LEAN TOOLS ADOPTION FOR ENHANCING MANUFACTURING PERFORMANCE

Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

by

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DECLARATION

I hereby, declared this report entitled “Lean Tools Adoption for Enhancing Manufacturing Performance” is the result of my own research except as cited in references.

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

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ABSTRACT

Lean tools adoption is a structured approach to diverse management approaches that may impact the job content of individuals and also the quality of jobs. This lean tools is needed because of the fast changing environment and also the manufacturing industries is going in advance direction at the moment. The major problem in the industry was the lack of cutter tools such as end mill and insert on the production line which slow down the production line. The aim of this study is to investigate the problems that affect the production performance at Elite Industries Sdn. Bhd. and to identify the appropriate method using the lean tools for enhancing the performance of production line. Interview session is conducted to get information from the workers and the CEO about problems related to the manufacturing process in the industry and data given were collected over a three months period. The method used are 5S and Kaizen in order to solve the problem in the production line. The results showed that lean manufacturing tools can dramatically increase the efficiency of production performance and reduce the searching time from 9.22 minutes to 1.51 minutes.

ABSTRAK

Penggunaan *Lean* adalah pendekatan berstruktur untuk pendekatan pengurusan yang pelbagai yang boleh mempengaruhi skop kerja individu dan kualiti pekerjaan. *Lean* diperlukan kerana suasana yang sentiasa berubah dengan drastik dan juga dengan perubahan industri pembuatan yang bergerak maju pada masa kini. Masalah utama dalam industri ini ialah kekurangan mata alat seperti *end mills* dan *inserts* pada barisan pengeluaran dan impikasinya akan menyebabkan kelewatan dalam prosess pengeluaran produk. Tujuan kajian ini adalah untuk mengkaji masalah yang mempengaruhi prestasi pengeluaran di Elite Industries Sdn. Bhd. dan juga untuk mengenal pasti teknik yang sesuai menggunakan kaedah *Lean* untuk meningkatkan prestasi pengeluaran. Sesi temu ramah telah dilakukan untuk mendapatkan maklumat dari pekerja dan CEO mengenai masalah yang dihadapi berkaitan dengan proses pembuatan di industri dan data untuk tempoh selama tiga bulan telah dikumpulkan. Kaedah yang digunakan adalah 5S dan Kaizen untuk menyelesaikan masalah di barisan pengeluaran. Hasil kajian menunjukkan bahawa pembuatan *Lean* dapat meningkatkan kecekapan prestasi pengeluaran secara dramatik dan mengurangkan masa pencarian dari 9.22 minit ke 1.51 minit.

DEDICATION

Only

My beloved father, Sabuddin Abdullah,

My beloved mother, Seniah Binti Dolah,

My lovely siblings Muhd Shahrull, Nur Elya Fatin, Nur Farahin and Nur Farhana,

To my supervisor. Profesor Dr. Mohd Rizal bin Salleh,

My honorable lecturers and my fellow friends

For giving me moral support, guidance, money and encouragement in completing my final year project.

Thank you so much.

ACKNOWLEDGEMENTS

In the name of Allah S.W.T., the most merciful, the most gracious with the highest praise to Allah that without difficulty, I manage to complete this final year project in time with great manner even with this rough time with online learning because of Covid-19 situation. Without His blessing, this project would not has been possible.

I would like to thanks to my esteemed supervisor, Professor Dr. Mohd Rizal Bin Salleh for guiding and monitoring me during the final year project. All of his advices encourage me in finishing the final year project and without his guidance, I would not be able to finish this. I am grateful for having him as my supervisor.

Moreover, I would express my gratitude to Elite Industries Sdn. Bhd. for having me as their trainee student during my industrial training and give a case study for my final year project. Thank you for their support and helps during my time conducting the case study.

Last but not least, I would like to appreciate my family, lecturers and my fellow friends for giving their precious time and cooperation which help me to finish this final year project on time and successfully.

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LIST OF ABBREVIATIONS

Sdn. Bhd	-	Sendirian Berhad
CEO	-	Chief Executive Officer
CNC	-	Computer Numerical Control
CAM	-	Computer Aided Manufacturing
VSM	-	Value Stream Mapping
PDCA	-	Plan Do Check Action
TPM	-	Total Quality Management
WRM	-	Waste Relationship Matrix
WAQ	-	Waste Assessment Questionnaire
SOP	-	Standard Operation Procedure

LIST OF SYMBOLS

%	-	Percentage
mm	-	Millimeter

CHAPTER 1

INTRODUCTION

For this section, this study is divided into five subtopics which are research background, problem statement, the objectives of the study, research scope and significance of the study.

1.1 Research Background

In industry, lean manufacturing tools is one of the most importance tools to enhance the manufacturing performance. This tools can improve the productivity, the efficiency and also it can reduce waste for the industrial manufacturing. This study is conducted in Elite Industries Sdn. Bhd. in Kuching, Sarawak. The industry is a manufacturing industry, which manufacture custom – made parts according to the customer’s requirement. This study is about on how to find and solve the problems using lean tools for enhancing the manufacturing performance for the industry.

Lean manufacturing is a very important because it has a lot of benefits such as improved the management knowledge (Melton, 2005). This is crucial because to have a good company performance, the company should have a proper method or tools to manage their business. To maintain the competitiveness, the company should implement the lean tools to reduce the waste, to minimize the cost and also to increase the productivity, which will benefit the company in the long term and also in the short term (Esa et al., 2015).

The modern, rapid changing situation in the industry has challenged the industry to develop strategies to improve their business in order to stay reliable in the current state, especially in this pandemic situation which can make the company to loss profit and make their business going bad to worst (Ahuja & Khamba, 2008). The lockdown contributes 20% of gross domestic product (GDP) which has a lot of effect on the manufacturing industry.

This effect can make small organization because of small profitability, such as the company that I conducted for my research (Kapparashetty et al., 2020).

There are a lot of types of wastes that can be found in manufacturing industries such as the transportation of materials, the operations that is not necessary to be done, poor step of processing and also surplus of tool inventory (Rathilall & Singh, 2018). This type of waste can make a company profit to decrease and also impact to the economy of the company in the long term.

For this case study, the lean tools are implemented to solve the problem based on the problem occur in the industry. There are a lot of lean tools available such as 5S, Kaizen, Kanban and Value Stream Mapping.

1.2 Problem Statement

In the industry, by considering the current method of managing tools, cutter such as end mills and inserts, it is known to create problems for the industrial production because of insufficient tools needed. The absence of suitable inventory management for cutter slow down the production and also affect the quality control. This problem will also lead to delays in handing the product to the customer which will affect the profit and time consuming of the company. Based on input given by Elite Industries Sdn. Bhd. through interview that has been done with the CEO of the company, the idle time for machine down due to lack of tools is around 10 – 15 per cent of working hours which make a big impact to the company's production process.

The interview with the CEO also stated that the production per month for the company production is approximately 100-200 part per month. The CEO also stated that the important of tooling stock systems which is by knowing the life span of a cutting tool. Different brands have different life span and grade. When a tool breaks it must be changed before the CNC can continue running, otherwise the part will be scraped. When the stock of end mills runs out, the company will need to buy from a local supplier which uses a different brand than the regular brand. Because of this, the life span for the tools cannot be estimated which, means the machinist need to check the machine every 15-20 minutes to make sure the tool has not broken. Besides, this also affects the efficiency because the machinist need to adjust the CAM program to accommodate for the new tool.

Moreover, the CEO also stated in the interview that the important of tooling stock system for rarely used tools. Sometimes, if there is a job that requires uncommon tooling, the company will have to order it from the supplier. The time for ordering tools such as end mills and inserts usually takes two weeks and this will cause problems for the production because without cutting tools, the machine cannot operate, thus will affect the time and profit for the company and also make the customer to wait for longer time to receive their parts. Having some stock of small end mills means that they can launch a job immediately once the order is received. Therefore, this is why it is important to have an inventory system that tracks each of the sizes and notifies production when a size low on stock and needs to be ordered.

1.3 Objectives

i. To investigate the problems that affect the production performance at Elite Industries Sdn. Bhd.
ii. To propose the appropriate methods using the lean tools for enhancing the performance of production line.
iii. To validate the propose improvement methods for production line.

1.4 Research Scopes

This project is mainly focused on the inventory stock of the tooling cutter which is inserts and end mills. This investigation is done by monitoring and capturing the problems in the industry during their working hour and also to get the feedback from the general manager and also machinists about the current tooling system. Moreover, the research is done by researching the specification of cutter and sort it according to its specification. This will provide information which tools always are used regularly.

1.5 Significance of the Study

The investigation of the case study will help the industry to solve their problems on the tools inventory and to implement lean tool to enhance their manufacturing performance. This will also provide the suitable method needed to improve their manufacturing performance. The lean tools are the tools used to remove any waste in the industry to maximize the profit or any unnecessary activity so that the industry can perform better.

The study also will propose a new inventory system for the tools so that it can enhance the manufacturing performance and will not make the production stop because of insufficient tools. The system is based on the lean tool method which will organize the system with better improvement than the current manual system and the workers can review the available stock in the new system.

1.6 Summary

Lean tools are an important tool in manufacturing industry that can enhance the manufacturing performance, which can increase the productivity and efficiency especially in the Elite Industries Sdn. Bhd. The lean tools also can help to minimize waste in the industry and to propose a new system for their tool inventory management.

CHAPTER 2

LITERATURE REVIEW

This chapter consists of a review based on the research conducted according to the objectives and scope. The literature review focus on the past studies on lean tools adoption for enhancing manufacturing performance, which has been conducted by researchers based on their journals, articles, and website. This literature review is based on the information and the method used related to this study. A summary of lean tools also discussed in this chapter.

2.1 Company Background

The case study has been conducted at Elite Industries Sdn. Bhd. in Kuching, Sarawak based on the problem identified during the industrial training. The industrial supervisor had asked to solve a problem in the industry on the tooling stock system for end mills and inserts that always make the production to stop when there is no certain cutter that is needed for the project. The research on the type of inserts and end mills that used regularly is done so the current stock will easily to be monitored.

Based on the data given by the industry, for insert's brands that always been used in the company was *Seco, Mitsubishi, Carmex, Lamina, Sumitomo,* and *Walter* and the type of inserts are boring, turning, grooving, parting, threading and drilling respectively. While for end mills there is on only one brand which is Li Hsing and the type are square and ball nose end mill. The factors that make the cutting tools to quickly replace are because of wear and tear. Wiciak-Pikuła (2020) stated that the speed of cutting, the rate of feed and the depth of cut played major role in the wear and tear of the cutting tools. This is because the tools might be forced to do an excessive amount of work that is needed to be done than it can afford to do. Thus will make the cutting tool life to be shortened and new tools are needed. This also affects the stock of current tools.

The delivery of the new order tools to arrive took around 2 weeks, which is a very long time to wait because when there is no cutting tools, the machine will also have to stop and this will affect the entire process of the product. The company usually order 2 boxes of inserts which in the box contain about 10 pieces of inserts and for end mill the company usually order about 5 pieces of end mills.

For the inventory, the company uses manual system by counting the current stock available in each box. This system has many weaknesses which are when the person who in charge on the stock might forget how many left before the cutter are empty and he might forget to order new stock for an upcoming project. Besides, there is no record for in and out tools, whether it is in hardcopy or softcopy to monitor the current stock available in the inventory.

Figure 2.1: Current system inventory for cutting tools.

2.2 Introduction to Lean Tools

The successful implementation of lean tools gives industry a high quality system which makes the productivity increased and reduce the waste, thus will also increase profits and benefit the industry in the long term (Shah & Ward, 2003). The lean tools are known to identify and eliminate waste of non – value added activities which are to improve the service and quality, decrease the total costs, minimize the time and to remove the waste. This is to make a smooth manufacturing performance that can satisfy the customer's requirement without any waste involved (Zhou, 2016).

For industry in Malaysia, the most utilized lean tools are Kaizen, 5S and Standardised Work as shown in Figure 2.2. This shows that every industry need the lean tools to make their organization to be better and it is also to improve their knowledge on how to implement in their organization (Yahya et al., 2019).

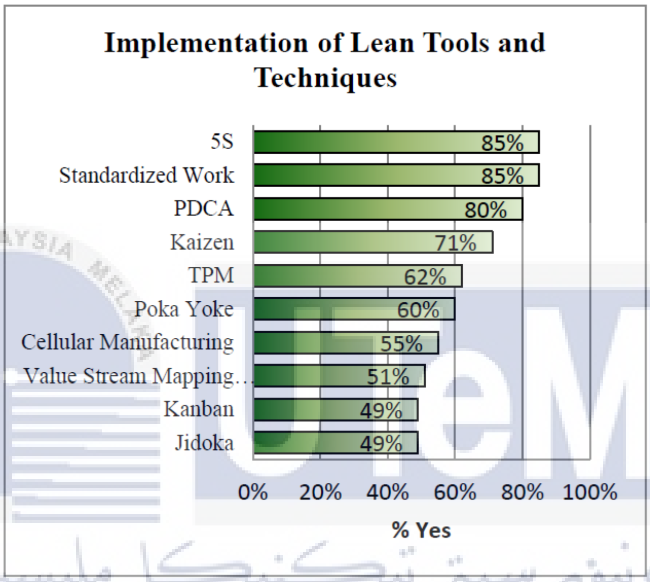

Figure 2.2: Lean tools status implementation in Malaysia (Yahya et al., 2019).

2.2.1 5S

5S is a one of the important lean tools in manufacturing management. The meaning of 5S in English are sort, set in order, shine, standardize and sustain. This tool can eliminates and make the management more solid when doing their business. Besides, 5S is also a basis attainment in quality management which helps to remove wastes thus will improve the working performance and also make it become more organize (Randhawa & Ahuja, 2018). For the implementation of 5S in their industry in three years, it can be concluded that during that time the result shows that the industry is determine in practicing 5S by good support from the management (Randhawa & Ahuja, 2017).

The first 1S of 5S lean tools is sort which means removing any unnecessary things in the worktable or working area. This is also to organize back all the things to their own original place to make it easier to find it back for future use. Seiri make the process of picking tools smooth for the workflow and also make the searching time shorter (Mehta & Dave, 2020). In the industry, especially in the storage and office area, the majority of the industry has performed well in the implementation of sorting tools and now are free from any of the unwanted waste such as time wasting in searching, inventory that is not needed, and also the freedom from any crowdedness (Randhawa & Ahuja, 2017).

The second S is for Seiton which mean set in order. This is a method to arrange the tools by their own use or specification which help to achieve 30 seconds retrieval of tools (Randhawa & Ahuja, 2017). This is important because it can make the process of taking out tools even faster than before which also make the production line more efficient. Seiton also can make the work more safer, create a better working environment and also to remove useless finding (Mehta & Dave, 2020).

The third S is Seiso which means shine. This is a process of cleaning the equipment, machines and also the workplace (Randhawa & Ahuja, 2018). The cleaning of the mind is a result of clean surrounding (Randhawa & Ahuja, 2017). This is because when the workplace is clean, the mind will also at ease when doing work. This also can increase productivity and release the stress during working time and also effect workers' health and the product quality.

The fourth S is the Seiketsu which when translated means standardize. To make the good habit last for longer time, the management and the workers play an important role in preserving clean environment and good work in the industry (Randhawa & Ahuja, 2018). It is the best when the all the worker practices and follow all the guidelines when standardizing the 5S lean tools for better productivity (Bharambe, 2020).

The last S of the 5S is Shitsuke which means sustain. The implementation of this 5S is depends on workers self – discipline and it will be successful if they maintain the good working attitude for a long time without going back to the bad habit (Randhawa & Ahuja, 2017). This need regular practices on the 5S tools such as doing a consistent cleaning to make the workers always practice the 5S lean tools.

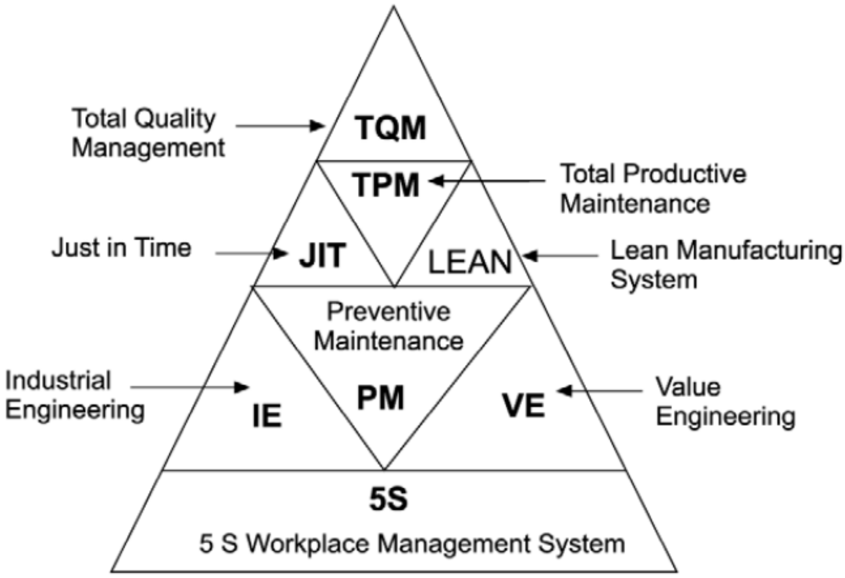

Figure 2.3: The base for lean manufacturing is 5S (Singh & Ahuja, 2015).

2.2.2 Value stream mapping

According to Verma & Sharma (2017), Value Stream Mapping is an action that combines all the activities of a product which is the value added and non-value added that shows the flow of the material to the customers. The objective of VSM is to get to the problem and solve the waste by eliminating all the wastes (Rohani & Zahraee, 2015). All of these have the same objective which is to improve the productivity and to add more value onto the product.

Rohani & Zahraee (2015) found that the first step of VSM is to get a product which needed improvement. Secondly, create a process flow in map to show how the process from start to finish. Harun et al. (2018) stated that by gathering all the data in current state map, this data shows the status for the current system and from that the process is investigate and improvement methods are applied. Thirdly, to show how the waste has been eliminate, draw a map for the future state (Rohani & Zahraee, 2015). Harun et al. (2018) claimed that for future state map, it is for the future improvement after all the wastes is eliminated. This will help to identify and design better value stream. Finally, a map for suggestion is created to review any changes needed for the system. According to Deshkar et al. (2018), 15% to 89.85% are the increase of value added time when VSM is implemented in the industry. This shows that the VSM is one of the tools to increase the value of production.

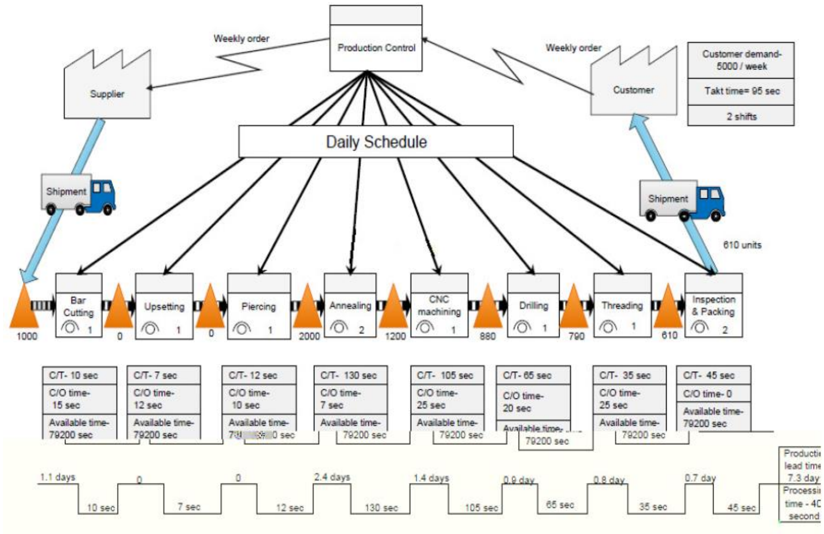

Figure 2.4: The value stream mapping in future state (Verma & Sharma, 2017).

2.2.3 Kanban

Kanban is one of the most important tools in the lean manufacturing industry, which means signal or visual and to achieve minimization of inventory and Just-in-time for the production (Li et al., 2019). There are three focus of Kanban, which are the information flow of materialization, the work flow of visualization and lastly the work-in-process of restriction (Powell, 2018).

Guia et al. (2019) claimed that the performance of the production is enhanced when the Kanban system is implemented in the company which make inventory more effective, organized and homogeneous. Guia et al. (2019) also stated that there is different situation in industrial unit before and after the Kanban system is implemented which shown in table below. Mahdi (2015) stated that to do Kanban, the container is put with a card then is transferred to following phase as shown in Figure 2.5. After arriving to the next phase, the Kanban card is separated from the container to make a signal. Then, the Kanban card is placed in the holder. This is one of the process stated by (Mahdi, 2015) that can be conducted in the manufacturing industry.

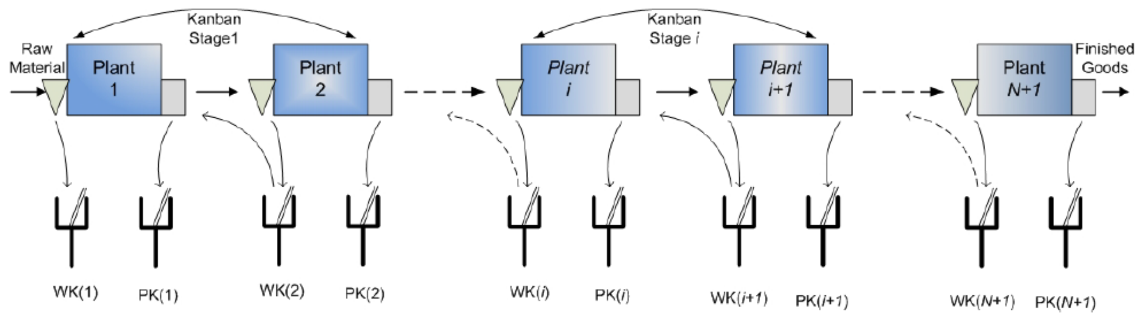

Figure 2.5: The view of Kanban philosophy (Mahdi, 2015).

2.2.4 Kaizen

Kaizen is another type of lean tools, which mean continuous improvement of workers practice which involve all the people working together in an organization and has been practicing since World War II in Japan industry. Kaizen is the use to continuous improvement in production and also to decrease the cost in resources. This is for the long term future, which will improve in terms of the delivery times, the productivity and also the costs (García-Alcaraz et al., 2017). Kaizen system will make the organization to become better in all aspects for enhancing the manufacturing process. The error that the company made is a lesson for improvement and will develop a habit which make the organization to master and improve from the mistakes. By implementing the Kaizen system it will erase any barrier between the working forces (Arya & Choudhary, 2015).

The benefits of Kaizen are the inventory reduction between 30% - 70%, which will reduce the inventory costs and also reduce the operating space for 50%. The improvement of productivity is also improve 20% - 60% that can enhance the manufacturing performance and quality in the company, thus will increase the company profit (García-Alcaraz et al., 2017). Kumar et al. (2018) stated that the increase of 47% per hour for production shows that implementation of Kaizen is very beneficial and the working condition is at ease and make the production to run smooth. Vo et al, (2019) stated that the Kaizen can help to reduce downtime tracking which by visualizing the downtime as a communication tool in workplace as shown in Figure 2.6. The color is used to visual an action that needed to be done for the production line.

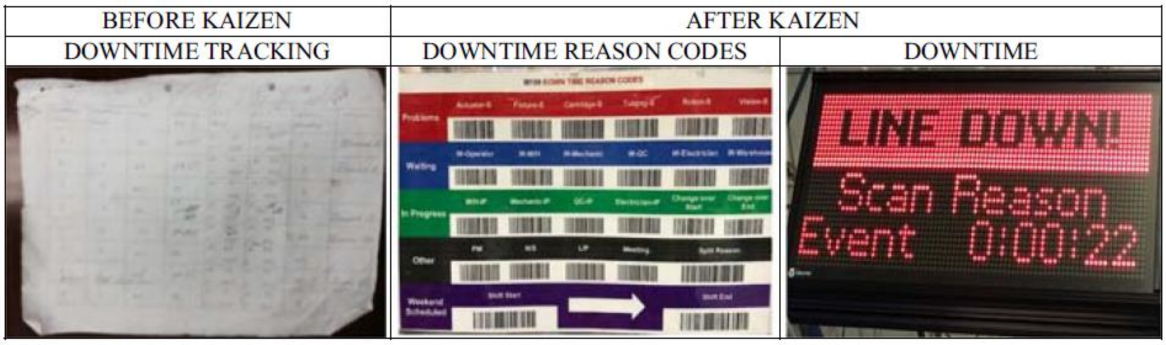

Figure 2.6: The Kaizen implementation before and after (Vo et al., 2019).

2.2.5 PDCA

Plan do check action is another lean manufacturing tools that can enhance the manufacturing performance and first introduced in 1950 by W. Edwards Deming who was an American engineer. He introduced the Deming wheel that shows the relationship between the sales, research, design and production to create a greater quality in the organization (Lodgaard et al., 2013). In the modern day era, PDCA is known as a continuous improvement approach in enhancing manufacturing performance and also improving in organization culture of companies (Realyvásquez-Vargas et al., 2018).

In PDCA, there are 4 phases which are Plan, Do, Check and Act. The activity for Plan is to get data collection, research priority and also making interview. For Do, the activity is to make a plan and improve the plan. Check is to check the stability of the process such as the Process Capability Index (Cpk). Lastly Act, which is to standardize the action (Sunadi et al., 2020). Realyvásquez-Vargas et al.,(2018) stated that in Plan is to organize and proposed a strategy to solve the problem for the current situation. For Do, the plan is implemented and record all the information. For Check, the data from the results is analyzed for before and after the implementation for PDCA to make the comparison. And lastly the Act, this phase is to develop the methods which is to improve the standardization after the objectives is reached.

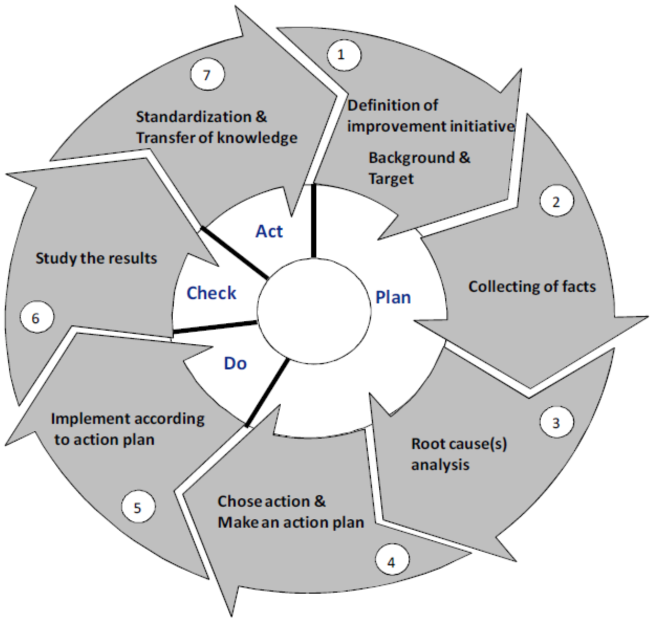

Figure 2.7: Plan, do, check and act cycle (Lodgaard et al., 2013).

2.2.6 Total quality management

Total Quality Management (TPM) is a system to eliminate the main of a problem which started from the beginning and find the causes. This to make sure that the management and the machine's reliability are always improving and all the workers are working together in order the implementation of this system to become successful. There are about three concepts for this system which are maintenance of the autonomous operator, the effectiveness of optimal equipment and the activities of the group (Sachin Modgil, 2016.) Agustiady et al. (2018) stated that TPM is to achieve close to perfect production operation which come from equipment sustainability from the workers that always maintain their equipment.

There are a lot of benefits of TPM such as improve skills and knowledge of the employees, the variation of equipment can be controlled and downtime can be eliminated (Agustiady et al., 2018). TPM can bring more profit to the organization by eliminating the non-value added and will help to sustain the organization for longer time. Thompson. P (2019) stated that the benefits of TPM are can reduce the maintenance time that was not needed during working hours by giving them ownership for their own machine thus make the production uptime to be increased. Besides, TPM also makes the environment safer than before because 5S model is used to make sure everything is in good condition. TPM also can increased the input quality and also customer satisfaction thus will also increase the morale the workers.

Agustiady et al. (2018) stated that in TPM there is eight pillars and the first pillars is autonomous maintenance. Autonomous maintenance is a system that give workers ownership to their machinery or equipment that they handle every day. This can increase their skill and knowledge. Second pillar is planned maintenance. Planned maintenance is to measure the rates or failure of the equipment to decrease the spontaneous downtime. Quality maintenance is the third pillar which is to prevent any problems to reoccurring again in the first place by analyze the root cause. The fourth pillar is focused improvement. Focus improvement is a gathering of 6-8 people in a groups to work together in order to eliminate the wastes and defects and also to make a continuous improvement. Ahuja & Khamba (2008) also stated that the fifth pillar is education and training which is to improve the knowledge and skills of the workers by sending workers to training in order to understand more about TPM. The sixth pillar is health and safety, which is to ensure the environment for working is safe that can reduce the accidents or injuries to the workers. The seventh pillar is TPM office, which is a focusing in the administration office and also focus issues on cost. The last pillars which is also the eight pillar is the development management that helps to minimize the problem and also make a initiatives for maintenance improvement.

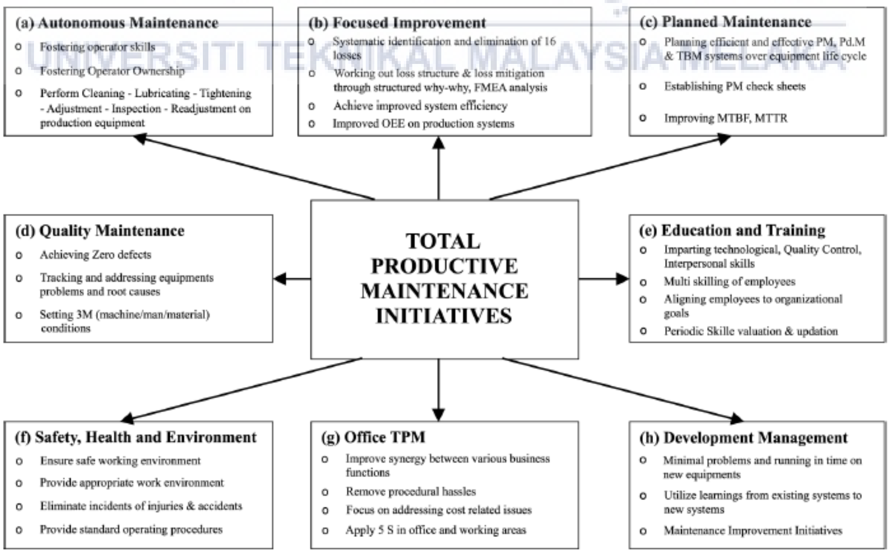

Figure 2.8: Eight pillars of TPM (Ahuja & Khamba, 2008).

2.2.7 Poka yoke

Poka Yoke which means mistake proofing is another manufacturing tool that can be implemented to enhance the manufacturing process. Poka Yoke is done by preventing any errors from occurring thus the quality of the product can be improved and the manufacturing process can run steadily (Helmi et al., 2017). de Souza et al. (2018) claimed that Poka Yoke is an instrument that can help to minimize waste and also to remove any errors in any organization.

Dudek-Burlikowska (2009) stated that there are two methods in Poka Yoke which are control methods and warning methods. Control methods is to the detect problem and immediately respond to the problem by stopping the production line to avoid other problem while warning methods is to warn whether the product is to be accepted or reject based on the situation. Malega (2018) claimed that there are six steps in applying process of Poka Yoke. First, by using a Pareto chart to identify the most valuable process. Secondly, by finding five reasons of the problems, get to know the causes and understand the problem. Thirdly, in the organization, the application form is chosen based on Poka Yoke. Fourthly, the suitable method is choose to solve the problem. Then, the results is taken after the methods is tested. Finally, the performance is evaluate and the operator is trained.

Therefore, Poka Yoke is to find the errors from the main source and control the production by preventing other errors to occur in the future (Helmi et al., 2017). Poka Yoke is a system that excels in eliminating human errors, thus help to reduce costs in the production (Malega, 2018).

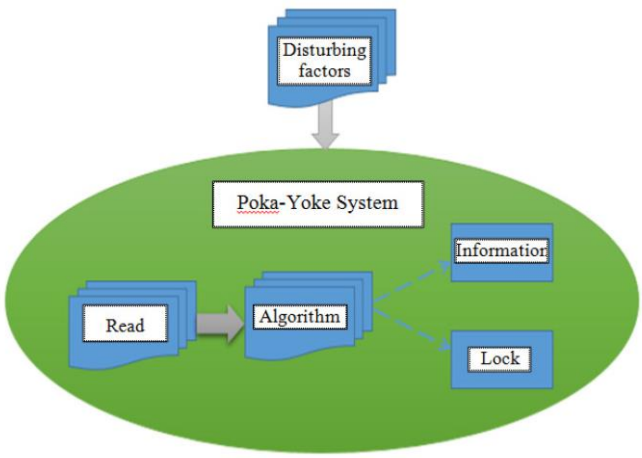

Figure 2.9: The Poka-Yoke element in the system (Bălan & Janłă, 2019).

2.3 Types of Wastes

Waste is a thing that does not add value to the service or product in manufacturing performance (Cueto et al., 2020). To find the main problem of the waste, the lean tools is used to find, solve and prevent the problems from occurring which can disturb the manufacturing performance. The elimination of waste is important because it can add more value for the final product and can make companies to survive longer and better in manufacturing performance (Amrina et al., 2019).

There are 7 type of wastes which are overproduction, defects, unnecessary inventory, inappropriate processing, excessive transportation, waiting and unnecessary motion. There are two type of wastes which is task that add no value added to the customer but is needed. Second is the task that do not create value. This can be remove immediately for an example the type of waste are waiting and unnecessary motion (Kundu, 2015). The total life cycle probably more effective than other tools to which gives 60% of data that all firms using scorecard as an approach to reduce waste (Shah et al., 2017). Amrina & Lubis (2017) claimed that one of way to identify wastes is by using the Waste Relationship Matrix (WRM) method and also using Waste Assessment Questionnaire (WAQ).

Amrina et al. (2019) stated that in order to find and eliminate wastes, the Value Stream Analysis Tools is used and then by using the Fishbone Diagram, the root of the waste can be detected by brainstorming the problems occur. Jaffar et al. (2015) investigated that by using field observation which is by scanning the area with high possibilities of wastes to be occurring, then record the activities can identify the wastes in the industry.

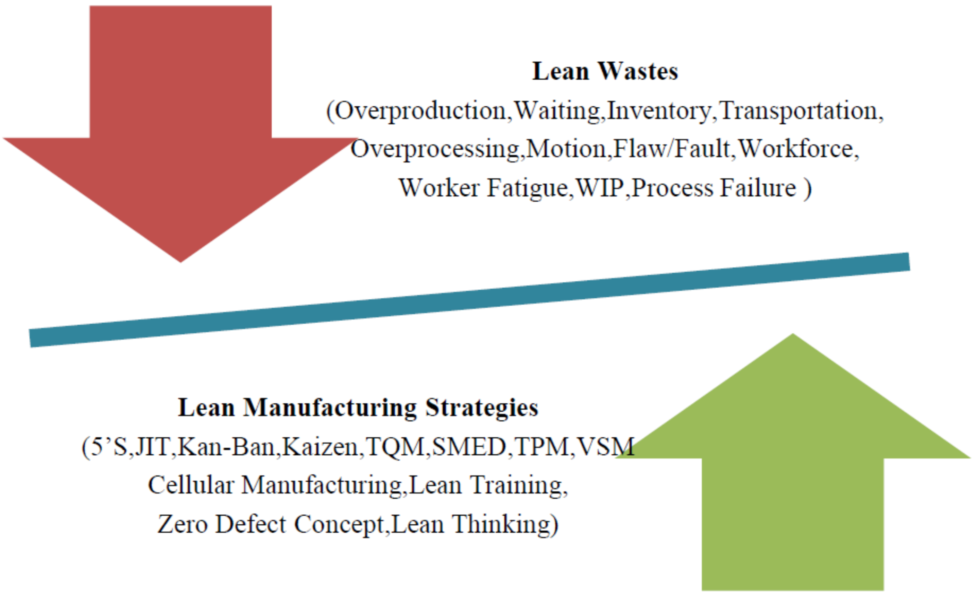

Figure 2.10: Lean wastes and on how to eliminate wastes (Chahal & Narwal, 2017).

2.3.1 Overproduction

Overproduction is considered as being the most harmful among the seven wastes (Shah et al., 2017). Complete cost waste such as overproduction can also be removed, which raises inventory costs due to storage requirements. Chahal & Narwal (2017) stated that overproduction that needs time, resources, additional actions of staff and additional inventory.

2.3.2 Defects

Defects are regarded as the production of flawed or incomplete goods which contributing to examine, rework and fixation (Shah et al., 2017). Chahal & Narwal (2017) stated that defects are often non-value added work that exists for multiple reasons. For example, poor quality of tools, lack of worker concentration, and inadequate inspection.

2.3.3 Unnecessary inventory

Unnecessary inventory is referred as providing excess raw materials or parts that are not processed, semi or finished goods, hence allowing additional storage space needed for companies (Shah et al., 2017). Chahal & Narwal (2017) stated that unnecessary inventory occurs when the push device operates without any order with time and money often enable this kind of loss which is nit value added work to be brought.

2.3.4 Inappropriate processing

Inappropriate processing is defined as making unnecessary steps in a manufacturing phase that are not needed, which is beyond consumer specifications (Shah et al., 2017). Chahal & Narwal (2017) stated that inappropriate processing is an external job takes place on the work piece or computer to discourage rejection or to work properly which is often quite costly. It also takes time and resources which divert the actions of employees.

2.3.5 Excessive transportation

Excessive transportation is a waste that in order to transport goods between the supply chain (Shah et al., 2017). Chahal & Narwal (2017) stated that the advancement of workstations of numerous machine tools and materials is believed to be a non-value added tasks. The expense and time are high in the estimation form and can also be a source of mishap.

2.3.6 Waiting

Waiting is whenever time is not handled or spent well, waiting takes place. This is where the machines, products, consumers or staff do not move, run or add value to the manufacturing process (Shah et al., 2017). Chahal & Narwal (2017) stated that waiting is a waste that during one process to another is inefficient and time consuming. Waiting is various kinds of waiting which are the waiting waste. For example, work schedule, order, computer parts and email.

2.3.7 Unnecessary motion

Unnecessary motion involves employee activity in the form of bending, reaching, extending, walking in a distance that is very long to get a material or even moving their body to see better the object (Shah et al., 2017). Chahal & Narwal (2017) stated that it is a basically an aspect of ergonomics which is a close human-machine interaction. When employees need to twist, the movement from the workstation to another position occurs.

2.4 Advantages of Lean Tools

There are a lot of advantages of lean manufacturing such as helping companies to reduce cost to maximizing the profits. By implementing lean manufacturing, the company can control their expenses which are by their practice of lean management in their company. Besides, lean tools can help to increase the productivity, help to reduces cost, and also can make the flexibility volume to increase (Wickramasinghe, 2017). However, Zhou (2016) claimed that lean manufacturing can be used to decrease the total costs and time, eliminate waste and services can be improved when implementing the lean tools. Tortorella et al (2017) stated that lean manufacturing can help to improve sustainability of continuous improvement among the workers and productivity which influences by individuals attitude and quality of work through the training and involvement.

2.5 Seven Quality Tools

The fast flowing industry needed every improvement to stay relevant in order to compete with others by implementing the seven quality tools to improve their activities and decision making process (Kuendee, 2017). In quality tools, there are seven basis quality tools that can help in solving problems and also for enhancing manufacturing process which can increase the quality of the product (Ishikawa, 2017). The main objective of quality tools are the product is achieving the standard quality that is required, the price of check-up is as little as possible, to make sure the costs of processes and design using the quality production is little as possible and supply the manufacture costs as small as possible (Suryoputro et al., 2017).

2.5.1 Cause and effect diagram

Cause and effect diagram which is also known as Ishikawa Diagram is a tool to find and solve problems which the data is then analyzed to find the root cause. The main categories which always been used in order to find the causes are machine, method, material, measurement, personnel and environment (Ishikawa, 2017). This will help to narrow down the causes and each of the branches are indication of the problems from the first problem to the last problem. Magar & Shinde (2014) stated that the first steps for cause and defect diagram is to decide the classification of the causes and link through the large bones to the backbone. Second, make a brainstorm to investigate the potential problem and categorized the problem into the main group. Third is after all the groups are completed, brainstorm is done again to find more causes that might escaped. Lastly, the data is analyzed to find the significance of the causes.

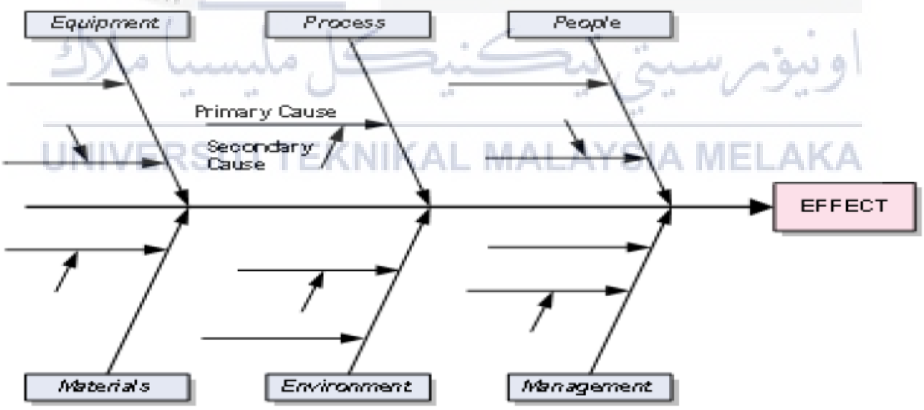

Figure 2.11: The fishbone diagram to find the root cause (Magar & Shinde, 2014).

2.5.2 Pareto diagram

Pareto Diagram is a tools that set up items based on their benefaction and identify the items that has the most impact on the process. The Pareto Diagram is used to improve the quality of the project, make a corrective action in order to solve problems, recognize products that has the most objection and pinpoint the most chronic causes for rejections (Magar & Shinde, 2014). Ishikawa (2017) stated that Pareto Diagram is a tools to show the importance of variables from left to right by descending order. It is use to work out the unstable data figures, preservation of data, data service, and other sources. Pareto charts also used to rank the problems according to sign of the problems and also the cause as shown in Figure 2.12. (Suryoputro et al., 2017).

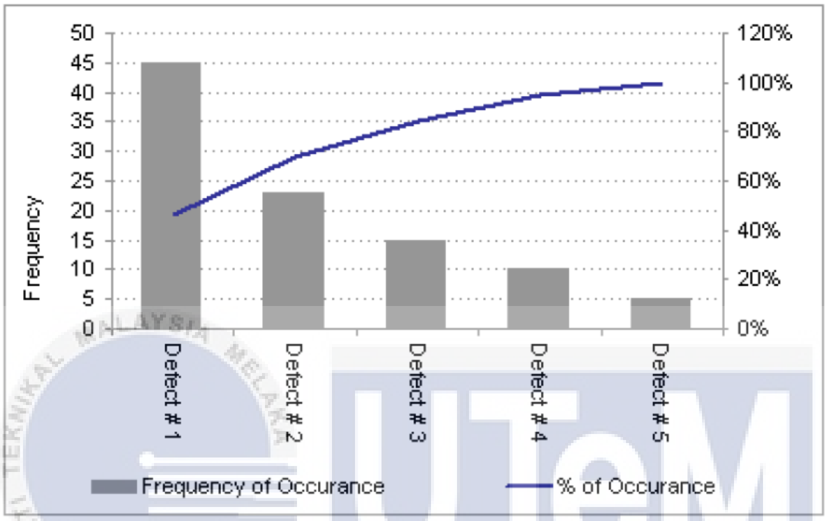

Figure 2.12: Pareto diagram (Suryoputro et al., 2017).

2.5.3 Flow chart

Flow chart is a chart that shows the step of a process in correct order. The flow chart is also a medium to show the step which is under analysis by the team that make quality improvement, identify the points for control in the critical process and also improve the areas that need further improvement (Kuendee, 2017). This tool can help to show the area that needed to be analyzed and which step of process might has a potential problems which can disturb the production (Ishikawa, 2017).

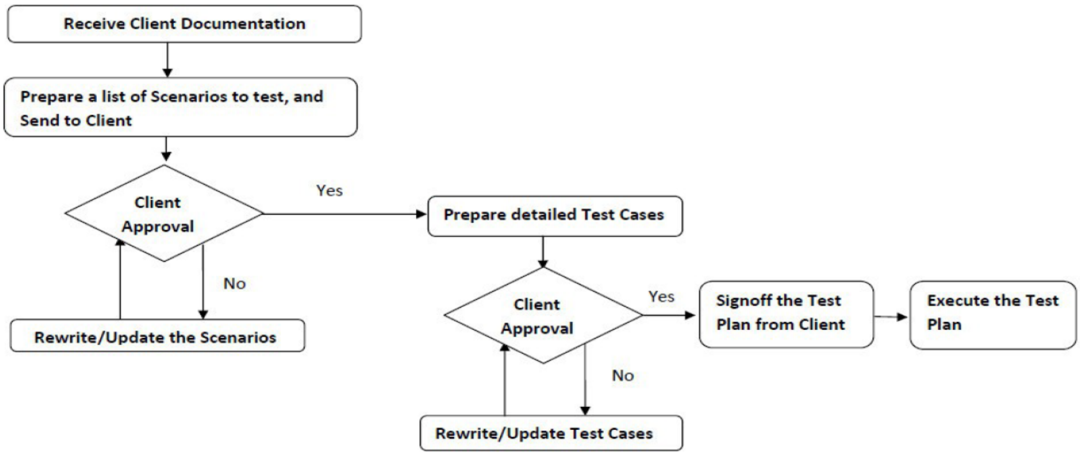

Figure 2.13: Flow chart of process (Neyestani, 2017).

2.5.4 Histogram

Histogram is a graph that shows distribution of a value based on the frequency and also show the set of data that occurs in different value (Kuendee, 2017). Suryoputro et al. (2017) stated that histogram is a tool that can assist on finding the variations and to construct an outline of the statistics to be analyze which the data then can be graphically shown. Ishikawa (2017) claimed that histogram is a tool that picture both attribute and variable data of a product or process. The histogram need to be properly design in order for the workers to easily understand what is the meaning of the histogram. Figure 2.14 shows that the frequency of defects in a manufacturing process by using histogram.

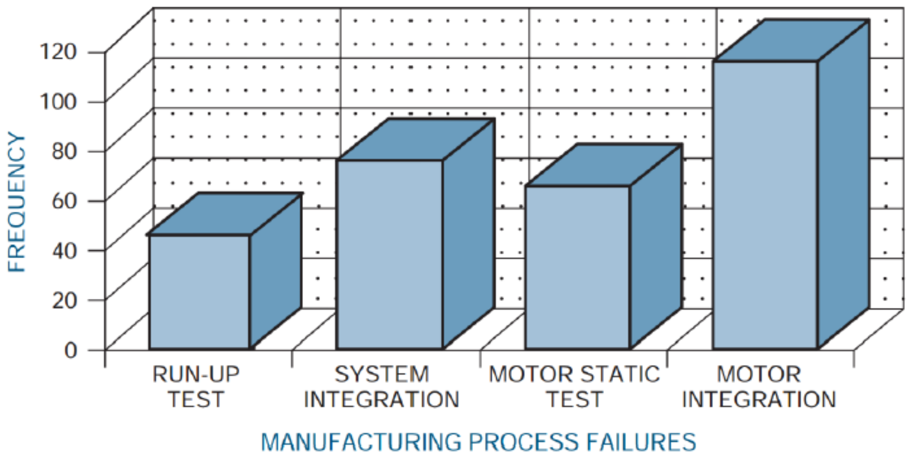

Figure 2.14: The variables of histogram (Neyestani, 2017).

2.5.5 Scatter plot

Scatter Plot or also known as Scatter Diagram is a tool that can show the position of information which can helps to recognize and examine the relationships pattern between the variables (Ishikawa, 2017). The Scatter diagram also help to identify whether the relationship between those variables is positive or negative (Suryoputro et al., 2017). Magar & Shinde (2014) found that if there is more than one set of values are the same, the same spot will need more points on the Scatter Diagram. Then, a draw circle around the original dot to show second point that has same values. By the way of the point scattered shows that whether the variables is in good positive or negative relationship.

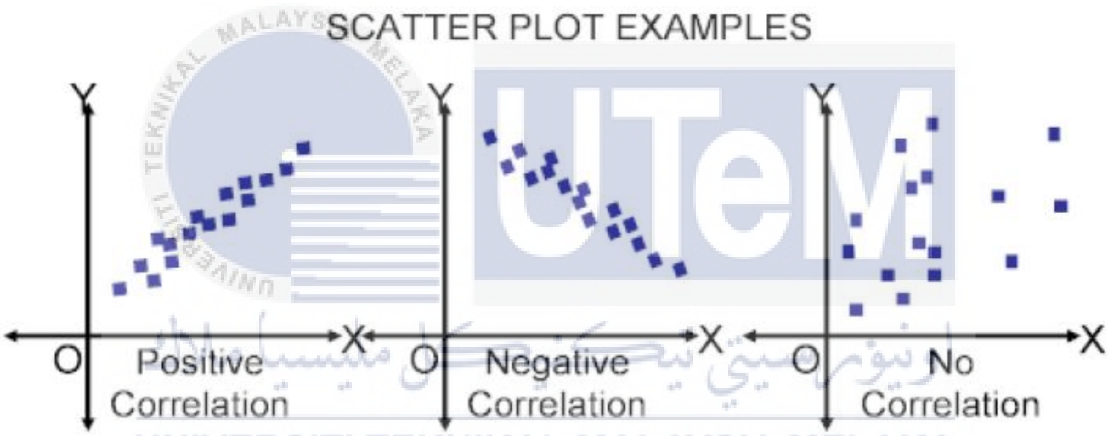

Figure 2.15: Scatter diagram of data (Neyestani, 2017).

2.5.6 Control charts

Control chart is another quality tool that help to determine the performance of the process for upper control limit and lower control limit (Suryoputro et al., 2017). Besides, the control chart also help to improve and the product quality and decrease the spoilage and rework (Magar & Shinde, 2014). The control chart demonstrate the quantity and nature of difference time of process over time. It also shows what is happening in the process control chart is a tool to detect and keep track of data to make sure that the process is going smooth and efficient (Ishikawa, 2017). If the data is out from the dotted line, it means that the process is out of control which then the next process is to find and analyze what is the cause of the problem.

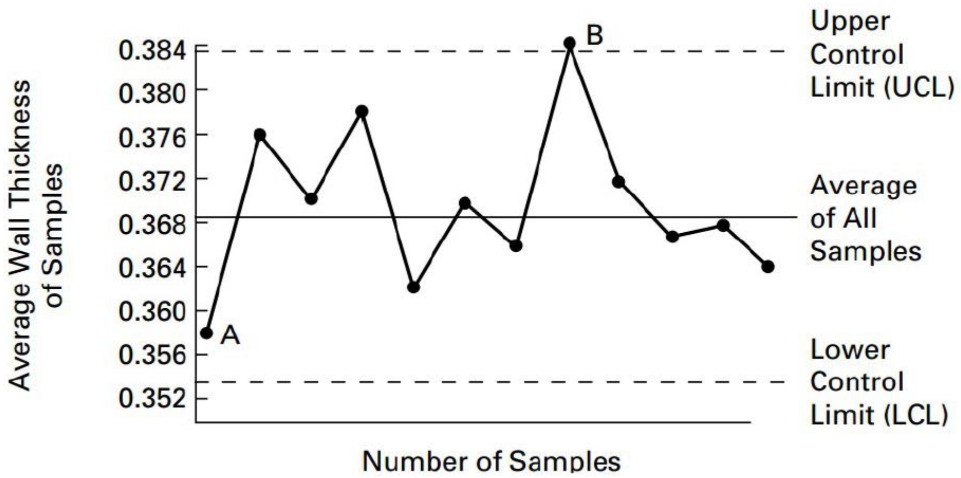

Figure 2.16: Control chart (Neyestani, 2017).

2.5.7 Check sheet

The best tool for collecting data is check sheet which help to collect specific type of data (Magar & Shinde, 2014). There are many types of check sheet as for an example daily maintenance records. This is one of the systematic data collection to help improve the productivity and efficiency of a machine so it the machine will be regularly check to detect any problem or maintenance needed for the machine. Kuendee (2017) stated that check sheet is a structured and form that has been prepare to collect and analyze data. This form can be used for many purposes in the industry. Ishikawa (2017) found that there are three types of check sheet which are tally check, defect cause and defect location. This tool can help to identify the problem that occur frequently in the manufacturing process.

Table 2.1: Example of check sheet (Neyestani, 2017).

Reason	Day					
	Mon	Tues	Wed	Thurs	Fri	Total
Wrong number	卌	||	|	卌	卌 ||	20
Info request	||	||	||	||	||	10
Boss	卌	||	卌 ||	|	||||	19
Total	12	6	10	8	13	49

2.6 Addressing System

A hierarchical system that establishes connections between addresses is known as an address system. Address systems may be used to identify address ancestry across a hierarchy of geographical addresses. According to (Choojan & Chutima, 2016), the operating time for transferring parts increased to 439 minutes each shift once the process was enhanced, which is 99.2 percent of the goal. As a result, Operator's component transferring efficiency increased by 24 percent. Based on (Niemczyk, 2016) has achieved the following advantages almost a year after implementing the system: volume of warehouse inventory optimization, extremely high storage system effectiveness, and improved speed of warehouse operations, all of which have resulted in increased warehouse capacity.

Digits or Alphabets	X	-	XX	-	XX	-	X	XX
Meaning	1		2		3		4	5

Meaning	Example
1. Zone	A,B,C
2. Station number	01,02,03
3. Shelf number	01,02,03
4. Level	A: Level1, B: Level 2
5. Position	01,02,03

Figure 2.17: Addressing system (Choojan & Chutima, 2016).

2.7 Advantages of Quality Tools

There are a lot of advantages of using quality tools such as:

i. Maximize the quality control
ii. Customer happiness
iii. The cost of production can be decreases
iv. The cost for inspection is small
v. The morale increase for employees
vi. The sales can be increase and more profit is achievable

2.8 End Mills

For end mills used in the industry, there are many types of brand and specification that always been used for CNC and manual milling machine. The common type of end mills that been used was square end mills. This square end mills are in different sizes and the materials the coating that always been used was solid carbide with aluminum-titanium-nitride (AlTiN) coating. The common number of flute that used in the industry is between 3 and 4 flutes. The supplier of the end mill was Li Hsing based on the data given by the industry. But if the current stock is unavailable, the industry will get the end mill from local supplier which means the quality of the end mill are not very good.

(a) (b)

Figure 2.18: (a) Solid carbide square end mill with 4 flute. (b) Solid carbide square end mill with 3 flute.

2.9 Type of Inserts

For inserts, there is no specific type of inserts that always been used by the industry. There are boring, turning, grooving, threading, drilling, grooving, parting and knurling of process that has each of their own inserts. For the brand of the inserts itself, it has different type of brand which are from Mitsubishi, Carmex, Seco, Ecodex, Lamina, Sumitomo and Walter. This is because when the industry has deficiency of inserts needed as quickly as possible, the industry will try to get from local brand which also has low quality standard thus can affect the final product.

Figure 2.19: The type of inserts in the current inventory.

2.10 Summary

Lean tools is a way to solve a problem that require minimum amount of time, energy and money. There are many lean tools technique which has been mention in this chapter but the most suitable to use for this case study are 5S, Kanban and Kaizen which can use to improve the inventory management for the cutter tools. Lean tools can help to eliminate waste and inefficiency in the production line for the Elite Industries Sdn. Bhd.

CHAPTER 3

METHODOLOGY

This chapter explains on the method used to solve the problem related to the case study, which is on how to enhance the manufacturing process in the industry. This chapter consists of descriptive method of the whole project that discussed about procedures and practices. This chapter also addresses the flow of the overall process from start to finish.

3.1 Project Planning

Project planning is a part of the management of a project in order to make sure everything is on schedule or incorrect way when doing the project. The procedures and methods are constructed based on the scopes for the objectives to be achieved. To make sure that the task is completed, the documentation is generated to make sure all is well. The process flow of the project is shown by using flow chart which gives an idea about the overall process to obtain an acceptable result starting from data extraction, the method of conducting the case study and data analysis. The Gantt chart is used to plan the activities for the project and also to keep everything in schedule for the project management. Besides, this chapter also addressed the methods used to enhance the manufacturing process in the industry, which are using lean tools and quality tools.

3.2 Flow Chart

The flow of the process is often shown in the flow chart to visualize the step of the process from start to end for conducting the study. The process is described by using the symbol for each step. Based on the flow chart, the objectives are achieved by using the suggest method. Figure 3 shows the flow chart of the overall process of the project.

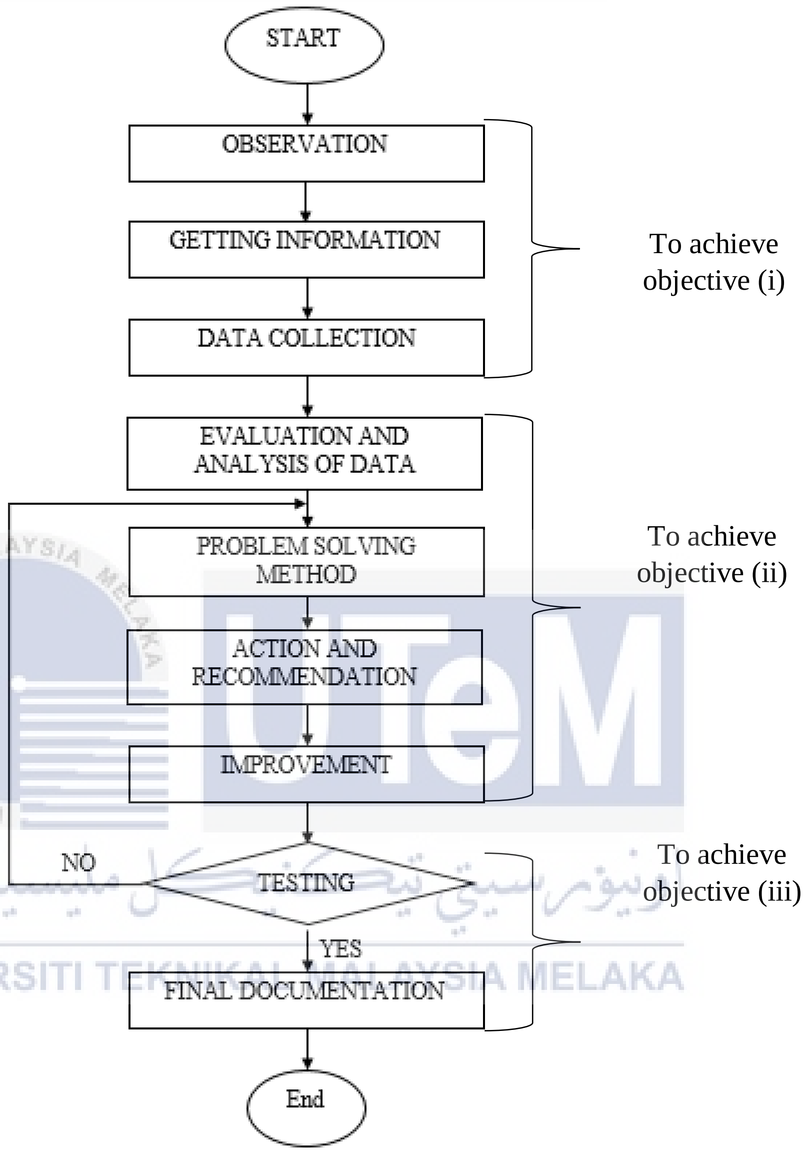

Figure 3.1: The project flow chart.

3.2.1 Observation

Observation is done by observing the inventory of cutting tools. By observing the inventory, the process of receiving and issuing the tools by the machinists is monitored and the process is quite unorganized. The machinists take the tools without writing or record anything that can give information to the general manager about the current stock of the tools in the inventory. This will create problems when the tools are low in stock when needed for the manufacturing process. Besides, the tools label in the storage box is also confusing and unorganized that can lead to wasting of time when looking for the tools that is needed. This will slow the production due to unorganized inventory.

3.2.2 Getting Information

Getting information is about to identify and understand the problem that happened during the manufacturing process. The information is obtained from the machinists and also from the CEO. The method of getting information is by conducting interview session to get some information about the problem related to the manufacturing process. This is to make sure that all the data is valid and can be used for the analysis of data.

3.2.3 Data collection

Data collection is the method of collecting and evaluating information in a defined, systematic manner on variables of interest in which helps one to answer the specified study questions, test the theories and analyze the findings. Based on the collected evidence, a researcher may test their hypothesis. Data collection is the primary and most important step for the study, regardless of the area of research. Based on the necessary details, the method of data collection is different for different fields of research.

3.2.4 Evaluation and analysis of data

The study section consists of analysis by using the seven quality tools to find the root cause of the problem by using cause and effect diagram. Then, the flow chart is used to shows the step of process that need to be analyze.

3.2.5 Problem solving method

Method of investigation is done by using lean tools to solve the problem related to the manufacturing process. Lean tools are used to minimize the expenditure of resources that added no value to a product. The related lean tools including 5S, Kaizen and Kanban.

3.2.6 Action and recommendation

Action and recommendation are a method to improve on the problems occur during the manufacturing process. The improvement is based on the machinists and CEO discussion and also brainstorming to find suitable improvement which can be used to improve the manufacturing process. The recommendation is by considering the technique which is fed into the features created by a particular recommendation technique.

3.2.7 Improvement

The improvement is by improving the manufacturing process based on the method that has been done and also based on the analysis that has been done. Then, make the comparison between the condition before and after to make sure there is an improvement.

3.2.8 Final documentation

The final documentation is to explain what has been done for the case study to show the improvement that has been conducted. The improvement is written on online software by using excel to show how many current tool left in the inventory. This can be used for reordering the tool if the current stock is below the minimum amount of tool required in the stock.

3.3 Summary

The flow chart is to show how the process of this case study is being conducted and to show what method to be performed. This will help to analyze the result and data for chapter 4 later in semester two. All the planning will be useful in for this case study progress, especially in semester two.

CHAPTER 4

RESULT AND DISCUSSION

This chapter is to show the result of implementation using lean tools for the problem occurred in the industry. The result is obtained and analyzed by using cause and effect diagram and also by using flow chart.

4.1 Fishbone Diagram

Based on the fishbone diagram on Figure 4.1, the problem related on the production line was brainstorming to find the problem related to the machine performance of the company. For the machine, the problem started when the machine cannot run due to insufficient tools to cut the raw material for the milling machine. The machine performance also affected by the machine maintenance due to milling machine breakdown and cannot be operated. This problem requires outsource maintenance to solve the problem. Besides, machine stoppage also occurs because of tools cutter is broken. This caused the product to be wasted because the broken tools can damaged the raw material.

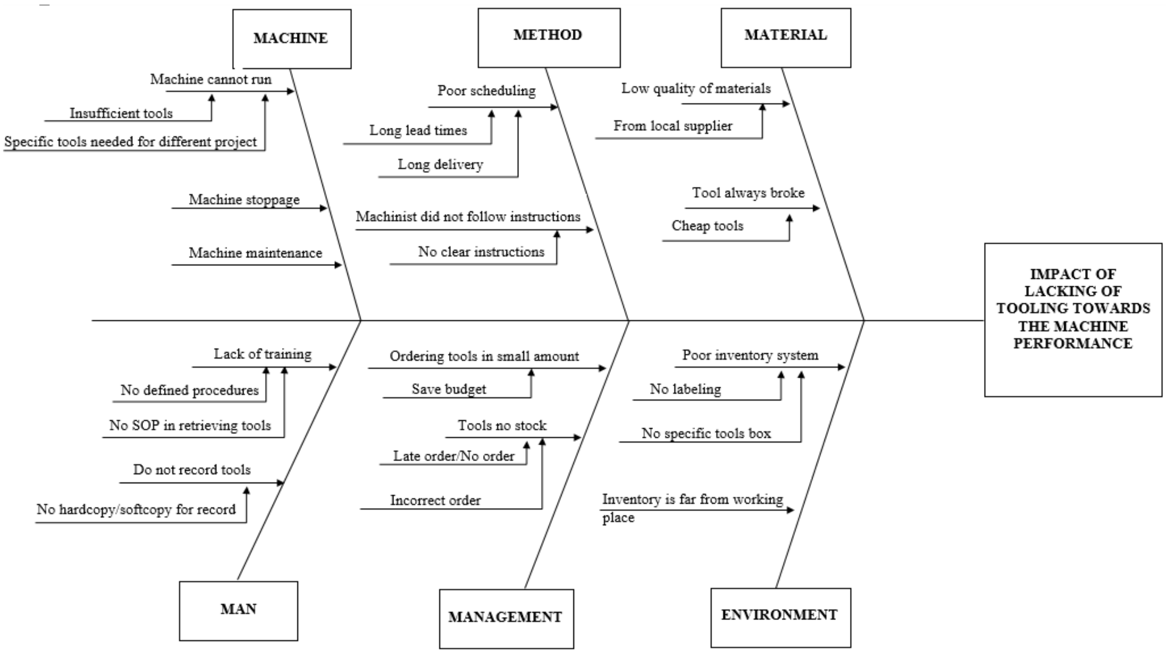

Figure 4.1: Fishbone diagram.

The method involved due to poor scheduling also affect the performance of the machine. This was due to poor method scheduling which lead to long lead times when ordering the tools which usually took almost 2 weeks to arrive. The long delivery also means that the project cannot run until the tools arrived. Furthermore, the machinist did not follow the proper instructions during retrieving the tools. This was because there was no clear SOP on retrieving the tools such as record books and no system to monitor the number of tools stock. This caused uncertainty for the amount left in the tooling stock.

The material that affect the machine performance was because of the low quality of tools material. This low quality of tools was purchased from local supplier when an urgent project was needed to be completed as soon as possible. The low quality tools always broke or chip during the machining process. This affect the product quality especially when doing the finishing process. Certain product cannot been saved and it will be wasted thus the company lost profit.

The man factor that affect the machine performance were lacking of training and no record of tools that coming in and out of the inventory. The lack of training for the workers was cause by no SOP when retrieving the tools and no defined procedures when the tools arrived. When the tools arrived, the machinist usually took it to their table and kept it there. This can led the tools to misplace and eventually the tools is missing. Besides, there was no record for tools either in hardcopy or softcopy in the system. This created a problem on checking how many tools were left in the inventory.

The management factor that affect machine performance was the management always ordering tools in small amount of quantity which was to save budget. This will affect the machine performance because whenever they order in small quantity, there was no guarantee that the tools for the project will last long for another project. Besides, the tools was always low in stock because there was no system to monitor the stock and the management always order the tools late. Sometimes, the management also order the incorrect tools which also will affect the machine performance and delay the product submission to client. This was due to miscommunication between the assistant production and admin.

Lastly, for the environment of the poor inventory system created a lot of problem to the machinist because the box that kept the tools were not the same of tools in the box. This made the machinist to find their tools harder and taking much more time thus decreased the productivity. Besides, the inventory closet was far from the machinist working place. This made the process of retrieving the tools longer thus will made the machine stop longer.

Thus, Figure 4.1 of the fishbone diagram shows that by brainstorming the problem in the manufacturing industry, it helps to identify the possible causes for poor machine performance causes by lack of tooling. This also shows that the industry did not have proper tooling stock system that can monitor the amount of tooling left in the stock.

4.2 Identification of Waste

Based on the brainstorming of the fishbone diagram, there were waste that occur during the production such as:

- Time consumption during searching for tools
- Defect cause by cheap tools
- Waiting for order tools
- Unnecessary motion cause by searching the tools

4.3 The Implementation of Kaizen in Inventory during Access Time

4.3.1 Performing 5S

The first step was to sort things for insert tools in the inventory by keeping any useful tools and discard all the tools which was necessary and unnecessary in the tools box based on Figure 4.2. The tools was checked and sorted into their own box. Many of the tools were already mixed in one box and the sorting process was by putting it in the same box. The old label on the box is removed. By removing the label, the box was clearer and easier to find the inserts. Then, organized back the insert tools by sorting from critically used to lowest used arrangement from left to right based on Figure 4.2 (b). This was to make sure that the most critically used tools will be faster to retrieve. Besides, for insert tools, the indicator was using used inserts as an indicator on the box because machinists would usually observed the shape of insert rather than reading the label. This made the process of retrieving the tools faster and efficient for the machinist rather than reading the label because machinist focused on their shape.

(a) Before (b) After

Figure 4.2: Sorting out of insert tools based on most critically used.

The same sorting process based on Figure 4.3 is conducted for end mill tools by sorting the same end mill with same diameter into the same box and created new label to replace the old label which is shabby and hard to read. The old label on Figure 4.3 (a) is removed to make sure that the old label is not disturbing the reading process. After that, new label is printed and pasted onto the small box.

(a) Before (b) After

Figure 4.3: Sorting out of end mill tools.

Based on Table 4.1, the blue color line from left to right indicates the flow of sorting which is sorted based on the brand of the tools for inserts while for end mill is sorted by the size of the end mill from small to large diameter. This was to make the finding of the tools easier and faster to minimize the waste of time finding the right tools. Besides, by using the addressing system from Table 4.1, the alphabet were read horizontally to the right and numbers were read vertically downward. The specified place of the tools can be determined by using this addressing system thus will help the assistant operator and machinist to update or retrieved the tools easier and faster based on the Figure 4.4.

Table 4.1: Addressing system.

Row / Column	1	2	3	4	5
A					
B					
C					
D					
E					

Figure 4.4: The increasing of diameter from left to right for sorting.

After sorting tools according to the box, the Seiton process which was Set–in-Order was done by placing back the tools that critically to be used at the top half of the inventory while the not critically to be used on the bottom half of the inventory based on Figure 4.5. This made the process of retrieving the tools faster for machinist and made it easier for them to find the tools which always been used. Besides, this process can help to eliminate waste which was any unnecessarry motion. The systematic arrangement can result in minimum time for searching the tools.

(a) Before (b) After

Figure 4.5: 5S Implementation on the inventory.

4.3.2 Observation of old conditions

Based on the old condition before 5S was implemented on Table 4.2, the average time consumed by the machinist searching for the tools was 9.22 minutes. The time taken started when the machinist start to open the inventory storage until the machinist find the tools and close the inventory storage again. The number of time taken is based on the one tool taken per day, which was from Monday to Friday.

Table 4.2: Average time for machinist searching tools on old condition.

Condition / Number of taken	Old Condition
1	9.58 minutes
2	8.45 minutes
3	10.11 minutes
4	9.21 minutes
5	8.33 minutes
Average	**9.22 minutes**

4.3.3 Analysis of old condition

Based on the old condition of the inventory, the machinist relies on the labelling on the box in order to search for the tools. The machinist always confused by the wrong label or wrong tools in the box. This problem led to wastage of time. The amount of time wastage can reduced the profit and also making the machinist to develop the unnecessary motion during searching the tools. Thus, machinist would tired faster and lost focus. Besides, the longer the searching time also affect the product delivery, which also affect other incoming project to be done. The client have to wait longer time and affect the company reputation or the client would find another fabrication company. Thus, reduced the incoming project in the future.

4.3.4 Comparison of condition before and after implementation

The inventories before Kaizen implementation were many unnecessary item which not supposed to be there that cause troubles when searching tools in the small inventory. The machinist spent an average of 9.22 minutes searching for the tools every time. This caused a lot of time wastage. Different boxes have been given in the action plan to keep inventory and tools organized. On the tooling box, proper labels were provided to guarantee that the worker selects the correct item from the correct box in the shortest amount of time. Covers, clothing sticks, and other unwanted things were removed. After the implementation, the machinist searching time for the tools is reduced to 1.51 minutes based on the Table 4.3.

Table 4.3: Average time for machinist searching for tools on new condition.

Condition / Number of taken	New Condition
1	1.35 minutes
2	1.51 minutes
3	2.1 minutes
4	1.43 minutes
5	1.55 minutes
Average	**1.51 minutes**

4.3.5 Analysis of new condition

Based on Figure 4.6, the bar chart shows the average time taken before and after the implementation of Kaizen. The implementation reduced to 85.80 percent which was a significantly big difference compared to before implementation of Kaizen and 5S. By reviewing of this result, this data was parallel to the findings made by (Arya & Choudhary, 2015). The reason behind this was because of new way in retrieving the tools, which was more efficient and faster than the old condition. The machinist did not waste their time on searching the tools and quickly find the right tools that their wanted.

The bar chart shows the big different before and after Kaizen implementation and the difference in time was 7.31 minutes between before and after condition. This was because the improvement help to minimize the tools searching time and reduced any unnecessary motion for the machinist during searching. Besides, the project can be run faster without any delay when searching for the tools.

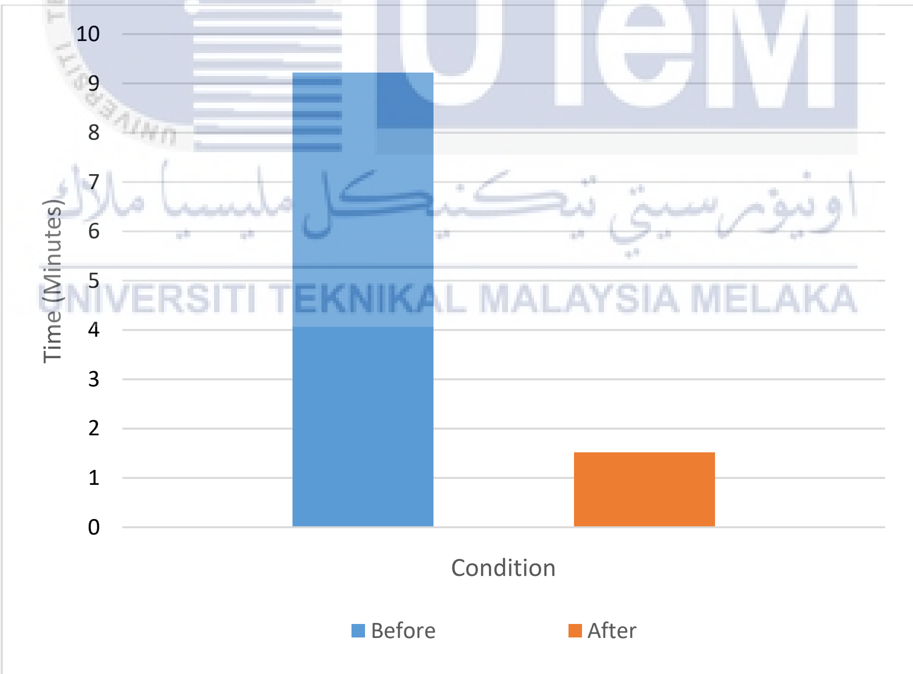

Figure 4.6: Comparison before and after for searching tools after Kaizen implementation.

4.3.6 Create new database for tooling stock system

A new database system is created as shown in Table 4.4 because there is no system to monitor the current amount of tooling stock available in the inventory. This database also came with the specification of each tools. The job was easier for the assistant production to monitor the current stock available and to purchase it again because it includes the ISO code for each tools. This will fasten the process in finding the ISO code when purchasing the right tools.

Besides, the database for tools for example inserts also include the brand, type of insert, number of side, size, radius, and the stock to keep. Stock to keep was to monitor the minimum amount of tools. For example, the tools that regularly been used was set at 20 pieces. If the amount of tools is less than 20 pieces, the assistant production would issue a purchase request to restock back the tools. This was to ensure that the tools which were regularly been used has good amount of stock left in the box. The full list of inserts and end mill database was shown in Appendix IV and V.

The color of the tools was between red and white. This was to differentiate between the most uses tools which was red as shown on Table 4.4 and the least use tools which was white as shown on Table 4.5. This was to make finding the tool easier when purchasing or retrieving the tools later on for stock counting. Moreover, the ordering time was shorten because the assistant production can ordered right away any low in stock tools when the tools was under minimum quantity for stock to keep.

Table 4.4 Red indicator for tools.

Index No	Brand	Type of Insert	ISO Code	Shape (No. of Side)	Size (IC)	Radius (RE)	Stock To Keep	Current Stock
Ins 001	Mitsubishi	Boring	CNMG120404-MA UE6020	Diamond (4)	12.70mm	0.4mm	20	3
Ins 002	Mitsubishi	Boring	CNMG120408-MA UE6110	Diamond (4)	12.70mm	0.8mm	20	
Ins 003	Mitsubishi	Turning	DNMG110404-SH US735	Diamond (4)	9.525mm	0.4mm	20	7
Ins 003	Mitsubishi	Grooving	DGJ30CE VP20MF		25mm (length)	0.2mm	10	9
Ins 004	Carmex	Threading	16 ER AG60 BMA	Triangle (3)	3/8"	Pitch 8-48	20	11

Table 4.5: White indicator for tools.

Ins 028	Mitsubishi	Turning	TNMG160404-FY NX3035	Triangle (3)	9.525mm	0.4mm	10	4
Ins 029	Mitsubishi	Turning	TNMG160404-MA UE6021	Triangle (3)	9.525mm	0.4mm	10	18
Ins 030	Mitsubishi	Turning	TNMG 160408-MA UE6020	Triangle (3)	9.525mm	0.8mm	10	10
Ins 031	Mitsubishi	Turning	TCMT 110204 VP15TF	Triangle (3)	6.35mm	0.4mm	10	10

Table 4.6 shown that the hardcopy table for machinist to key in or record the tools that has been retrieved from the inventory. This hardcopy was put in the inventory. Every end of the day, the assistant operator would then record back in the database and update in the system in order to check the quantity for stock was in minimum number. If it less than minimum number, the assistant operator will inform or issue to general manager for ordering new tools.

Table 4.6: Hardcopy for machinist to record the tools retrieved.

Date	Name	Type of Tool	Size	Quantity	Sign	Remarks

4.3.7 Flow chart for tooling stock system

Flow chart is created based on Figure 4.7 to make sure the workers were always following the SOP and pasted on the notice board. The flow chart showed the process of getting the tools starting from purchasing until the end of the process. This was to make sure that the tools were always in stock and ready to be use whenever specific tools is needed during the manufacturing process.

The flow chart started with the machinist issuing tools stock system to request for tools that already at minimum amount of stock requirement to assistant production. The assistant production then issued the request to admin. It was important for the machinist to always alert with the amount of tools in the box always in minimum quantity because the duration for the new tools to arrive is about two weeks to avoid any project delay.

After the tools arrived, the assistant production made sure that the tools arrived is correct order. The assistant production then started the excel (Elite Industries Tooling Stock) and key in tools serial number in the specifications about the tools in the tooling stock database system. The assistant production also updated the current amount of tools that were in the box. If the amount of other tools were low, the general manager then issued another purchase request to the admin.

Then, new order tools were stored in the box. This helped the machinist to retrieve the tools faster when the tools are in the correct box. When the machinist took out the tools, the machinist recorded the tools serial number in hardcopy layout as for future reference for assistant production.

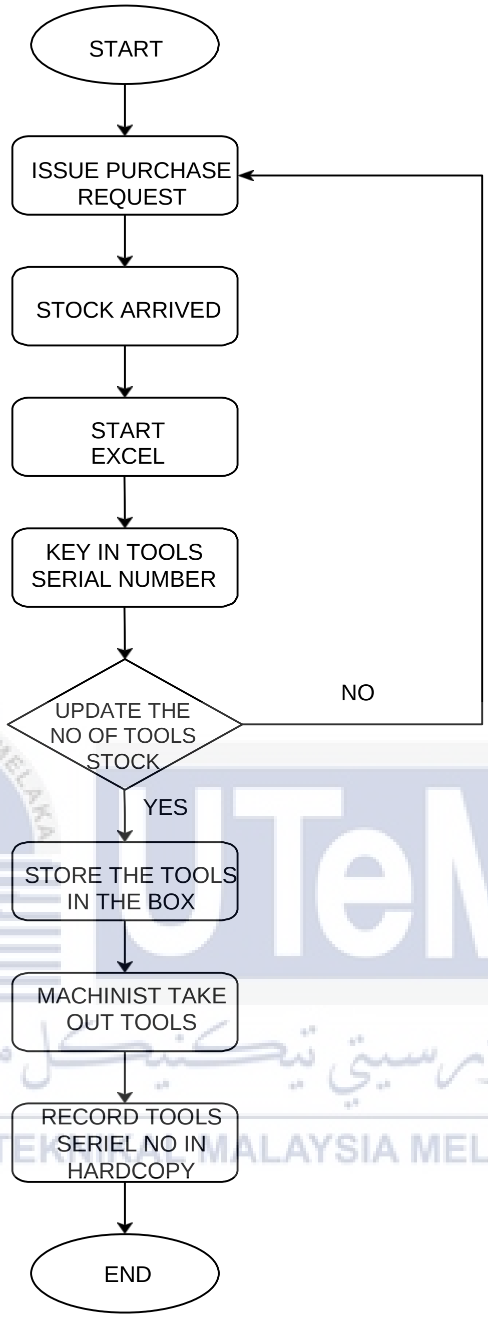

Figure 4.7: Flow chart of tooling stock system.

4.4 Summary

The result of this study helps to give useful information to achieve the objective of this study and also to implement the method on the industries, which also help to enhance the manufacturing performances.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

This chapter describes the overview of this study and it relation to the objectives. In addition, this chapter also proposes the conclusion and number of suggestions for improvement for future study.

5.1 Conclusion

In conclusion, this study was carried out to analyze and solve the problem occur in the Elite Industries Sdn. Bhd. about the tooling stock system that affect the production line. The findings of this study were examined in order to offer basic information on the tooling stock system.

The first objective of the study is to investigate the problems that affect the production performance at Elite Industries Sdn. Bhd. By using the fishbone diagram, the problems is analyzed and identified, which is the lack of tooling stock that affect the production.

The second objective of this study is to propose the appropriate methods using the lean tools for enhancing the performance of production line. The methods that has been used for lean tools are 5S and Kaizen. By using 5S, the inventory is organized and finding the tools are easier and reduce the time for searching from 9.22 minutes to 1.51 minutes which is by 85.80 percent. Besides, Kaizen method also improved the performance for the manufacturing production continuously. This method can lower the cost by reducing waste as well as to establish a safe workplace and increase the productivity of the company.

The third objective is to validate the propose improvement methods for production line. The SOP is created to validate the propose improvement methods for production line starting with the machinist open the inventory and close back after retrieving the tools for the machinist to follow

5.2 Recommendation

There are a few suggestion that might be made for further study. In the future, the system can be automated such as using programming method to track and order the tools automatically if the quantity is low. Besides, the system can link with the supplier and industries to increase the delivering real-time, actionable data and also improve decision-making. Therefore, this method can improve customer happiness, efficiency, and cost savings. Customers can provide information on how they use the product and how they handle it.

5.3 Sustainable Design and Development

The sustainability of the design process is very significant by preventing waste in the production. By using the new tooling stock system, many types of waste can be avoided. For example, the time consumption during searching for tools can be shorten and help to minimize motion of the machinist after implementing the lean tools in production line. Besides, it also help to reduce defect that occurred because of cheap tools. This defect usually end up in trash because it cannot be used anymore. With improved tooling stock system, the sustainability of environment also can be improved.

5.4 Complexity

The complexity of this study are doing the study in pandemic situation which is really hard. Everything need to do in online method with the industries, which is situated in Kuching, Sarawak. Besides, finding which tools that often used by the machinist during the production. There are many types of tools and sorting it takes about a week or two in order to find the correct tools. Besides, the communication between the machinist is hard because the machinist were always busy doing their job and asking them about which tools are critically needed also one of the challenges because different project need different tools. Moreover, this project is a cooperation between the industry and the industry were really confidential with their data. For example, the industry did not share the real data for production and did not allowed taking pictures or videos without their consent. The pictures that has been taken has been checked whether it needed to remove or not from my hand phone.

5.5 Life Long Learning

In this study, the lifelong learning is to be confident and always not afraid when facing with any failures in the future in order to improve ourselves. This will help to gain more experiences and knowledge for future study. Besides, by providing the training to the employees, the employees can search for the resources to enhance their quality of work. This can help to expose the employees to obtain new knowledge in the future. Moreover, this study also help me dealing with the industries in the future when needed to solve the problem.

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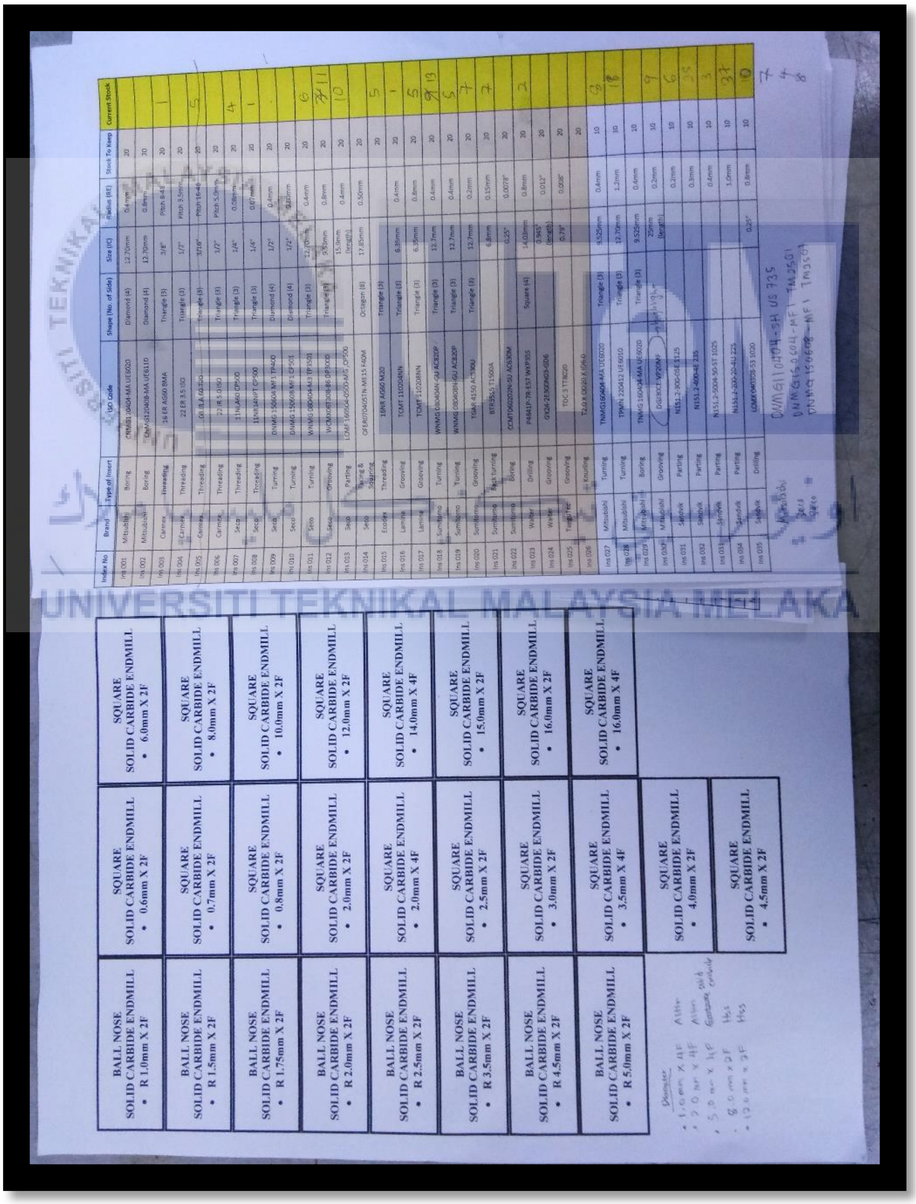
APPENDICES

APPENDIX I



APPENDIX II


Lathe (selalu pakai)
Grooving
Radius = 0,8
Facing
Knurling
Threading
Chamfering
Drilling
Reaming
Boring
Undercutting
Internal thread cutting
External thread cutting
Parting-off
Finishing
Layout
Roughing
Back turning

APPENDIX III

APPENDIX IV

Index No	Brand	Type	Material	Flute	Flute Length	Diameter	Total Length	Stock To Keep	Current Stock
Mill 001	Li Hsing	Ball Nose	Carbide	4	12.0mm	R3.0mm	60.0mm	6	1
Mill 002	Li Hsing	Ball Nose	Carbide	4	24.0mm	R6.0mm	75.0mm	6	
Mill 003	Li Hsing	Square	AlTiN	4	3.0mm	1.0mm	50.0mm	6	7
Mill 004	Li Hsing	Square	AlTiN	4	6.0mm	2.0mm	50.0mm	6	2
Mill 005	Li Hsing	Square	AlTiN	4	7.0mm	2.5mm	50.0mm	6	
Mill 006	Li Hsing	Square	HSS	3	8.0mm	3.0mm	50.0mm	6	2
Mill 007	Li Hsing	Square	AlTiN	4	8.0mm	3.0mm	50.0mm	6	
Mill 008	Li Hsing	Square	HSS	3	11.0mm	4.0mm	50.0mm	6	4
Mill 009	Li Hsing	Square	Carbide	4	11.0mm	4.0mm	50.0mm	6	
Mill 010	Li Hsing	Square	AlTiN	4	11.0mm	4.0mm	50.0mm	6	1
Mill 011	Li Hsing	Square	Carbide	4	13.0mm	5.0mm	50.0mm	6	2
Mill 012	Li Hsing	Square	AlTiN	2	13.0mm	5.0mm	50.0mm	6	3
Mill 013	Li Hsing	Square	HSS	3	13.0mm	5.0mm	50.0mm	6	0
Mill 014	Li Hsing	Square	AlTiN	4	13.0mm	5.0mm	50.0mm	6	3
Mill 015	Li Hsing	Square	HSS	3	15.0mm	6.0mm	50.0mm	6	4
Mill 016	Li Hsing	Square	Carbide	4	15.0mm	6.0mm	50.0mm	6	2
Mill 017	Li Hsing	Square	AlTiN	4	15.0mm	6.0mm	50.0mm	6	3
Mill 018	Li Hsing	Square	HSS	2	20.0mm	8.0mm	60.0mm	6	1
Mill 019	Li Hsing	Square	HSS	3	20.0mm	8.0mm	60.0mm	6	4
Mill 020	Li Hsing	Square	Carbide	4	20.0mm	8.0mm	60.0mm	6	2
Mill 021	Li Hsing	Square	AlTiN	4	20.0mm	8.0mm	60.0mm	6	3
Mill 022	Li Hsing	Square	HSS	3	30.0mm	10.0mm	75.0mm	6	1
Mill 023	Li Hsing	Square	Carbide	4	30.0mm	10.0mm	75.0mm	6	
Mill 024	Li Hsing	Square	AlTiN	4	30.0mm	10.0mm	75.0mm	6	
Mill 025	Li Hsing	Square	HSS	2	30.0mm	12.0mm	75.0mm	6	1
Mill 026	Li Hsing	Square	HSS	3	30.0mm	12.0mm	75.0mm	6	2
Mill 027	Li Hsing	Square	Carbide	4	30.0mm	12.0mm	75.0mm	6	1
Mill 028	Li Hsing	Square	AlTiN	4	30.0mm	12.0mm	75.0mm	6	
Mill 029	Li Hsing	Ball Nose	Carbide	2	4.0mm	R1.0mm	50.0mm	3	
Mill 030	Li Hsing	Ball Nose	Carbide	2	6.0mm	R1.5mm	50.0mm	3	
Mill 031	Li Hsing	Ball Nose	Carbide	2	7.0mm	R1.75mm	50.0mm	3	
Mill 032	Li Hsing	Ball Nose	Carbide	2	8.0mm	R2.0mm	50.0mm	3	
Mill 033	Li Hsing	Ball Nose	Carbide	2	10.0mm	R2.5mm	50.0mm	3	
Mill 034	Li Hsing	Ball Nose	Carbide	2	14.0mm	R3.5mm	60.0mm	3	
Mill 035	Li Hsing	Ball Nose	Carbide	2	18.0mm	R4.5mm	75.0mm	3	
Mill 036	Li Hsing	Ball Nose	Carbide	2	20.0mm	R5.0mm	75.0mm	3	
Mill 037	Li Hsing	Square	Carbide	2	1.2mm	0.6mm	50.0mm	3	
Mill 038	Li Hsing	Square	Carbide	2	1.4mm	0.7mm	50.0mm	3	
Mill 039	Li Hsing	Square	AlTiN	2	1.6mm	0.8mm	50.0mm	3	6
Mill 040	Li Hsing	Square	Carbide	2	6.0mm	2.0mm	50.0mm	3	
Mill 041	Li Hsing	Square	Carbide	4	6.0mm	2.0mm	50.0mm	3	
Mill 042	Li Hsing	Square	Carbide	2	7.0mm	2.5mm	50.0mm	3	
Mill 043	Li Hsing	Square	Carbide	2	8.0mm	3.0mm	50.0mm	3	
Mill 044	Li Hsing	Square	Carbide	4	10.0mm	3.5mm	50.0mm	3	
Mill 045	Li Hsing	Square	Carbide	2	11.0mm	4.0mm	50.0mm	3	
Mill 046	Li Hsing	Square	Carbide	2	13.0mm	4.5mm	50.0mm	3	
Mill 047	Li Hsing	Square	Carbide	2	15.0mm	6.0mm	50.0mm	3	
Mill 048	Li Hsing	Square	Carbide	2	20.0mm	8.0mm	60.0mm	3	
Mill 049	Li Hsing	Square	Carbide	2	30.0mm	10.0mm	75.0mm	3	
Mill 050	Li Hsing	Square	Carbide	2	30.0mm	12.0mm	75.0mm	3	
Mill 051	Li Hsing	Square	Carbide	4	35.0mm	14.0mm	100.0mm	3	
Mill 052	Li Hsing	Square	Carbide	2	38.0mm	15.0mm	100.0mm	3	
Mill 053	Li Hsing	Square	Carbide	2	40.0mm	16.0mm	100.0mm	3	
Mill 054	Li Hsing	Square	Carbide	4	40.0mm	16.0mm	100.0mm	3	

APPENDIX V

Index No	Brand	Type of Insert	ISO Code	Shape (No. of Side)	Size (IC)	Radius (RE)	Stock To Keep	Current Stock
Ins 001	Mitsubishi	Boring	CNMG120404-MA UE6020	Diamond (4)	12.70mm	0.4mm	20	3
Ins 002	Mitsubishi	Boring	CNMG120408-MA UE6110	Diamond (4)	12.70mm	0.8mm	20	
Ins 003	Mitsubishi	Turning	DNMG110404-SH US735	Diamond (4)	9.525mm	0.4mm	20	7
Ins 003	Mitsubishi	Grooving	DGJ30CE VP20MF		25mm (length)	0.2mm	10	9
Ins 004	Carmex	Threading	16 ER AG60 BMA	Triangle (3)	3/8"	Pitch 8-48	20	11
Ins 005	Carmex	Threading	22 ER 3.5 ISO	Triangle (3)	1/2"	Pitch 3.5mm	20	10
Ins 007	Carmex	Threading	22 IR 5.0 ISO	Triangle (3)	1/2"	Pitch 5.0mm	20	8
Ins 008	Seco	Threading	11NLA60 CP500	Triangle (3)	1/4"	0.08mm	20	4
Ins 009	Seco	Threading	11NR14NPT CP500	Triangle (3)	1/4"	0.07mm	20	1
Ins 010	Seco	Turning	DNMG 150604 MF1 TP400	Diamond (4)	1/2"	0.4mm	20	4
Ins 011	Seco	Turning	DNMG 150608 MF1 CP501	Diamond (4)	1/2"	0.80mm	20	8
Ins 012	Seco	Turning	WNMG 080404-M3 TP3501	Triangle (3)	12.70mm	0.4mm	20	6
Ins 013	Seco	Drilling	WCMX050308-85 DP3000	Triangle (3)	7.94mm	0.8mm	20	2
Ins 013	Seco	Grooving	WCMX06T308-86 DP3000	Triangle (3)	9.53mm	0.8mm	20	11
Ins 014	Seco	Parting	LCMF 160504-0500-MG ,CP500		15.9mm (length)	0.4mm	20	10
Ins 016	Ecodex	Threading	16NR AG60 M20	Triangle (3)			20	5
Ins 017	Lamina	Grooving	TCMT 110204NN	Triangle (3)	6.35mm	0.4mm	20	1
Ins 018	Lamina	Grooving	TCMT 110208NN	Triangle (3)	6.35mm	0.8mm	20	15
Ins 019	Sumitomo	Turning	WNMG 080404N-GU AC820P	Triangle (3)	12.7mm	0.4mm	20	13
Ins 020	Sumitomo	Turning	WNMG 080408N-GU AC820P	Triangle (3)	12.7mm	0.4mm	20	5
Ins 021	Sumitomo	Grooving	TGAR 4150 AC530U	Triangle (3)	12.7mm	0.2mm	20	7
Ins 022	Sumitomo	Back turning	BTR3515 T1500A		6.8mm	0.15mm	20	17
Ins 023	Sumitomo	Boring	CCMT060202N-SU AC630M		0.25"	0.0078"	20	2
Ins 024	Walter	Drilling	P4841P-7R-E57 WKP35S	Square (4)	14.03mm	0.8mm	20	2
Ins 025	Walter	Grooving	GX24-2E300N03-GD6		0.945" (length)	0.012"	20	20
Ins 026	TaeguTec	Grooving	TDC 3 TT8020		0.79"	0.008"	20	8
Ins 027		Knurling	T2.0 X OD20 X ID6.0				20	
Ins 028	Mitsubishi	Turning	TNMG160404-FY NX3035	Triangle (3)	9.525mm	0.4mm	10	4
Ins 029	Mitsubishi	Turning	TNMG160404-MA UE6021	Triangle (3)	9.525mm	0.4mm	10	18
Ins 030	Mitsubishi	Turning	TNMG 160408-MA UE6020	Triangle (3)	9.525mm	0.8mm	10	10
Ins 031	Mitsubishi	Turning	TCMT 110204 VP15TF	Triangle (3)	6.35mm	0.4mm	10	10
Ins 029	Mitsubishi	Turning	TPMN 220412 UE6010	Triangle (3)	12.70mm	1.2mm	10	18
Ins 031	Sandvik	Parting	N151.2-300-05E 1125			0.2mm	10	6
Ins 032	Sandvik	Parting	N151.2-400-4E 235			0.3mm	10	25
Ins 033	Sandvik	Parting	N151.2-5004-50-5T 1025			0.4mm	10	3
Ins 034	Sandvik	Parting	N151.2-200-20-4U 225			1.0mm	10	37
Ins 035	Sandvik	Drilling	LCMX 040308-53 1020		0.25"	0.8mm	10	10
Ins 036	Sandvik	Drilling	R290-12T308M-PL 4230	Round (1)	13.29mm	0.8mm	10	

Ins 037	Sandvik	Facing	N331.1A-115008H-WL	Square (4)	9.525mm	0.8mm	10	10
Ins 038	Sandvik	Insert Shim	5322 110-01	Round (1)	8.80mm		10	4
Ins 039	Seco	Threading	16ER AG60-A2 CP500	Triangle (3)	3/8"	0.08mm	10	
Ins 040	Seco	Turning	DNMG 110402-M3 TP2500	Diamond (4)	3/8"	0.2mm	10	29
Ins 041	Seco	Turning	DNMG110404-MF3 TP400	Diamond (4)	3/8"	0.40mm	10	13
Ins 042	Seco	Turning	DNMG110404-MF3 TP2500	Diamond (4)	3/8"	0.40mm	10	30
Ins 043	Seco	Turning	CCMT060202-FF1 TP200	Diamond (4)	1/4"	0.20mm	10	
Ins 044	Seco	Turning	CCMT 09T302-F1 TP300	Diamond (4)	9.5mm	0.20mm	10	
Ins 045	Seco	Turning	TPUN 160308 S25M	Triangle (3)	9.52mm	0.8mm	10	
Ins 046	Seco	Turning	WNMG 060402-M3 TP2500	Triangle (3)	12.70mm	0.2mm	10	29
Ins 047	Seco	Turning	WNMG 060404-M3 TP2500	Triangle (3)	12.70mm	0.4mm	10	30
Ins 048	Seco	Turning	WNMG 060408-M3 TP2500	Triangle (3)	12.70mm	0.8mm	10	30
Ins 049	Seco	Facing	SEKN1204AFTN-M18 T350M	Square (4)	12.70mm	1.00mm	10	17
Ins 050	Seco	Insert Shim	RCMT 0602 M0-F1 CP500	Round (1)	6.0mm		10	10
Ins 051	Seco	Drilling	WCMX080412	Triangle (3)	1/2"	1.20mm	10	
Ins 052	Seco	Grooving	TSN160312	Triangle (3)		1.2mm	10	3
Ins 053	Seco	Grooving	MWN080412	Diamond (4)		1.2mm	10	4
Ins 054	Seco	Parting	LCMF 160302-0300-MT CP500		15.9mm (length)	0.2mm	10	3
Ins 055	Seco	Turning	220.13-621	Octagon (8)	1/2"		10	2
Ins 056	Seco	Chamfering	XOMX120408TR-ME08 T350M		11.60mm (length)	0.80mm	10	19
Ins 057	Seco	Milling	XOMX060208R-M05 F30M		5.50mm (length)	0.80mm	10	8
Ins 058	Lamina	Milling	APMT 1135 PDTR		0.430"	0.7mm	10	5
Ins 059	Sumitomo	Turning	NU-TNMA 160408	Triangle (3)	9.525mm	0.8mm	10	3
Ins 060	Sumitomo	Facing	SEKN42MT	Square (4)	12.7mm		10	20
Ins 061	Sumitomo	Grooving	TGAR 3100	Triangle (3)	9.525mm	0.1mm	10	10
Ins 062	Sumitomo	Milling	APMT103508PDER-H		6.35mm	0.8mm	10	20
Ins 063	Sumitomo	Milling	AXMT123508PEER-G		3.302mm	0.8mm	10	10
Ins 064	Sumitomo	Milling	AXMT170508PEER-G		0.18"	1/32"	10	13
Ins 065	Kyocera	Turning	DCGT070204MF	Diamond (4)	5/32"	0.4mm	10	10
Ins 066	Kyocera	Grooving	TGF32R150	Triangle (3)		0.1mm	10	8
Ins 067	Kyocera	Turning	CNGA120408T02025	Diamond (4)	12.7mm	0.8mm	10	10
Ins 068	Kennametal	Turning	CNMG 12 04 08	Diamond (4)	1/2"	0.08mm	10	2
Ins 069	Kennametal	Turning	CNMA 120412	Diamond (4)	1/2"	1.2mm	10	1
Ins 070	Kennametal	Turning	1.81501R122	Square (4)		0.8mm	10	9
Ins 071	Walter	Milling	ADHT10T3PER-G88		0.285"	0.8mm	10	19
Ins 072	Korea Tungsten	Knurling	RNMG 540 KT150	Round (1)			10	9
Ins 073	Korea Tungsten	Knurling	RNMG 430 KT150	Round (1)			10	2
Ins 074	Osg Phoenix	Ball Nose	RPHT10T3M0EN-GL XP2040	Round (1)	10mm		10	7
Ins 075	Osg Phoenix	Milling	ZDKT11T304FR-NM		6.8mm	0.4mm	10	5
Ins 076	Rouse	Turning	SD 2.532E C5	Square (4)	5/16"	0.031"	10	