auditor will be divided into two teams which the first team will be from the AM' team and the second team will be from out of the AM's team. The AM's team can be represent by the Team Leader of the production line while the second team can be represent by the engineers of other production line or from other department [9]. The audits need to be conducted with proper step and also complete with all the forms for the auditors.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction to Manufacturing Process in industry

The company selected to carry out the case study is a food manufacturing company located in Enstek, Negeri Sembilan where the company produced potato chip as their product. There are six total of production line in the factory where each of the line are producing for different region or country. As an example, Line 1 is dedicated to Hong Kong and China market while Line 3 is dedicated for Japan market. There are different in every line because there is a different in customer demand characteristic. As for Japan market, they request for special sealing because Japan is the country that is very particular about the quality of product and they willing to pay more to get a higher quality product. So, for Line 3, there are different in the packaging area where there is a special sealer to seal the finished product. Basically, the different between the production line is only at the packaging area and not the processing area. The processing area are the same for all the production lines.

The production line is divided into two main area which is Processing and Packaging where the Processing Area is divided into ten sections which are Dry Mix section, Wet Mix section, Rolling section, Cutting section, Frying section, Cooling section, Seasoning section, Vibrator section, Can Filling section and lastly Checkweigher section. For a brief explanation, Dry mix section will mix the ingredient of the potato chip, then the mixed ingredient will be sent to wet mix section to be mixed with the liquid solution. At the wet mix section, it will produce dough that is then will go to the roller to create dough sheet. After created a dough sheet, it will go into the cutter to produce doval. The doval will travel into the fryer to make a chip and soon will go to the cooler to cool and erase the excess oil at the chip. Next, the chip will move to

the seasoning section to get the taste of the potato chip and lastly it will be inserted into the can at the can filling. Before going to the packaging area, it will go through a checkweigher to make sure the weight of the potato chip inside the can is in right amount. The whole production line is shown in Figure 4.1

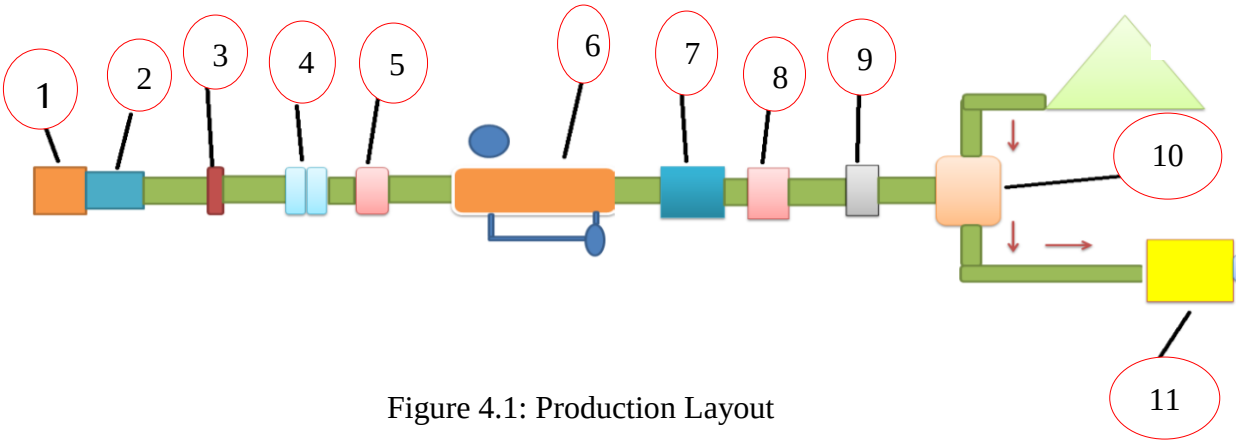

Figure 4.1: Production Layout

Production Area Machines:

1. **Dry Mixer** – Mix flour ingredients
2. **Wet Mixer** – Mix flour with liquid solution to produce dough
3. **Metal Inspection** – Inspect dough to ensure no metal in dough
4. **Roller** – Change dough into dough sheet
5. **Cutter** – Cut dough sheet to become doval
6. **Fryer** – Fry doval to become chips
7. **Cooler** – Cool down chips and erase excess oil on the chips
8. **Seasoner** – Shower chips with the seasoner flour
9. **Vibrator** – Removed excess seasoner flour
10. **Can Filler** – Insert chip into can
11. **Check Weigher** – Inspect the weight of the potato chips

Figure 4.2 and Figure 4.3 shows some of the area in the production line. The production line is fully automated from mixing to can filling. But, at the cooling area, there are worker that will dispose damage chip manually.

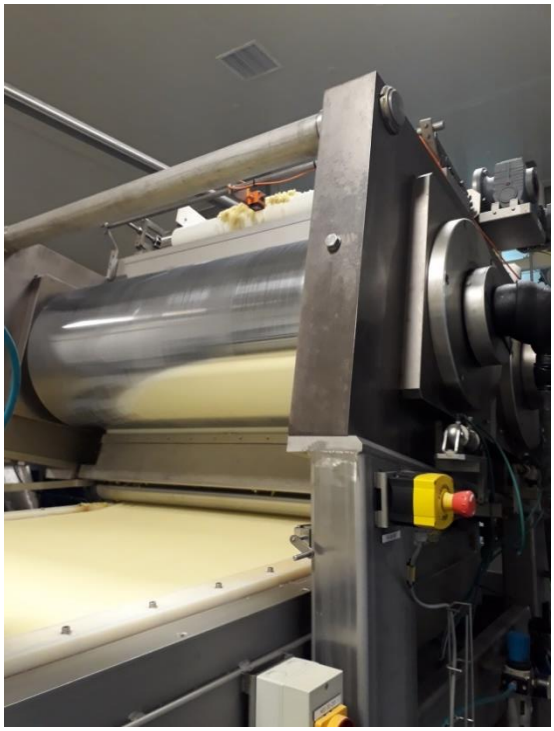

Figure 4.2: Roller to create dough sheet

Figure 4.3: Seasoning Section

4.2 Autonomous Maintenance Initial Preparation

4.2.1 Analysis on the Downtime in Production Line

First and foremost, the breakdown of the production line is being investigated to get the critical breakdown issue. Critical breakdown issue is the breakdown that have the largest number of downtimes. But for this investigation, only the critical issue that used Autonomous Maintenance as the countermeasure will be focused on. What is meant by that is, the breakdown issue that cause from Cleaning, Inspecting and Lubricating not being properly done will be focused on.

A bar chart as in Figure 4.4 is being used to identify the largest number of types of breakdown occurred at the production line. From the bar chart, the largest number of breakdowns that involve the autonomous maintenance role will be the one to be focused on. The data that were analysed is from January to June (6 months) 2018.