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APPLICATION OF SIX SIGMA MODEL IN PRODUCTION AND QUALITY OF THE STABILISER

MUHAMMAD FIRDAUS BIN AZMI

Report submitted in partial fulfillment of the requirements

for the award of Bachelor of Engineering (Hons.) of Manufacturing Engineering.

Faculty of Manufacturing Engineering

UNIVERSITY MALAYSIA PAHANG

JUNE 2015

UNIVERSITI MALAYSIA PAHANG

FACULTY OF MANUFACTURING ENGINEERING

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I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of the Degree of Bachelor of Manufacturing Engineering.

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Special thanks to my parents for their supports and cares, also for my siblings. Special dedications to my supervisor on his guiding towards my final project.

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ABSTRACT

Six Sigma applications is a one of the effective Total Quality Management tools in order to improve quality of the product and productivity in industry. However, while many benefits of Six Sigma are increasingly reported in other country, it is not very common among local company because lack of exposure and many companies in Malaysia afraid to take a high risk. Furthermore, although there have been numerous case studies, comprehensive discussions, books and websites addressing Six Sigma, a very little academic research has been done to examine the impact of the Six Sigma application in local industry. This project has been created to design a systematic project which will overcome the problem of low quality of the stabiliser bar due to the some problems at forging process at Company A, and the benefits to the companies that implementing Six Sigma application. This research has focus on one specific product which is SB 45 which is use in the Brand A car.

ABSTRAK

Aplikasi Six Sigma adalah salah satu alat pengurusan kualiti yang berkesan untuk memperbaiki kualiti produk dan meningkatkan daya pengeluaran didalam industri. Walaubagaimanapun, sewaktu banyak faedah Six Sigma semakin meningkat dilaporkan di negara lain, ia bukan menjadi kebiasaan dikalangan syarikat tempatan kerana kurangnya pendedahan dan kebanyakan syarikat takut untuk mengambil risiko yang tinggi. Tambahan lagi, meskipun terdapat banyak kes pembelajaran, pembincangan menyeluruh, buku dan laman web tentang Six Sigma, terlalu sedikit penyelidikan akademik yang dibuat untuk memeriksa kesan aplikasi Six Sigma didalam industri tempatan. Projek ini telah dicipta untuk mereka satu projek sistematik yang dapat menyelesaikan masalah kualiti “stabiliser bar” yang rendah disebabkan oleh terdapat masalah di proses “forging” di Syarikat A ,danjuga kelebihan kepada syarikat yang mengamalkan Six Sigma di syarikat mereka.Kajian ini menumpukan kepada satu jenis produk sahaja (SB45) yang digunakan pada kereta Jenama A.

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LIST OF ABBREVIATIONS

DMAIC	Define,Measure,Analyse,Improve,Control
PMI	Project Management Institute
FOA	First of Approval

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Sigma is a quality improvement approach which systematically effective to improve organization performance based on the use of various statistic analytic technique. The higher sigma level, the smaller probability level of defects occurs in products. However, a number of organizations prefer to use Six Sigma because it has standard of only produce less than 3.4 defects per million opportunities. The purpose is to reduce process variance by eliminate defects that bother customer satisfaction. Six Sigma has concern on improving quality by reducing defects. There are five phase in DMAIC steps which are (1) Define, is define the problem and scope of project; (2) Measure, is measure the performance quality of current process; (3) Analyze, is analyze process performance to separate problems; (4) Improve, is improve performance by giving problem solution (5) Control, is control the process or product which already improved to ensure the target attainment [1].

In this project Six Sigma quality tools are used to improve quality and productivity of the stabiliser bar produced by Company A. This company produces stabiliser bar and supply it to the Proton, Perodua, Honda and other automotive company. Specialize in producing cold drawn steel bars of various sizes for automotive industries and manufacturer of stabilizer bars. Now Sapura already lead a supplier of stabilizer bar in Malaysia. We also aim to bring our product abroad to make Malaysian product become well known.

1.2 PROBLEM STATEMENT

The quality of the stabiliser bar is low due to the some problems at forging process. The quality department faces some complaint from their customer because of the product do not follow the specifications that the customer needed.

1.3 OBJECTIVES

This study will utilize Six Sigma Quality Tools to design a systematic project which will overcome the problem of low quality of the stabiliser bar due to the some problems at forging process at Company A. Thus, the objectives of this study are indicated as follows:

I. To investigate and define the problems at forging process that cause low quality and productivity of the stabiliser bar
II. To measure and analyze the latest technical problem of the productivity and quality in the production line
III. To improve and control the latest technical problem of the productivity and quality in the production line

1.4 SCOPE OF RESEARCH

The scope of research focuses on implementing Six Sigma Quality Tools – DMAIC (define, measure, analyze, improvement and control). DMAIC method is a closed-loop process that removes unproductive steps, focuses on quality measurements, and applies new ideas for continuous improvement. Furthermore, the scopes of research are clarified in the following:

I. Study of productivity and quality problems in the production of stabilizer bar focusing on the forging activity
II. Project investigation is performed using Six Sigma model DMAIC (define, measure, analyze, improvement and control)

III. Research investigation is conducted at Company A. an automotive parts manufacturing company.

1.5 SIGNIFICANCE CONTRIBUTION AND EXPECTED OUTCOME

The significance contribution of this project is through implementation of Six Sigma Quality Tools which is DMAIC which produces suitable statistical process knowledge to better understand and improve future results. It is also a set of solid step and tools for process improvement. It can give variability knowledge in order to reduce instinctive reactions. Lastly, DMAIC is a based decision on facts and concrete quantitative analysis [2]. While, the expected outcome of this research are as follows:

I. The productivity will increase through the application of Six Sigma model in the production line
II. Higher quality of the product can be achieved after the application of Six Sigma model

1.6 OVERVIEW AND THESIS LAYOUT

This final year project thesis has been structured into 5 chapters. Chapter 1 contain the introduction of this research, it provides with the background of studies, problem statements, significance of study, objectives including the scope of study. Chapter 2 is literature review chapter which presents the previous research in various areas which is relevant to this study. The literature review begins with an explanation about Six Sigma Quality Tools and how to apply it in the real situation. The problem that we faced is also mentioned in this chapter. The methodology of this research is presented in Chapter 3. This chapter explains the technique of DMAIC which one of the method for Six Sigma Quality Tools. The experimental results and discussions which show the effect of this improvement for the quality of the products and the productivity are discussed in Chapter 4. The discussion will be focused on the how the Six Sigma Quality method can solve the problem in a quality and productivity aspects. For Chapter 5, the conclusions of this research study and recommendations for further work are discussed in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Current economic crisis raises the constant demand for profitable solutions that allow organizations to gain competitive advantage. For this reason, more and more companies search for management methodologies that allow them to improve their products and service characteristics, perfect their processes, decrease costs, improve the capital's profitability and costumers' satisfaction. This have been attempted through Six Sigma integrated approaches in their managerial and production processes in which, Six Sigma on the control and processes variability reduction, using statistical tools for this purpose.

2.2 SIX SIGMA QUALITY MODEL

The present article proposes a Six Sigma project management improvement model supported by the DMAIC (define, measure, analyze, improvement and control).cycle and integrating an enlarged and adapted set of statistical tools, given the nature of the project management main variables and the involved processes. The model allowed identifying company's main project management problems and associated causes and the selection of the causes to be first attended. The proposed model also permitted to systematically address the actions and solutions to be implemented in order to keep, in the long run, the continuous improvement of the project management processes in the organization [2].

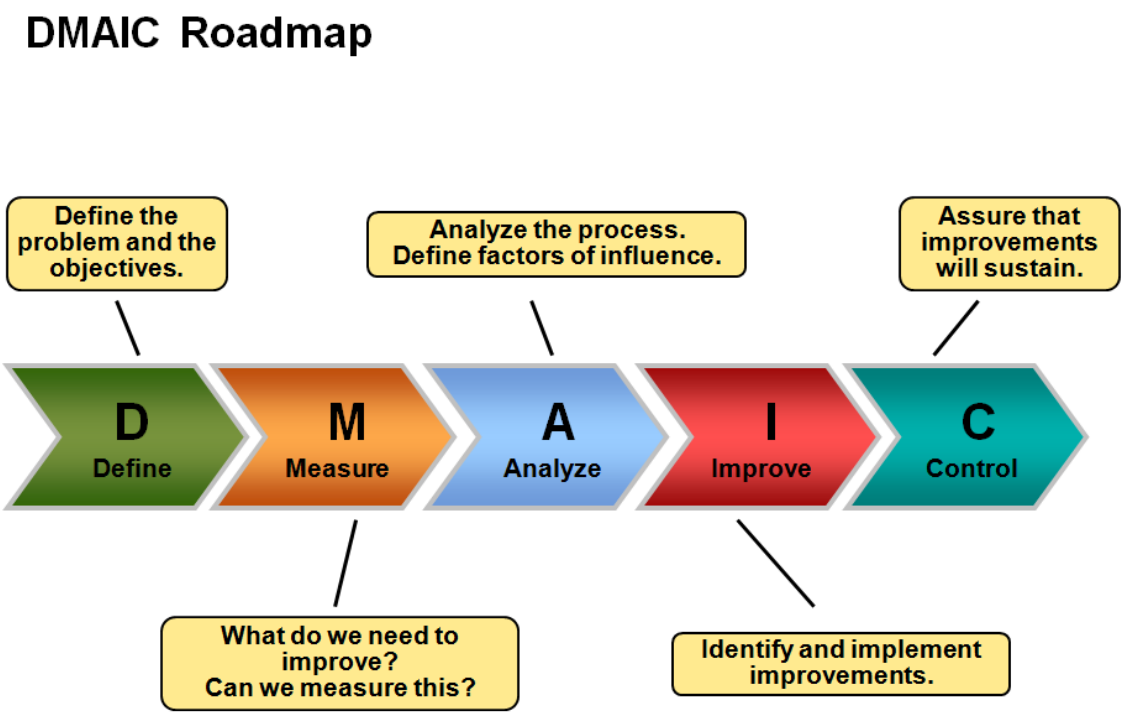


Figure 2.1: DMAIC Roadmap

Source: www.gm600bl.wordpress.com,2014 [3]

2.3 REVIEWS ON A SIX SIGMA MODEL

2.3.1 Contribution to the Optimization of Strategy of Maintenance by Lean Six Sigma

The efficiency of the maintenance of the industrial systems is a major economic stake for their business concern. The main difficulties and the sources of ineffectiveness live in the choice of the actions of maintenance especially when the machine plays a vital role in the process of production. But as Algeria has embarked on major infrastructure projects in transport, housing, automobile, manufacturing industry and construction (factories, housing, highway, subway, tram, etc.) requiring new implications on maintenance strategies that meet industry requirements imposed by the exploitation. From then on and seen the importance of the maintenance on the economic market and sound impacts on the performances of the installations, methods of

optimization were developed. For this purpose, to ensure the survival of businesses, be credible, contributing and competitive in the market, maintenance services must continually adapt to the progress of technical areas, technological and organizational even help maintenance managers to construct or to modify maintenance strategies, objective of this work [4].

Our contribution in this work focuses on the optimization of maintenance for industrial systems by the use of Lean Six Sigma bases. Lean Six Sigma is a method of improving the quality and profitability based on mastering statically of process and it is also a management style that based on a highly regulated organization dedicated to managing project. The method is based on five main steps summarized in the acronym (DMAIC): Define Measure, Analyze, Improve and Control [4].

Application of the method on the maintenance processes with using maintenance methods during the five phases of the method will help to reduce costs and losses in order to strive for optimum results in terms of profit and quality [4].

2.3.2 Information Quality Improvement Model on Hospital Information System Using Six Sigma

Hospital provides a number of health services and proper health facilities for society, one of the healthcares is inpatient. Because of the daily high demand of inpatients healthcare in a day, some hospitals seems too overwhelmed to control the information flow. Mainly, hospital already used Hospital Information System (HIS) for helping managing information flow. But some of it does not really care about the quality of information. Information quality is a key element to determine the level of healthcare in hospital. By the improvement of information quality, the quality of healthcare would improve to support the patient's satisfaction. A method used for information quality improvement is Six Sigma. Six Sigma could be used for reducing information variance in healthcare, especially information that used in Hospital Information System [5].

2.3.3 A Lean Six Sigma (LSS) project management improvement model

Current economic crisis raises the constant demand for profitable solutions that allow organizations to gain competitive advantage. For this reason, more and more companies search for management methodologies that allow them to improve their products and/or service characteristics, perfect their processes, decrease costs, improve the capital's profitability and costumers' satisfaction. This have been attempted through Lean Management and Six Sigma integrated approaches in their managerial and production processes in which, Lean focus mainly on the waste elimination, using simple and visual techniques whenever possible and Six Sigma on the control and processes variability reduction, using statistical tools for this purpose. The present article proposes a Lean Six Sigma (LSS) project management improvement model supported by the DMAIC cycle and integrating an enlarged and adapted set of statistical tools, given the nature of the project management main variables and the involved processes. The proposed model was tested in a Portuguese telecommunication company context which project management processes system are based on Project Management Institute (PMI) standards. The model allowed identifying company's main project management problems and associated causes and the selection of the causes to be first attended. The proposed model also permitted to systematically address the actions and solutions to be implemented in order to keep, in the long run, the continuous improvement of the project management processes in the organization [6].

2.3.4 Application of six-sigma in educational quality management

Understanding of the key features, barriers, elements and weaknesses of Six Sigma methods will allow the organizations to support their strategic directions and increasing need for coaching supervision and training. This also creates appropriate opportunities for implementation of Six Sigma projects. This article considers the evolutionary review of the benefits and challenges of Six Sigma projects and recognizes the key and influential elements of the successful approach of Six Sigma method. This article also combines the lessons learnt from successful projects and considers the forthcoming improvements of Six Sigma approach. Effective principals and activities of Six Sigma will be successful through the improvement and constant sequence of organizational culture. Cultural changes before internalization in organizations need enough time and sense of responsibility. The purpose of this paper is investigation the role of Six Sigma in the educational quality in organization [7].

Table 2.1: Summary of the latest product development research using Six Sigma Model

Authors	Field of implementation	Development and contribution
Youssouf et al., (2014)	Contribution to the Optimization of Strategy of Maintenance by Lean Six Sigma	Our contribution in this work focuses on the optimization of maintenance for industrial systems by the use of Lean Six Sigma bases. Lean Six Sigma is a method of improving the quality and profitability based on mastering statically of process and it is also a management style that based on a highly regulated organization dedicated to managing project. The method is based on five main steps summarized in the acronym (DMAIC): Define Measure, Analyze, Improve and Control.
Ratnaningtyas and Surendro (2013)	Information Quality Improvement Model on Hospital Information System Using Six Sigma	Mainly, hospital already used Hospital Information System for helping managing information flow. By the improvement of information quality, the quality of healthcare would improve to support the patient's satisfaction. A method used for information quality improvement is Six Sigma. Six Sigma could be used for reducing information variance in healthcare, especially information that used in Hospital Information System.

Authors	Field of implementation	Development and contribution
Petruta and Roxana (2014)	Integrating Six Sigma with Quality Management Systems for The Development and Continuous Improvement of Higher Education Institutions	The paper focuses on the way Six Sigma is applied to higher education and on integrating Six Sigma with one of the quality management systems, namely the model ISO 9000, for the development and continuous improvement of universities. A synergetic approach created by analyzing and simultaneously using the benefits of Six Sigma and ISO 9000 plays an important role in the development and success of a higher education institution [8].
Rohini and Mallikarjun (2011)	Improving the Quality of Operation Theatre	The paper identifies each stage in detail, discusses the tools required and points out the limitations to the success of the improvement initiatives. The paper develops a Design DMAIC Model that can be used as a template for improving the Operation Theatre Process in hospitals. Six Sigma is complimentary to other initiatives such as ISO, JACHO, TQM, NABH etc. The study recommends many OT related solutions for framing policies, for consultants and for supportive staff, engineering and IT services [9].

Authors	Field of implementation	Development and contribution
Mili (2014)	Six Sigma Approach for the Straddle Carrier Routing Problem	This paper discusses how to route straddle carriers in port container terminals. This problem is solved in the context of optimizing transport operations. The contribution of the work lies in the formulation and subsequent development of a Six Sigma Approach solution for the problem. Generating and prioritizing the critical Six Sigma transportation plans, however, are real challenges in practice [10].
Christyanti (2012)	Improving the Quality of Asbestos Roofing at PT BBI Using Six Sigma Methodology	By implementing Six Sigma methodologies, the team found that this condition was mainly caused by side flat as its dominant defect type due to speeding up the curing time without simultaneously increasing its temperature. To solve this problem, the team has proposed that the company should increase its temperature up to to 350°C by DOE (Design of Experiment) if it needs to speed up the curing time from normally 5 hours to 4 hours. As the result, the quality figure was better with improved sigma level to 5.02 sigma and DPMO level at 180. This result might not be

		significant because there were still many other defect types found in the product that should be followed up by continuous improvement in the company [11].
Lighter (2014)	The application of Lean Six Sigma to provide high-quality, reliable paediatric care	This paper describes an approach that can prove crucial to improving patient care, reducing costs, and ensuring sustainability [12].
Mehrabi (2012)	Application of six-sigma in educational quality management	The objective of this paper is to review and examine the evolution, benefits, and challenges of Six Sigma practices and identify the key factors influencing successful Six Sigma project implementation. The paper also integrates the lessons learned from successful Six Sigma projects and their potential applications in managing traditional projects, and considers further improvements to the methodologies used for managing Six Sigma projects.

2.5 SUMMARY

Six Sigma model is a quality improvement approach which systematically effective to improve organization performance based on the use of various statistic analytic technique. The higher sigma level, the smaller probability level of defects occurs in products. This Six Sigma model is apply at the quality department to control the quality of the product and reduce the reject part

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter discusses about the approach and methodologies used in gathering the data and formulas thought out the research. It is very important to apply suitable methods as it will reflect the findings of the research. Based on the literature review, it can conclude that many criteria that need to be considered in designing an experimental tool for Six Sigma model (SSM).

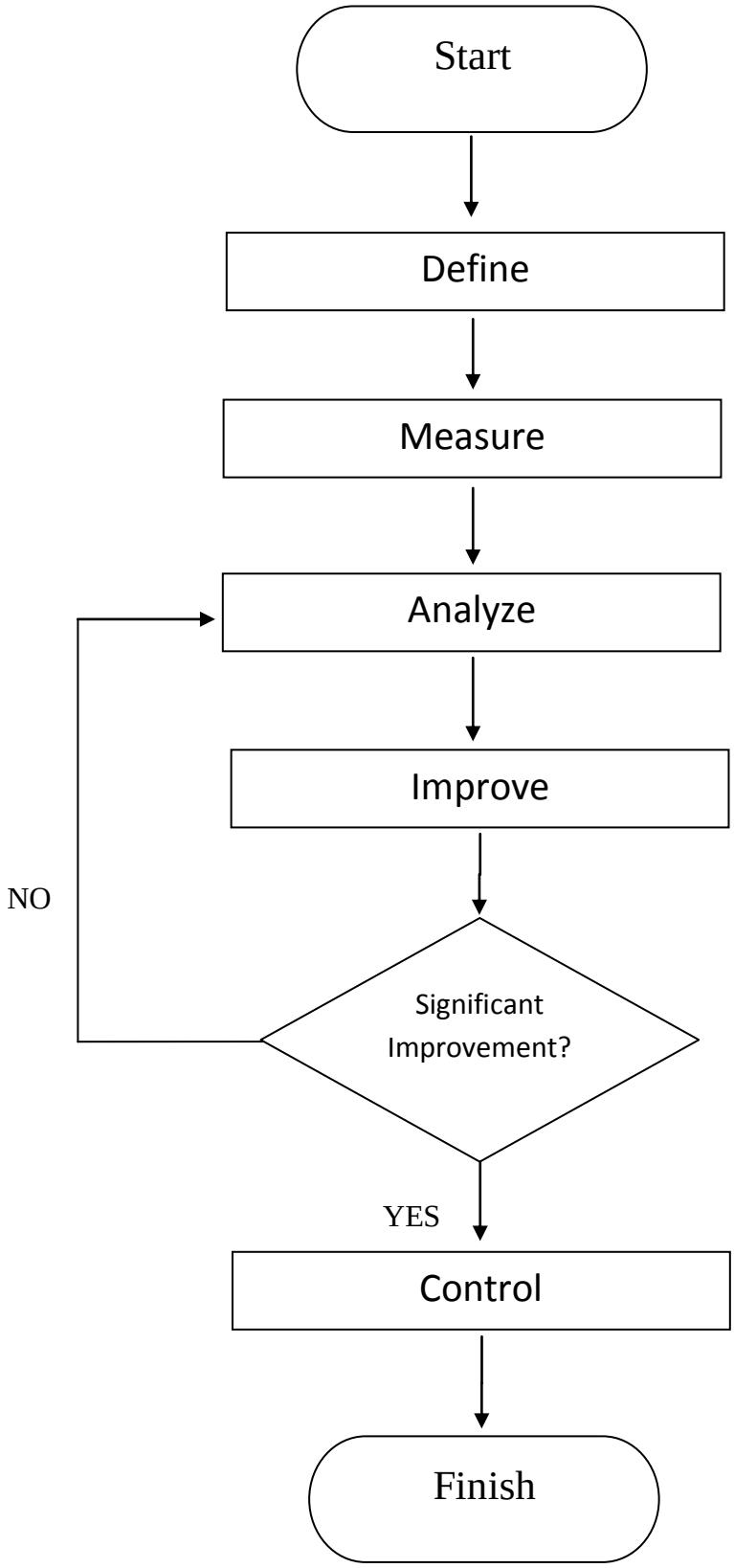
In this research we going to apply SSM in production and quality related problems to perform improvement and control in the productivity and quality of the product .The SSM methodologies use a specific problem solving approach and specialized Six Sigma tools to improve processes and products. This methodology is data driven with a goal of reducing the number of unacceptable products or events. The ideal technical goal of Six Sigma methodology is to reduce process variation to such degree that the amount of unacceptable product is no more than 3 defects per million parts [13].

The purpose of Six Sigma is to make a product that satisfies the costumer and minimizes supplier losses to the point where it is not cost effective to pursue tighter quality

3.2 DETAIL CHART OF METHODOLOGY

All the work to complete this project has been done step by step following the flowchart. In this project, methodology is an important element to be considered to ensure that the project perform smoothly follows as planning. It is also as a guideline in develops the project so that the project is always following the guidelines based on the objectives which is state in Chapter 1.

3.2.1 Flowchart



3.2.2 Define

The aim of this step is to clearly eloquent the business problem, potential resources, goal, project scope and high-level project timeline. The quality department in the Company A have define the problem by having some complaint from their customer because of the product do not follow the specifications that the customer needed.

3.2.3 Measurement

The aim of this step is to objectively set up current baselines as the basis for improvement. This is a data collection pace. The performance metric baseline(s) from the Measure phase will be compared to the performance metric at the conclusion of the project to determine objectively whether significant improvement has been made. Production on 13/8/2014 has been choosing to make it as experimental data. The data have been collected for one day period on one specific model of stabiliser bar which is SB 45

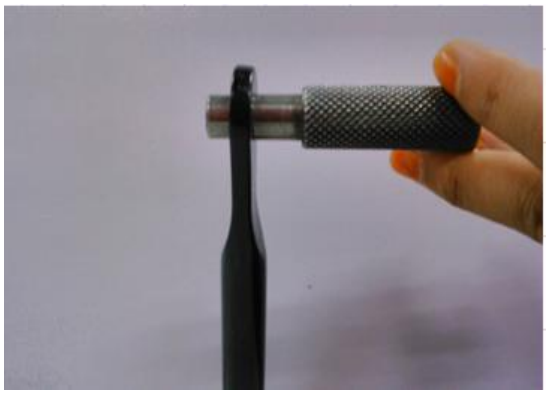


Figure 3.1: Good Product Hole Diameter (12.5±0.25 mm)

Figure 3.2: Reject Product Hole Diameter (Out spec ≤12.25mm)

3.2.4 Analyze

The aim of this step is to identify, validate and select root cause for elimination. A large number of potential root causes of the project problem are identified via root cause analysis. The top 3-4 potential root causes are selected using multi-voting or other consensus tool for further validation. A data collection plan is makes and data are collected to establish the relative contribution of each root causes to the project. This process is repeated until "valid" root causes can be identified. Within Six Sigma, often complex analysis tools are used

3.2.5 Improve

The purpose of this step is to identify, test and implement a solution to the problem; in part or in whole. This depends on the situation. Identify creative solutions to eliminate the key root causes in order to fix and prevent process problems. Use brainstorming or techniques like Six Thinking Hats and Random Word. Some projects can utilize complex analysis tools like DOE (Design of Experiments). The Ishikawa diagram is the best tools to be used to show the causes of the problem and the effect of the problem, from the Ishikawa diagram the engineer of the company will know what actions need to be taken [14].

3.2.6 Control

At the end of the improvements it may be warranted to calculate new process control limits and make these limits the triggers for corrective and preventive action. The new process need to be continuously improving the process by using Lean principles. The four principles of Value, Flow, Pull and Perfection should remain constant objective for all organizations. While handhelds on the results of each project Continuous Improvement Efforts should be made to relay this approach to employees who use the new and improved process. The new process also needs to be properly managed and supervised, to ensure that the process is being. In order to maintain this approach, the team must reduce vital few measurements that want to maintain continuous monitoring of process performance. This monitoring is accompanied by a plan of response indicating the levels at which the process should work and what to do if the process must exceed these levels. This can lead to continued refinement process.

3.3 COMPANY'S BACKGROUND

In this project Six Sigma quality tools are used to improve quality and productivity of the stabiliser bar produced by Company A. This company produces stabiliser bar and supply it to the Proton, Perodua, Honda and other automotive company. Specialize in producing cold drawn steel bars of various sizes for automotive industries and manufacturer of stabilizer bars. Now Sapura already lead a supplier of stabilizer bar in Malaysia. We also aim to bring our product abroad to make Malaysian product become well known

3.4 FORGING PROCESS

Forging is a manufacturing process involving the shaping of metal using localized compressive forces. Forging is often classified according to the temperature at which it is performed: "cold", "warm", or "hot" forging. This forging machine is use to make a hole at the end of the stabiliser bar [15].

Figure 3.3: Forging Machine

The stabilizer bar hole at the end of the bar does not follow the specifications. There are some conformities at the hole area. So I decided to use the DMAIC method to solve this problem. There have a lot of possibilities which contribute to this problem

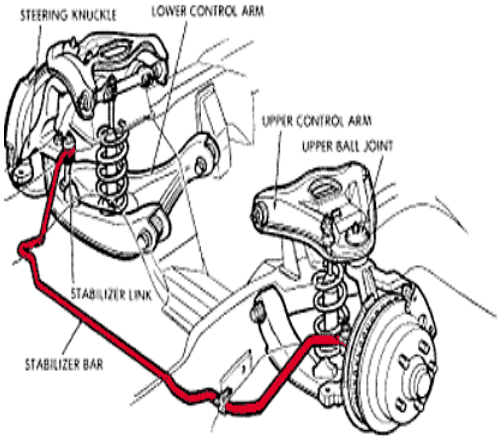


Figure 3.4: Stabilizer Bar

Source: www.enginebasics.com,2010 [16]

Figure 3.5: Good part and reject part

3.5 SUMMARY

This chapter discussed the choice of Six Sigma tools methodology as a suitable research methodology for this study. It is also to explain the DMAIC process, describe process flow diagram and collecting the data. Many criteria need to be considered while applying the Six Sigma Model in quality related problems.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 INTRODUCTION

This project includes the review over the research on Six Sigma by conducting a research and applies Six Sigma in that project. Sigma is a quality improvement approach which systematically effective to improve organization performance based on the use of various statistic analytic technique. This project starts with defining the problem in the Company A. Recent performance of the company was record; recent performance becomes the reference point. This is a key step that the data collected will be used throughout the project. Next, the performance need to be analysed to know what is the problem and then we can improve the performance by solving the problem that we have faced before. The result are presented and discussed in this chapter.

4.2 DETAIL OF RESULTS AND DISCUSSIONS

4.2.1 Define

The quality of the stabiliser bar is low due to the some problems at forging process. The quality department faces some complaint from their customer because of the product do not follow the specifications that the customer needed.

4.2.2 Measure

In this research, the data is collected by using a check sheet method. Company A will produce the product based on the customer requirement. The quantity of the product does not fix. It is decided to choose production on 13/2/2014 to make it as the experimental data. The data for one day period on one specific model of stabiliser bar which is SB 45 have been collected. By this method, the performance of model SB 45 production can be measure.

There have five control items in this check sheet which are bar diameter, hole outside diameter, head outside diameter, head thickness and end-end length. The entire control items have their own specifications that Sapura Company needs to follow. The quality department will take two samplings for every one hour in one day. The result as in the Table 4.1.

No	Control Item	Specification	Equipment	1	2	1	2	1	2	1	2	1	2
				13.30	13.30	14.30	14.30	15.30	15.30	16.30	16.30	17.30	17.30
1	Bar diameter	20.0±0.3 mm	Caliper	19.94	19.94	19.92	19.93	19.94	19.93	19.92	19.92	19.92	19.93
2	Hole diameter	12.5±0.25 mm	Caliper	12.72	12.72	***12.23***	***12.24***	***12.23***	12.74	12.72	12.74	12.74	12.73
3	Head outside diameter	30.0 mm MAX	Caliper	29.98	29.93	***30.3***	***30.2***	29.95	29.91	***30.3***	29.95	29.96	29.99
4	Head thickness	6.0±0.5 mm	Caliper	***6.70***	6.07	6.06	6.07	6.08	***6.70***	6.05	6.06	6.06	***6.80***
5	End-end length	1406.0±2.0 mm	Measuring table	1406	1406	1406	1406	1406	1406	1406	1406	1406	1406

No	Control Item	Specifications	Equipment	1	2	1	2	1	2	1	2	1	2
				08.30	08.30	09.30	09.30	10.30	10.30	11.30	11.30	12.30	12.30
1	Bar diameter	20.0±0.8 mm	Caliper	19.92	19.92	*19.66*	19.93	19.94	19.93	19.92	19.92	19.92	19.93
2	Hole diameter	12.5±0.25 mm	Caliper	12.72	12.75	12.74	12.73	12.74	*12.24*	*12.22*	*12.24*	*12.24*	*12.23*
3	Head outside diameter	30.0 mm MAX	Caliper	29.91	29.93	29.95	29.93	29.95	30.5	*30.5*	29.95	29.94	29.95
4	Head thickness	6.0±0.5 mm	Caliper	6.22	*6.70*	6.19	6..07	6.08	6.07	*6.60*	6.06	6.07	6.07
5	End-end length	1406.0±2.0 mm	Measuring table	*1408.5*	*1408.2*	*1408.1*	*1408.1*	***1406***	1406	1406	1406	1406	1406

Table 4.1: Forging Inspection Report

4.2.3 Analyse

The collected data must be analysed to know what the main problems of model SB 45 production are. For this case, Pareto Chart is the mostly suitable to analyse this kind of data. By using a Pareto diagram, the most risky problems among a (typically large) set of factors can be detected. In quality control, it represents the most common cause of defects, the highest occurring type of defect, or the most frequent reasons for customer complaints, and so on. From this Pareto chart, it can conclude that the hole diameter and the head thickness is the most frequent reasons for customer complaints.

Table 4.2: Analysis of the main problem in the forging process in one day

No	Problems	Frequency	Percent, %	Cumulative %
1	Hole diameter	8	35	35
2	Head thickness	5	22	57
3	Head outside diameter	5	21	78
4	End-end length	4	18	96
5	Bar diameter	1	4	100

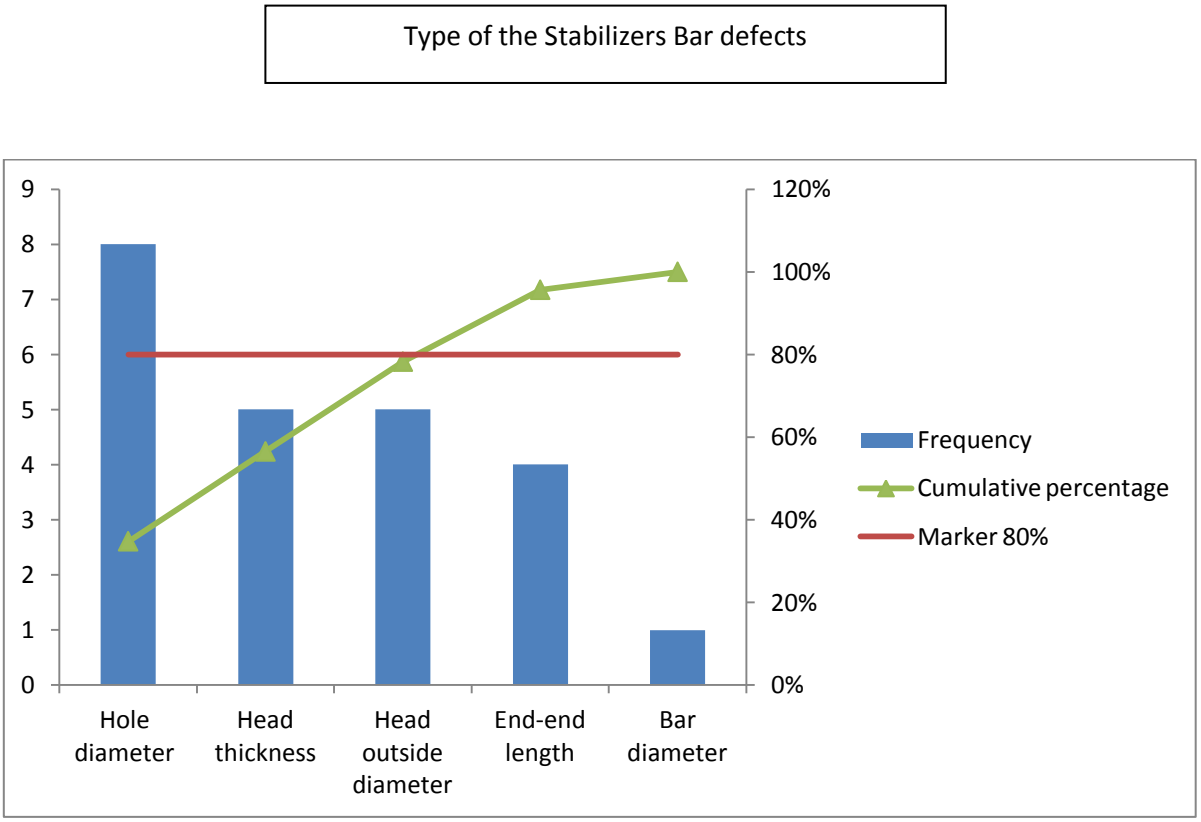


Figure 4.1: Pareto Chart

From the Pareto Chart in Figure 4.3, the three bar on the left are the problems that Company A company need to put more concern. These three problems are hole diameter, head thickness and head outside diameter. The highest percent of problems is hole diameter with 35 % of reject part. Then follow with head thickness problem with 22 % of rejections. For the head outside diameter the percent of rejections is 21%.Next is end-end length with 18 % of rejections and lastly is bar diameter problem with 4% of rejection

One of the method of improvement is cause and effect diagram. Cause and effect is the method which need a brainstorming between team members to identify potential factors causing an overall effect. The 5M's method is commonly used in manufacturing industry which means machine, methods, material man power and measurements. Diagram below shows the cause effect in Company A

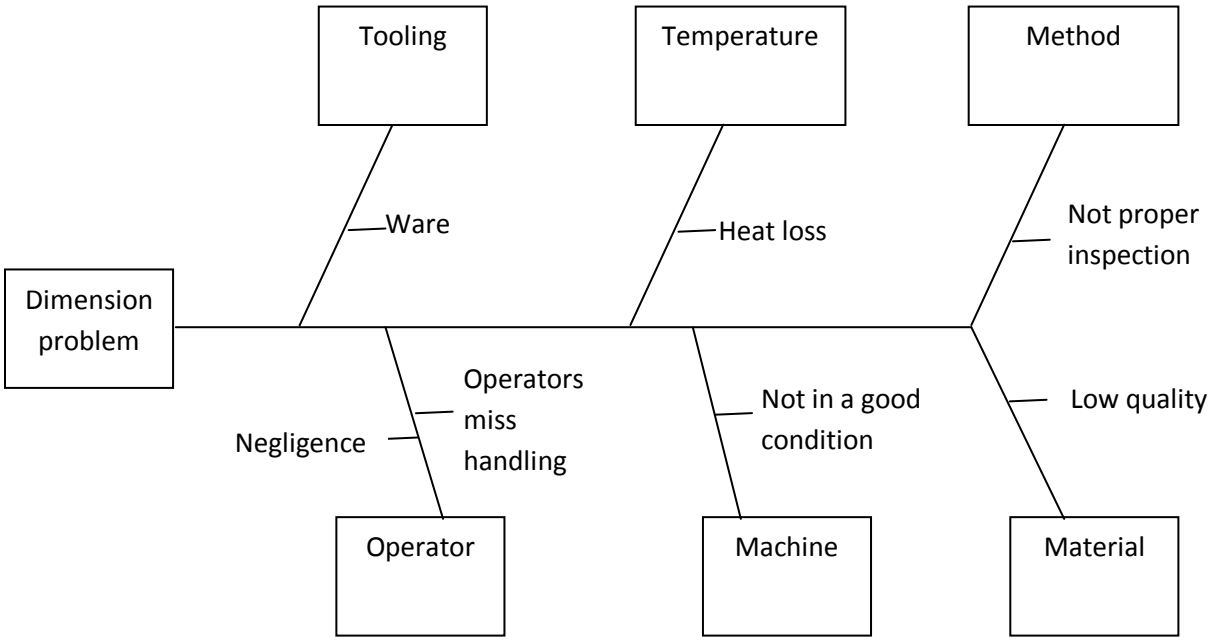


Figure 4.2: Ishikawa Diagram

From this Ishikawa diagram in Figure 4.4, all the factors that have been considered may be affected to the dimension problem. From the brainstorming, there have six causes that effect to the dimension problem. The first one is tooling, the tooling maybe have wear because of the tooling has exceed the life span. This may lead to the dimension problems. Other than that, the operator also in one of the factors that lead to dimension problem. The operator may be having some negligence during working. The factor of temperature is also one of the factors that lead to dimension problems. The stabiliser bars does not heated to optimum temperature so it lead to forging problems and lastly affect the dimension of the stabiliser bar. The forging machine not in a good condition can also contribute to the dimension problem. The machine does not stamp the stabiliser bar to the required thickness. The low quality of the material and wrong method to conduct the forging process also can contribute to dimension problem.

4.2.4 Improve

Improve is the step to identify, test and implement a solution to the problem. After the problem have been analysis and the root cause have been identified. The creative solutions need to be identifying to eliminate the key root causes in order to fix and prevent process problems. Ishikawa method is the best QC tools to identify the cause of the problems. From the Ishikawa diagram all the causes have been study and improved. From the study, the Sapura Company have listed the main problem that leads to dimension problem of the stabiliser bar. The main problem is the negligence of the workers and tooling has exceeded the life span. Company A has overcome those problems by asking the supervisor at forging department to supervise the operator that conduct the forging process and control the life span of the tooling. The result as shown below is the result before and after implementing Six Sigma methods to this company

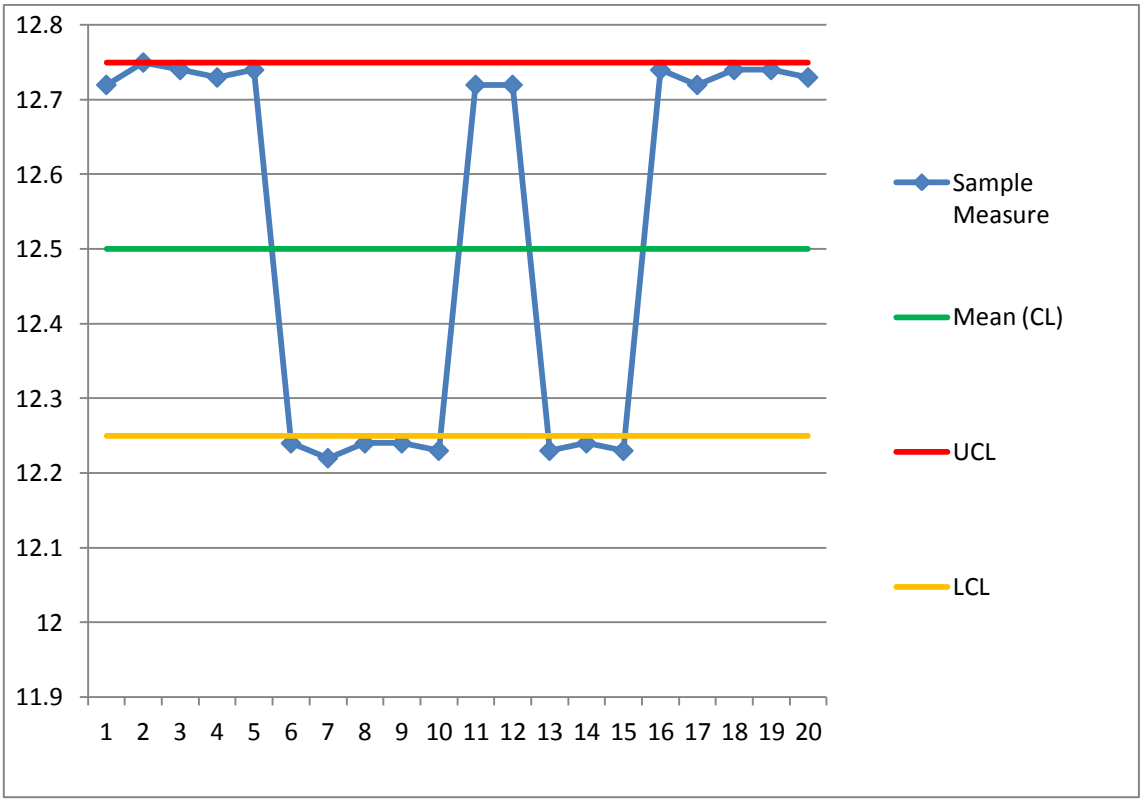


Figure 4.5: Hole diameter before implementing Six Sigma

For the hole diameter the specifications is 12.5±0.25 mm. Before implementing Six Sigma the number of rejects part for the hole diameter is 8 and there has a large variance. This result is not good for the production because the reject part is a lot.

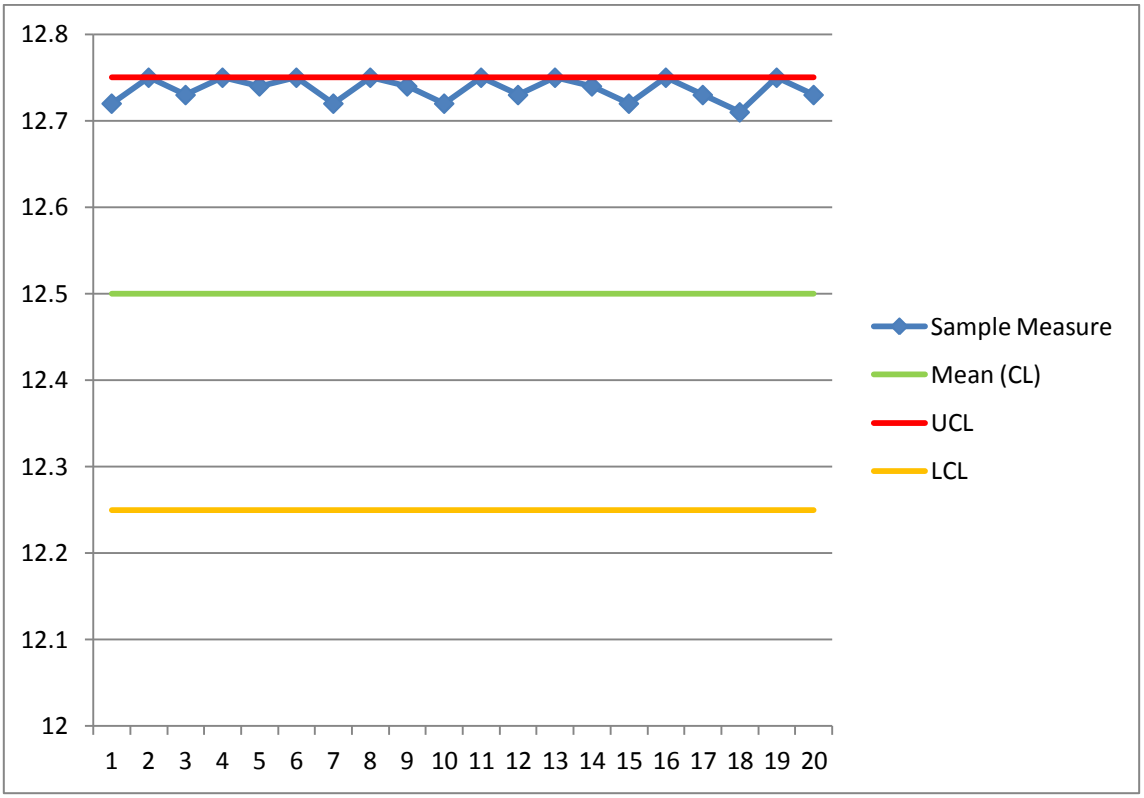


Figure 4.6: Hole diameter after implement Six Sigma

After implementing Six Sigma there has zero number of rejects parts and small variance for a hole diameter. This result is good for a production because there is no reject and reworks part

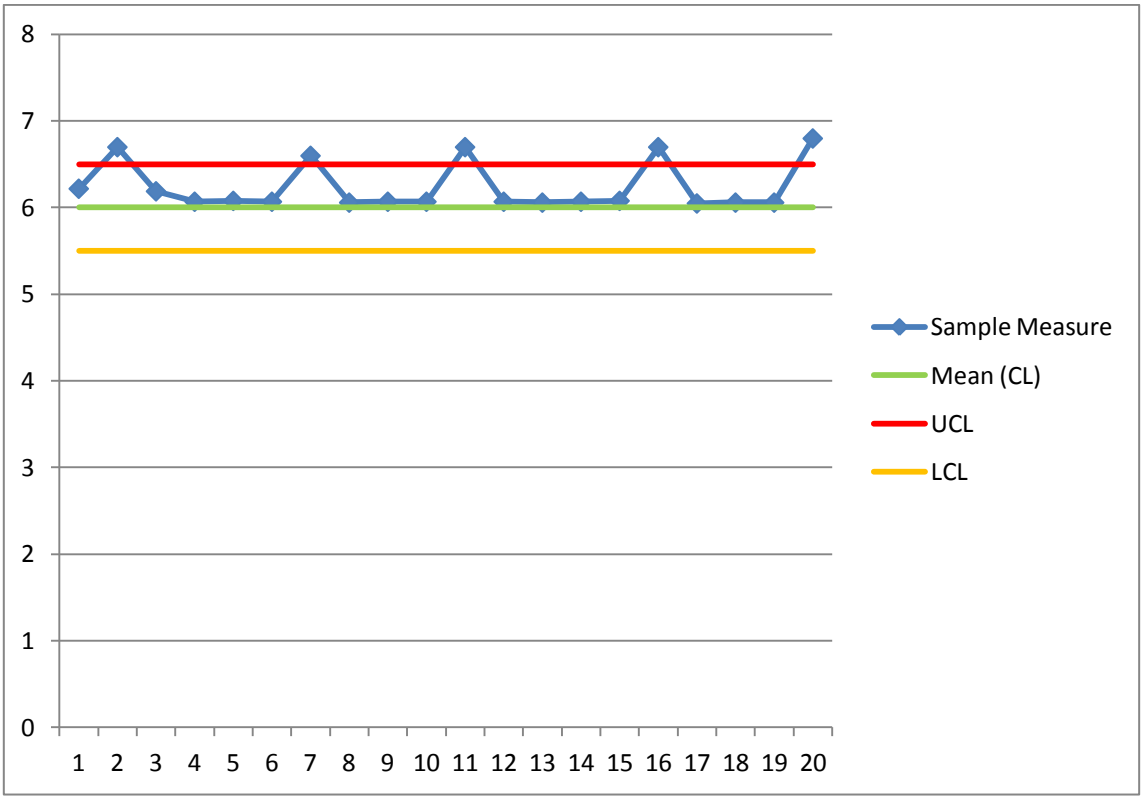


Figure 4.7: Head thickness before implement Six Sigma

For the head thickness the specifications is 6.0±0.5 mm Before implementing Six Sigma the number of rejects part for the head thickness is 5. This result is not good for the production because the reject part is a lot.

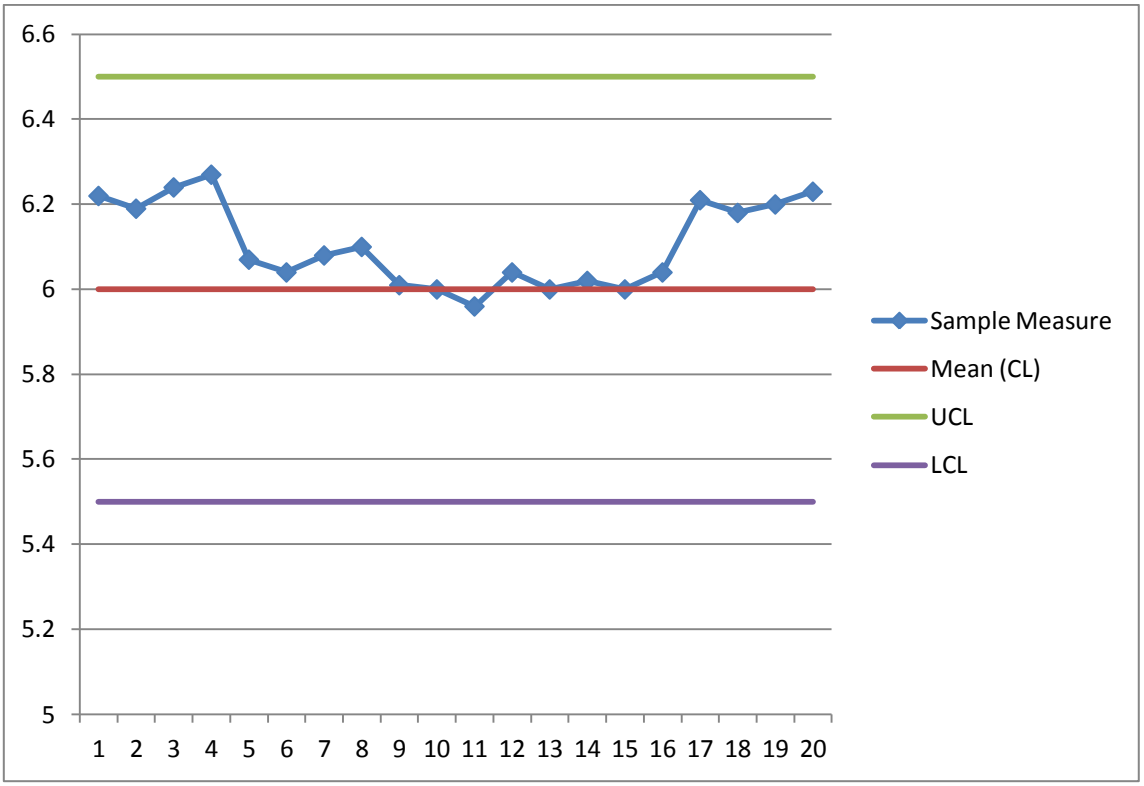


Figure 4.8 Head thickness after implement Six Sigma

After implementing Six Sigma there has zero number of rejects parts. All the sampling is under control which means that there is no sampling that out of specification. This result is good for a production because there is no reject and reworks part

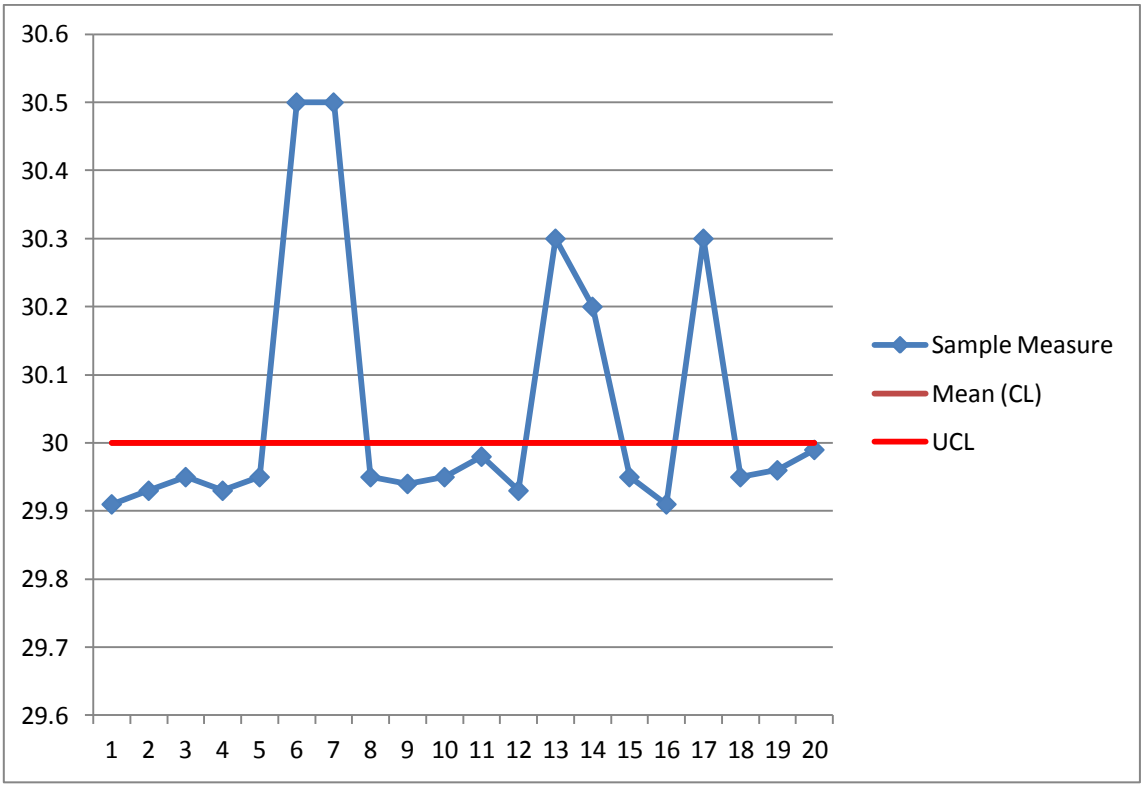


Figure 4.9: Head outside diameter before implement Six Sigma

For the head outside diameter the specifications is 30.0 mm MAX. Before implementing Six Sigma the number of rejects part for the head outside diameter is 5 and there has a large variance. This result is not good for the production because the reject part is a lot.

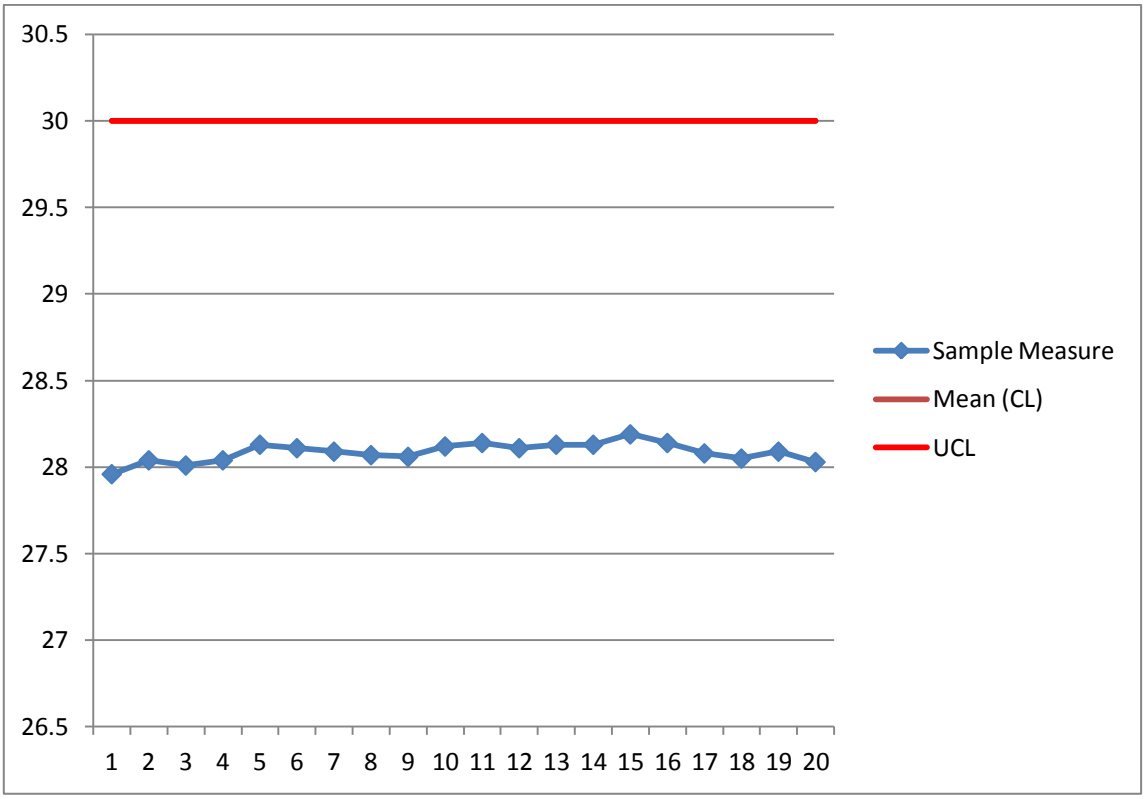


Figure 4.10: Head outside diameter after implement Six Sigma

After implementing Six Sigma there has zero number of rejects parts. All the sampling is under control which means that there is no sampling that out of specification. This result is good for a production because there is no reject and reworks part.

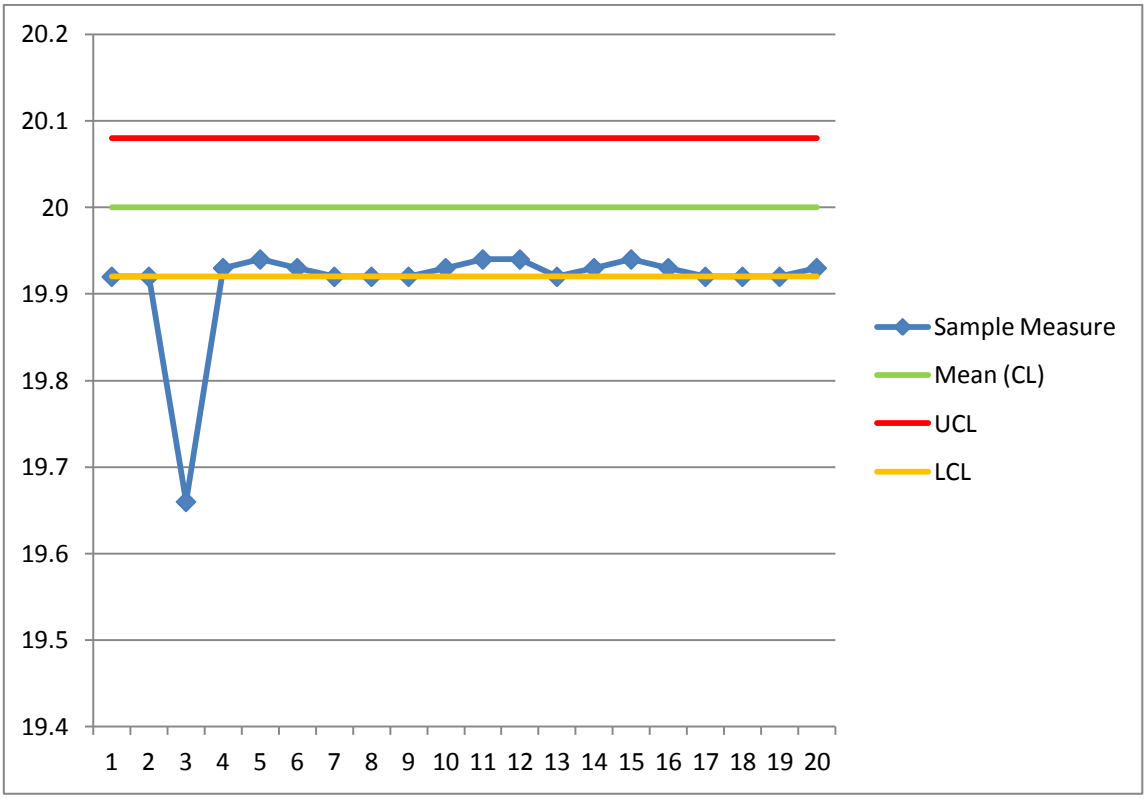


Figure 4.11: Bar diameter before implement Six Sigma

For the head outside diameter the specifications is 20.0±0.8 mm .Before implementing Six Sigma the number of rejects part for the bar diameter is 1.

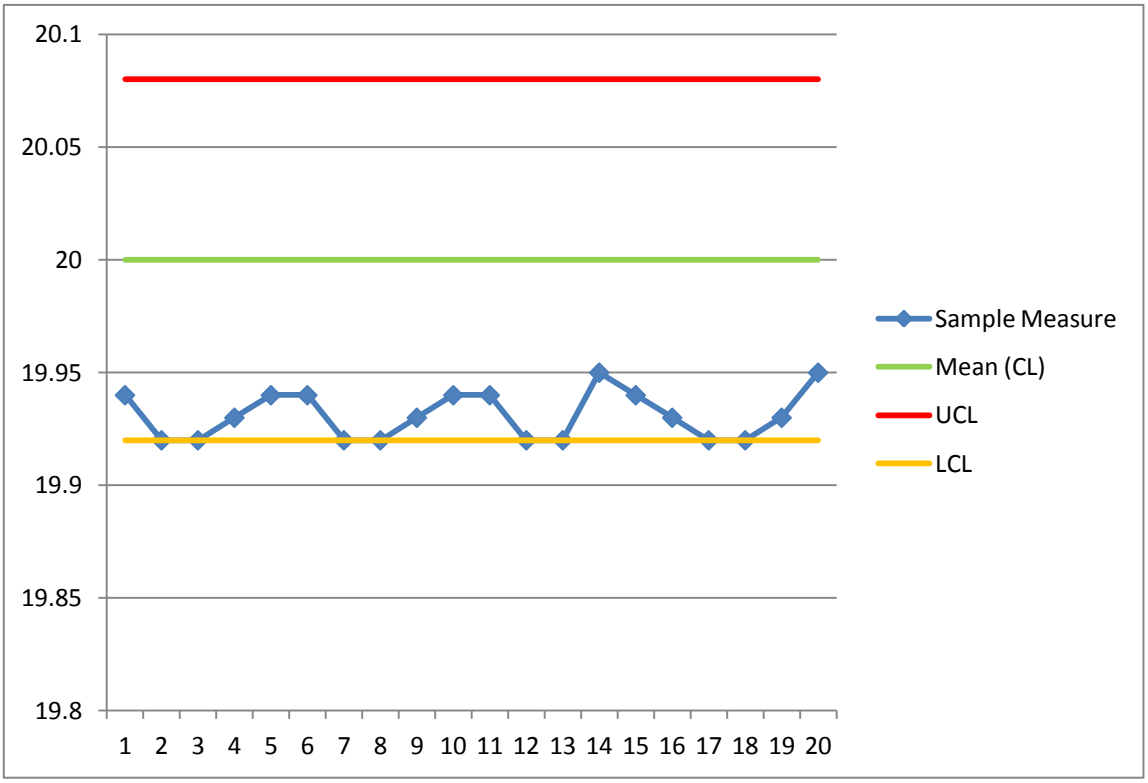


Figure 4.12: Bar diameter after implement Six Sigma

After implementing Six Sigma there has zero number of rejects parts. All the sampling is under control which means that there is no sampling that out of specification. This result is good for a production because there is no reject and reworks part.

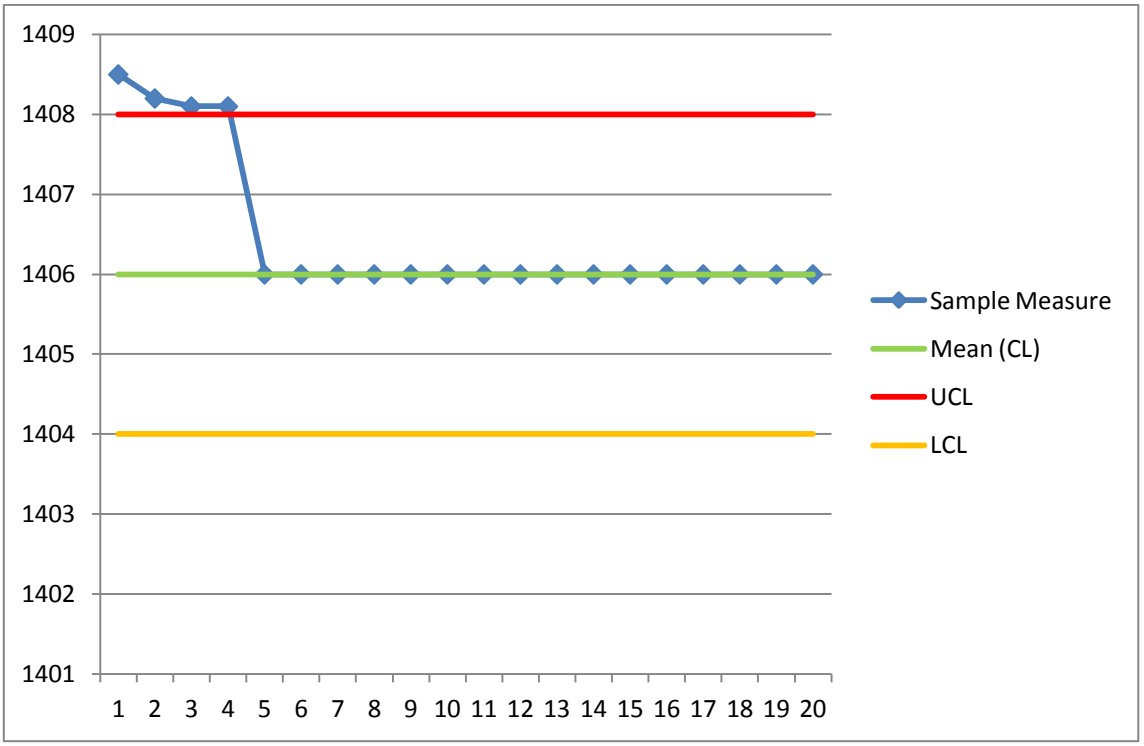


Figure 4.13: End-end length before implement Six Sigma

For the head outside diameter the specifications is 1406.0±2.0 mm. Before implementing Six Sigma the number of rejects part for the end-end length is 4. This result is not good for the production because the reject part is a lot.

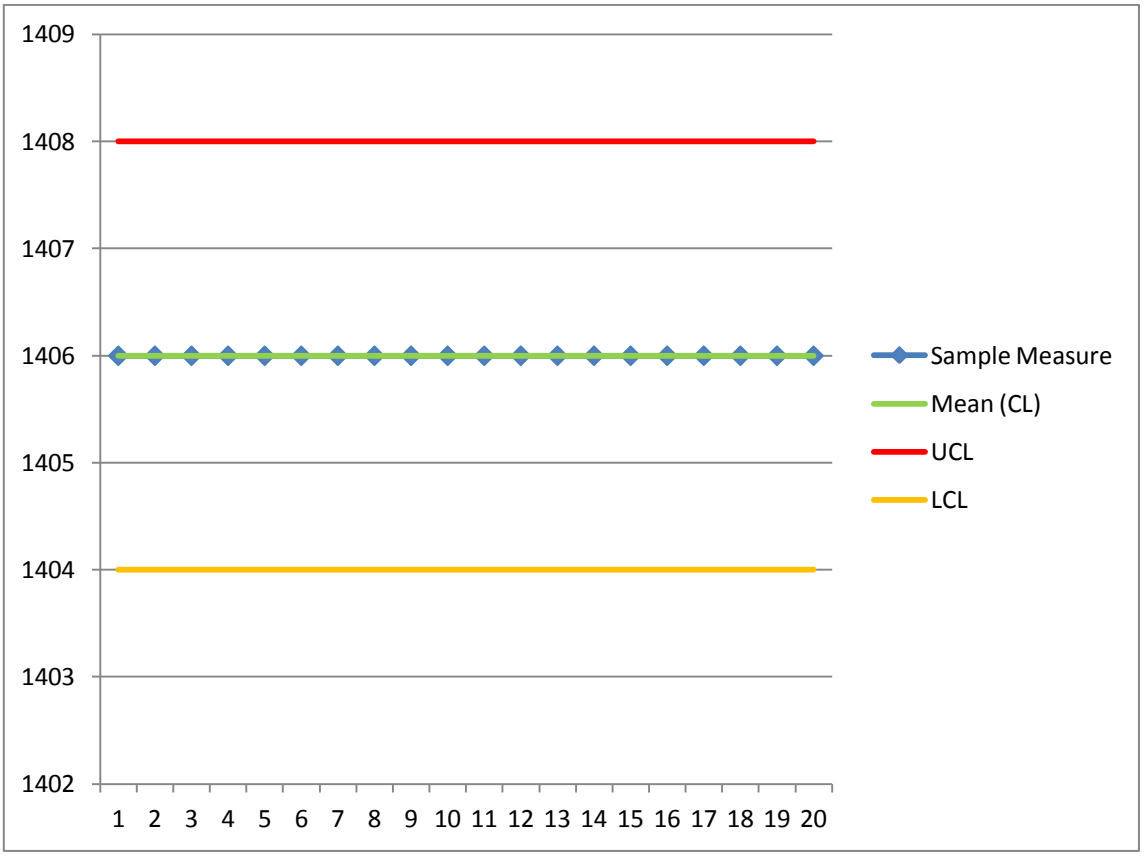


Figure 4.14: End-end length before implement Six Sigma

After implementing Six Sigma there has zero number of rejects parts and no variance for a end-end length. All the sampling is under control which means that there is no sampling that out of specification. This result is good for a production because there is no reject and reworks part.

4.2.5 Control

The new forging process is continuously improved to ensure that the quality of the product is under control. Other than that the first of approval technique (FOA) is implementing in that company. The purpose of FOA is to ensure that only a good product can be produce in that company. Lastly, the workers need to check the product hourly by take a sampling every hour to do a quality check so that the quality of the product can be control.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter will discuss about the conclusion of the project and suggested the way to improve the project through recommendations for future works

5.2 CONCLUSION

The objectives of this research had been accomplished by DMAIC Six Sigma method. The hole diameter, head thickness, head outside diameter, bar diameter and end-end length result have been improved from the previous data after applying Six Sigma method for this company. It can be concluded that 6 sigma techniques can improve the performance of the company in terms of quality of the products by using DMAIC methods.

5.2 RECOMMENDATIONS

This study have accomplished important contribution for the quality and production of the stabilizer bar of Company A .Nonetheless, there are some limitations which can be addressed for the future study as recommended below:

1. Investigation to combine Six Sigma with other quality management technique such as lean production.
2. Study to apply Six Sigma project for other products quality within the same company.

3. Investigations using other Six Sigma method like DMADV. D is for define, M is for measure, A is for analyze, D is for design and V is for verify.

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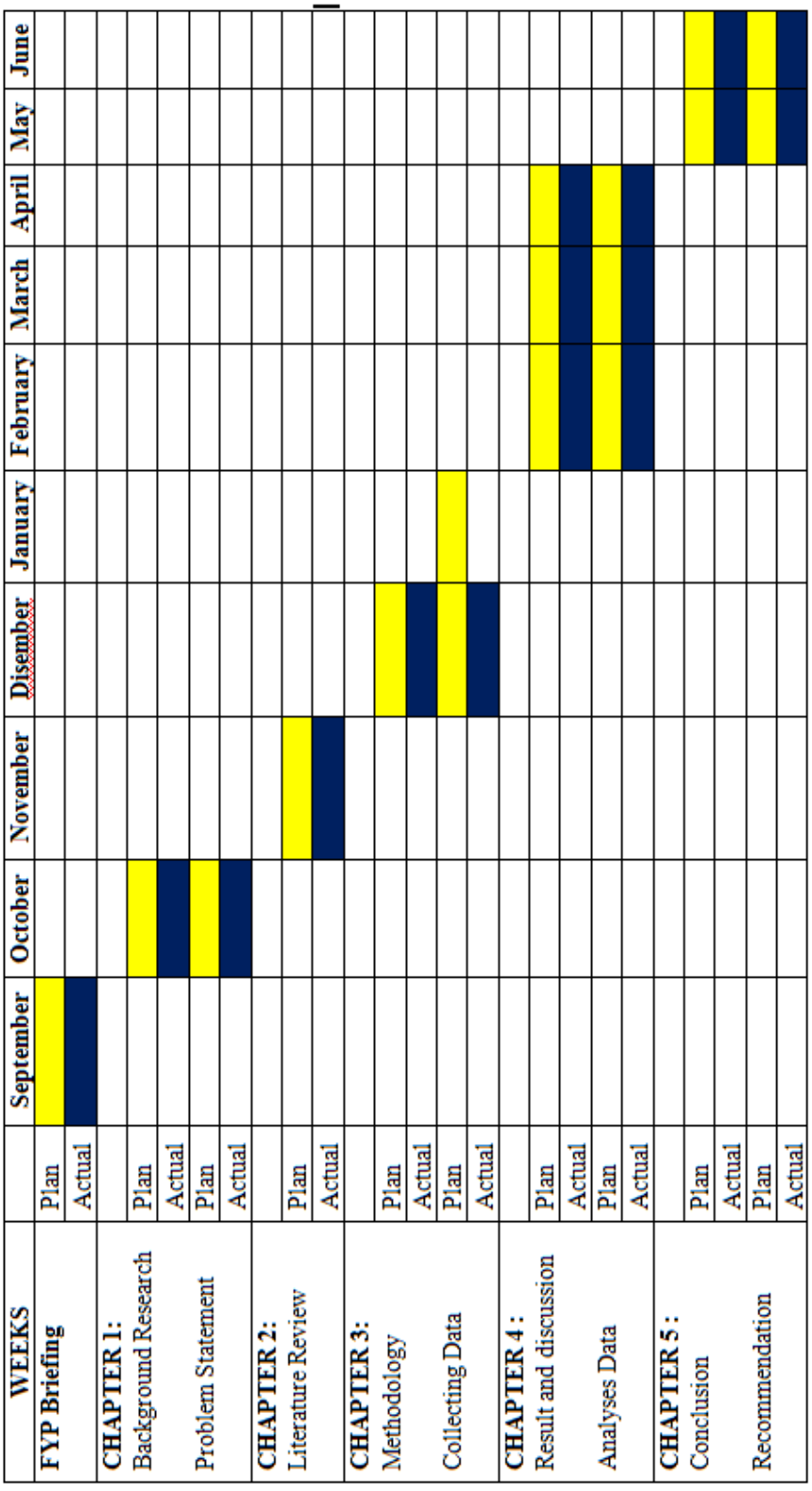
APPENDIX A


WEEKS
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FYP Briefing
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Result and discussion
Analyses Data
CHAPTER 5 :
Conclusion
Recommendation

APPENDIX B


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