



**Application of DMAIC Six Sigma in Manufacturing
Field: Case Study in Yield Improvement in Production**

by

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**APPLICATION OF DMAIC SIX SIGMA IN MANUFACTURING FIELD: CASE
STUDY IN YIELD IMPROVEMENT IN PRODUCTION**

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ACKNOWLEDGEMENT

A chapter in my life has finally been completed and stepping by to a new world, my final year project in line with UNIMAP's education design. It has been a long sail, a voyage that brought about priceless experiences in building and shaping me. All this was made possible by countless valuable contributions by many parties. I would like to take this opportunity to acknowledge the support and help of numerous people, without whom this project would not have been possible. Here I wish to extend my deepest appreciation to my primary supervisor Assoc Prof Dr. Muhammad Shahar Jusoh for his invaluable guidance and support throughout this Final Year Project execution. His encouragement and constructive comments were very helpful for me to complete this project. His endless guidance and assistance have given me the strength to complete this Final Year Project. I also would like to thank people that involved in completing my Final Year Project, for their idea and thought. Thank you so much Dr. Wan Munirah Ariffin as my secondary supervisor. Last but not least, to my beloved family. Thank you so much for your support, courage, blessings, and always being by my side in my ups and downs. I appreciate it.

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TABLE OF CONTENTS

	PAGE
DECLARATION OF THESIS	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	vii
LIST OF ABBREVIATIONS	viii
LIST OF SYMBOLS	viii
ABSTRAK	ix
ABSTRACT	xi
CHAPTER 1 : INTRODUCTION	1
1.1 Background of Study	1
1.2 Problem Statement	3
1.3 Research Questions	8
1.4 Research Objectives	8
1.5 Significance of the Study	9
CHAPTER 2 : LITERATURE REVIEW	10
2.1 Introduction	10
2.2 Six Sigma Quality Model	10
2.3 Taguchi Method Analysis	11
2.4 Lean Six Sigma Optimization Strategy for Sustaining Model	12

2.5	Six Sigma Model Research Synopsis in Operational Management	12
2.6	Parameter of the study	15
2.6.1	Theoretical Implications	15
2.6.2	Practical Implications	16
2.6.3	Theoretical Implications	17
2.7	Summary	17
CHAPTER 3 : METHODODOLOGY		19
3.1	Introduction	19
3.2	Research Methodology	19
3.3	Methodology of Research	21
3.4	Research Design	21
3.5	Analysis Of Variance (ANOVA)	23
3.6	Implemented of Taguchi method	23
3.7	Selection Orthogonal Array (OA)	25
CHAPTER 4 : RESULTS & DISCUSSION		27
4.1	Introduction	27
4.2	Data Collection	28
4.3	Data Analysis	29
4.4	Analysis Of Variance (ANOVA)	31
4.5	Selection of Optimum Level	33
4.6	Confirmation Experiment	35
CHAPTER 5 : CONCLUSION		37
5.1	Conclusion	37
5.2	Limitation of Research	38
5.3	Future Reference	93
REFERENCES		40

LIST OF TABLES

	PAGE
Table 1.1 Pre Six Sigma Data	5
Table 3.1 The process of parameters factor and ratio levels	24
Table 3.2 Orthogonal array	25
Table 4.1 Combine the value of the process parameter and result	28
Table 4.2 Research proposed optimum parameter	34

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LIST OF FIGURES

	PAGE
Figure 1.1 Pareto Chart Defect (Pre Six Sigma)	5
Figure 1.2 Pie Chart Defect (Pre Six Sigma)	6
Figure 1.3 Time Series Plot of Yield Loss (Pre Six Sigma)	7
Figure 3.1 Methodology	20
Figure 3.2 Minitab Design Table Randomize	24
Figure 3.3 Minitab Design Table Summary	25
Figure 4.1 Main Effect Plot for Flux	29
Figure 4.2 Interaction Plot for Flux	30
Figure 4.3 Cube Plot	31
Figure 4.4 Interaction Plot	32
Figure 4.5 Pie Chart Defect (Post Six Sigma)	35
Figure 4.6 Pareto Chart Defect (Post Six Sigma)	36
Figure 4.7 Yield losses 24 WW Data (Pre and post-Lean Six Sigma)	36

LIST OF ABBREVIATIONS

S/N	Signal-to-noise
FYP	First Pass Yield
DMAIC	Define-Measure-Analyze-Improve-Control
PC	Private Computer
VA	Value Add
NVA	Non-Value-Add
LSS	Lean Six Sigma
SSM	Six Sigma modeling
VSM	Value-Stream Mapping
KPI	Key Performance Index
ANOVA	Analysis of Variance
DOE	Design of Experiment
CTQ	Critical to Quality
L8	Leg 8
CONC	Cost of Nonconformance
COPQ	Cost of Poor Quality
IV	Independent Variable
DV	Dependent Variable

LIST OF SYMBOLS

Tiox	Titanium Dioxide
X	Mean
°C	Degree Celsius
mg	Milligram

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Aplikasi Enam Sigma DMAIC dalam Bidang Pembuatan: Kajian Kes bagi Peningkatan Hasil Pengeluaran

ABSTRAK

Penyelidikan ini adalah bertujuan untuk menangani peningkatan hasil pas pertama di lantai pengeluaran ABC Semikonduktor. ABC adalah sebuah syarikat yang menghasilkan produk kompleks daripada pelbagai variasi sejajar dalam industri memori dalam operasi. Hasil pas pertama merujuk kepada perkadaran produk yang dibina sepenuhnya yang lulus ujian tanpa memerlukan kerja semula tambahan. Projek hasil lulus pertama (FPY) bermula pada tahun 2015 dan menunjukkan kemajuan yang mantap untuk lima tahun pertama. Tetapi dalam tempoh satu tahun berikutnya, hasil utama yang pertama kali lulus hasil kekal dalam dalam status yang sama. Matlamat kertas kerja yang dibentangkan di sini adalah untuk menganalisis sebab-sebab prestasi semasa dan mencadangkan cara baru untuk meningkatkan metrik sekali lagi menggunakan alat pengurusan kualiti untuk menaibakkan hasila dalam pas pertama. Satu cadangan peningkatan kualiti utama dibentangkan dalam penyelidikan ini yang paling biasa adalah menggunakan kaedah alat 7QC dengan mengkategorikan rejek kategori yang akan membawa kepada tindakan pembetulan yang disasarkan untuk mengurangkan berulangnya mod kegagalan yang telah dikenal pasti. Metodologi DMAIC ditubuhkan mengenai cara menentukan tindakan pembetulan yang cekap, bersama-sama dengan tiga kecacatan utama pada data yang diperolehi dari organisasi ABC.

Application Of DMAIC Six Sigma In Manufacturing Field: Case Study In Yield Improvement In Production

ABSTRACT

This research here addresses the improvement of first pass yield on the production floor of ABC Semiconductor. ABC is a company running a multiple volume complex product in alignment with the memory business in the operation. First pass yield refers to the proportion of fully built products that pass testing without the need for additional rework. The first pass yield (FPY) project began in 2015 and showed steady progression for its first five years. But over the following years, the primary yield metric which is first passed yield has stayed stagnant. The goal of the paper presented here is to analyze the reasons for the current performance and propose novel ways of improving the metric again using quality management tools. In this research, multiple quality tools have been demonstrated to enable the quality improvement recommendation which is classified as the statistical and systemic approach is being presented. The most common is using the 7QC tools method by categorizing failure pareto that will lead to targeted corrective action to reduce the recurrence of pre-identified failure modes. A DMAIC methodology is established on how to define an efficient corrective action, along with a top-three major defect on data acquired from the ABC organization.

CHAPTER 1 : INTRODUCTION

1.1 Background of Study

ABC Semiconductor's experts in their field research and produce storage devise and memory technologies that are applied in a range of appliances including private computers (PCs), networks, data centers, and the automotive industry. The firm manufactures memory cards, SSDs, and infrastructure technology under its several global brands, including ABC semiconductor. ABC, being the world's leading semiconductor business in the storage and memory market, confronts stiff competition from companies like Seagate Technology (STX), Intel Corp. (INTC), Sandisk, Western Digital (WDC), and other chipmakers like Taiwan Semiconductor Manufacturing Company (TSM).

Around COVID-19, a substantial change has been identified for self-storage enterprises. Customers are sheltering in place, and online stores are being modified in the new era of the world, so the operation has less onsite traffic. As a result, their working methods and strategy were devised. According to a study, IoT, 5G, and automation will be used in every aspect of life, including personal, work, health care, autonomy, and big data. In line with this, the ABC board of directors has directed all departments to pursue cost-cutting initiatives as much as possible during this pandemic. In reality, the entire top-level executive team is focused on cost competitiveness not just in the semiconductor business, but also in other industries such as medical, manufacturing, automotive, agriculture, and oil and gas.

Though, at the ABC manufacturing department, it has been a strategic approach to have a project to ensure that production yield improvement is tackled appropriately using the DMAIC technique in a Six Sigma manner.

Motorola introduces Six Sigma to businesses in 1980. Currently the most widely used operational method. The goal of Six Sigma is to increase process quality by discovering and eliminating problems. The aim is to raise the degree of execution into performance so that it reflects the needs of the customers. Less than 3.4 DPPM is required to achieve a Six Sigma level. As a result, Six Sigma is viewed as a problem-solving strategy that employs tools to enhance processes. Six Sigma is a statistical strategy for minimizing faults to boost profitability. The "DMAIC" logic and approach is the foundation logic and methodology, which contains multiple phases starting with Define. Secondly continued with Measure, next phases is Analyze and subsequently will be Improve, and final phases are Control. Six Sigma offers several tools for a reduction in rejects and improving the quality of the product and process.

The statistical approach is used in the Six Sigma approach to compile, assess and analyze the data in the order form to follow steps forward. Six Sigma delivers not value-added features to customer-defined scope but simultaneously comes with the high-quality, but the cost-effective solution as beside a never-ending stream of attempts to eliminate waste and non-value-added tasks, as well as continuous improvement. Following Motorola, Toyota, Nokia, Ford Motor Company, Dell, and Densi utilized the same methodology.

Six Sigma systems increase customer happiness, quality, process speed, product and process knowledge. According to the Six Sigma principle, faults can be avoided through minimizing variances such as customer needs, operating expenses, and profitability.

It's also a technique for identifying problems. Six Sigma provides tools for defining processes and conducting statistical analyses. It raises quality and reduces faults. Six Sigma is a corporate approach for decreasing defects and reducing process variability.

Management engagement, dedication, improvement tracking, checking, coaching, collaboration, and project selection align with business needs are all important aspects of Six Sigma projects. With the help of Six Sigma, the cost of nonconformance, instrument expenses, labor fees, production queuing time, index price, capacity, manufacture time, control duration, incoming material supply, and internal wastes were decreased, resulting in improved annual benefits.

Finally, Motorola designed and deployed Six Sigma to attain production perfection and maintain a competitive advantage. To handle production process problems, Six Sigma employs statistical methodologies such as Business Process Engineering, Kaizen, DMAIC, Value Stream Mapping, Jidoka, and others. Six Sigma is a zero-defect methodology. To begin with, Six Sigma strives to identify and prevent problems. It also assists in lowering operating costs and increasing customer satisfaction by eliminating defects, which is linked to company strategy. Six Sigma decreases expenses by focusing on customer needs, waste prevention, cost savings, and cycle time reduction.

1.2 Problem Statement

In the current world in cooperate with rapidly changing market, industries must be competent to change to numerous stages of operation. In some semiconductors, various statistical approaches, and Lean principles (Taghizadegan, 2010) are used regularly. Lean and Six Sigma are two complementary (Setijono & Dahlgaard, 2007) approaches that are widely used across sectors. Six Sigma concentrates on reducing defects (Srinivasan, 2014) besides tackling causes of unpredictability, whereas Lean focuses on value-add (VA) in the process and eliminating non-value-add (NVA) from the manufacturing

process. Lean Six Sigma (LSS) is an integration of two concepts, and it is defined by using a quantitative method to uncover the root of problems and implementing well-thought-out and proven innovations. LSS tools have been used by many industries, and their application is beneficial.

The Lean Six Sigma (LSS) framework and technologies enable firms to gain an extensive interpretation of value-add and achieve a reasonable operational combination with minimal expenses and unpredictability. Even though the Lean Six Sigma (LSS) framework can help enhance many aspects of production, they rarely offer a methodical method that allows the operation to expand in a consistent and consistent performance over time.

On the other hand, requires a more precise methodology to hold out each assignment, while the Lean Six Sigma concept gives a comprehensive framework which is illustrated into multiple segment phases as Define-Measure-Analyze-Improve-Control sequence (DMAIC). The entire LSS framework concentrates on process improvement strategies. Lean Six Sigma (LSS) is thriving across many industries between a variety of domains, including manufacturing, engineering, operational, information technology, supply chain management, automotive industry medical devices, and healthcare services, according to research.

Additionally, this research examines various businesses that rely heavily on customization and production lines, as well as vast sets of items with multiple varieties. The ability to adapt to the needs of the consumer is frequently a healthier benefit in the industry. Those semiconductor and field industries are tough to computerize as automation since the requirement is only a few simple acts and continual labor necessity. Workstation design becomes critical in these situations, as most of the waste is caused by worker movement or material flow. A case study for an organization that makes a side

coating process will be presented in this study. The company had a rising demand and needed to boost unit production but faced high yield losses in the side coating process.

To get around the yield losses the manager realized that some parameters of the process should be studied from the primary line. The company's managers chose to restudy the production line by unifying and enhancing the side coat process by identifying major influencing factors in the side coat process by using the DMAIC approach.

Table 1.1 Pre-Six Sigma Data

Defect	No of Sample	%
Contamination	9	0.43%
Overflow	45	2.17%
Insufficient	206	9.94%
Under cure	93	4.49%
Pass Unit	1719	82.96%
Total	2072	100%

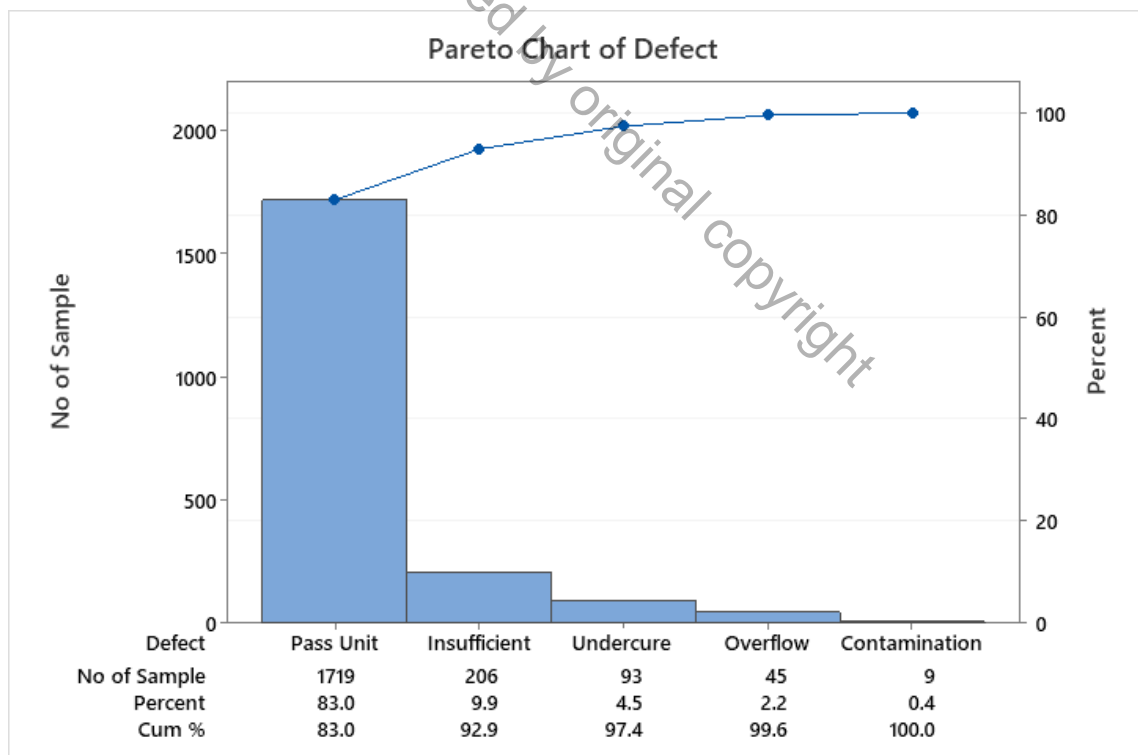


Figure.1.1 Pareto Chart Defect (Pre six sigma)

The calculation methodology outlines the pre six sigma result which has Table 1.1 pre six sigma data. The data drive for a total of 17.04% losses in the production output which has been categorized as a reject in form of contamination, overflow, insufficient, under cure whereby good unit categorizes as pass unit. The table consists of a unit of measurement of sample size and translates into percentages.

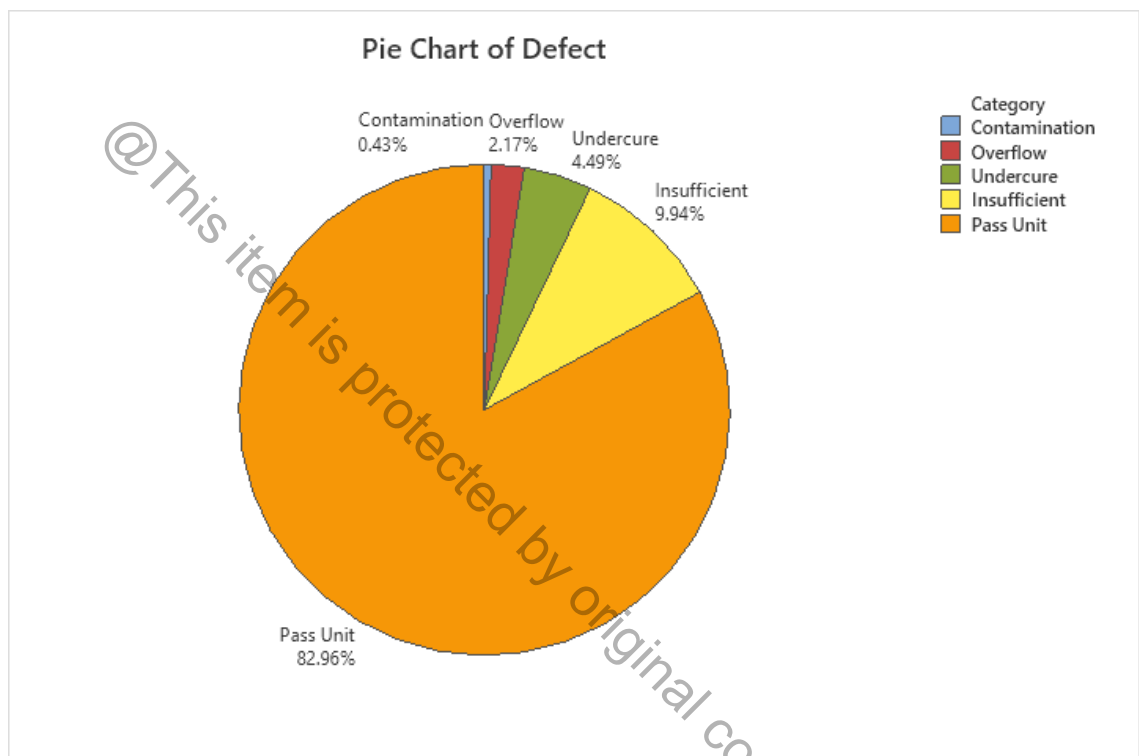


Figure.1.2 Pie Chart Defect (Pre six sigma)

The data has been analyzed into seven QC tools in form of a bar chart and pie chart to visualize the impact on the performance and translate into percentage measurement. Having these quality management tools (7 QC), enables the six sigma project team members to understand the independent variable of the study and the factors that influence each independent variable.

The past study provides essential technical data on the synthetic and mechanical characteristics of raw materials, the data, and technology stored for these data sheets are

generally not standardized and may need to be relevant for modern applications. This research study are focusing on reducing defects on the product by using the Taguchi method to help in reducing evaluation time and increasing production capacity.

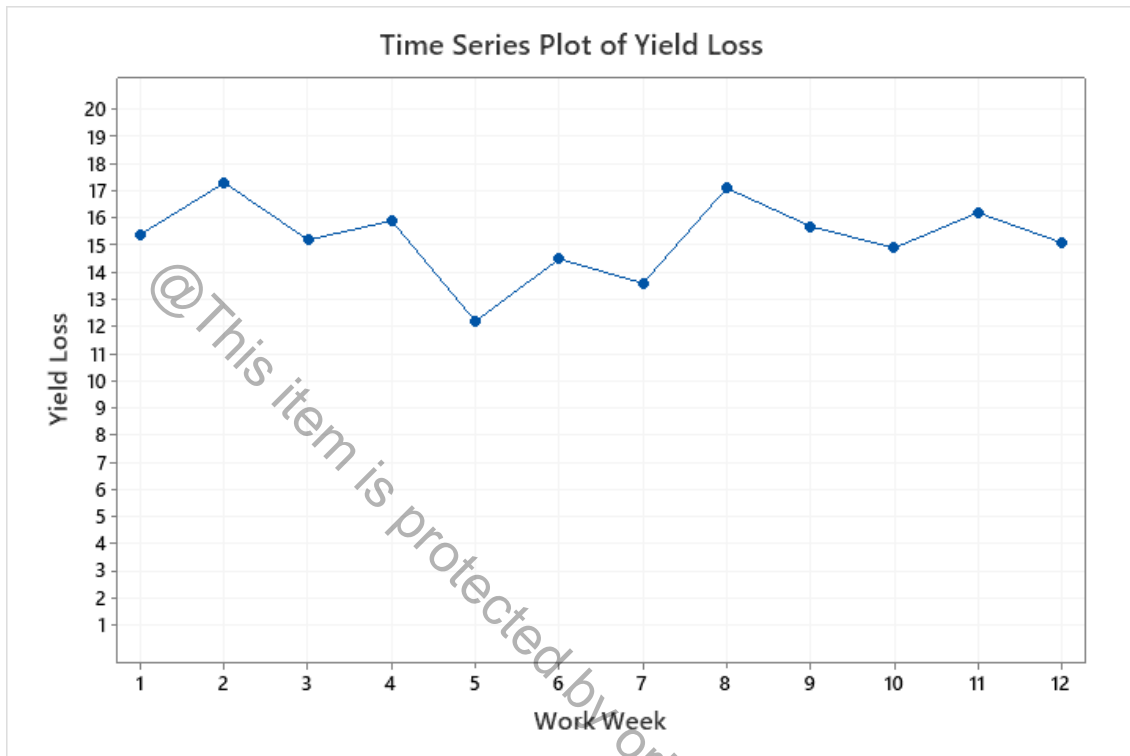


Figure.1.3 Time Series Plot of Yield Loss (Pre six sigma)

This Taguchi method is also a systemic approach which will be a complement of Lean and Six Sigma which is focusing on increasing the yield and at the same time reducing the defect which is classified as reject losses.

Based on the panacea mentioned above, this study focus on the methodological gap in the process of yield losses which is resulted in flux reduction. Based on the industrial report, this research adds the measurement gap which is used in Taguchi with all the three parameters mentioned in the research.

1.3 Research Questions

From the analysis the RQ which classifies as the research question segment enables the study to be presented by producing the process with a high yield output by reducing the number of defects or losses from the identified process. Hence, the selected control factor is controlled variance which impacts in reducing the number of defects. The volume of Tiox, plasma, and staging temperature is considered as control factors to achieve a low number of the defect. Below is a list of research questions for this study:

What is the optimum value process parameter control factor for Volume of Tiox, plasma, and staging temperature to enable production efficiency to reach higher yield?

1.4 Research Objectives

This research will deploy on Quality Tools from Six Sigma to construct a framework approach to ensure the issue of defect or classified as yield losses at the process at Company ABC will be solved. Therefore, the purposes of this research are revealed as below:

Identify the optimum parameter value based on all three factors mentioned in the above research study

1.5 Significance of the Study

Current work has centered on considering and identifying a generally new method that is low cost and can contribute to company profit in production. The reason for this research project is to show that the Taguchi approach can be used to classify which control factors are suitable for reducing the defect which causes the loss in terms of material, monetary, and yield. Through this project, effective ways of optimization control factors and leveled to the high-quality product which will increase the productivity. The control behavior strength and selected suitable parameter will be standard for performing any non-conformance in the yield losses.

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CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

The current economic crisis has increased the demand for profitable solutions that help businesses acquire a competitive edge. As a result, an increasing number of businesses are looking for management approaches that will enable them to improve their product and service qualities, perfect their processes, reduce costs, increase capital profitability, and increase customer happiness. This has been endeavored through Six Sigma incorporated methods in respective operational and manufacturing activities, in which Six Sigma efforts applied in process controlling the process in sustainability mode and reduction in the variability while engaging statistical tools in parallel.

2.2 Six Sigma Quality Model

The DMAIC approach is applied to enable a Six Sigma project embarking on the improvement model proposed in this article (started with define phase, continued with measure phase, subsequently move to analyze phase, improve on the next and finally control phase in the last). Continuous improvement project framework nature is identifying the variable and correspond with the processes from time to time as part of the process, and technology enhancement involved. . The proposed prototype also permitted for a systemic statistical approach guideline in techniques and solutions that needed to be carried with the aim of to sustain the organization's project management procedures in the long run.

2.3 Taguchi Method Analysis

Dr. Genichi Taguchi's "Taguchi Method" is an approach intended for discovering the best mixtures of process ecosystems which extensively treated in technical engineering evaluation and manufacturing. The Taguchi method is an extremely effective approach for creating and enhancing high-quality systems. The Taguchi technique is a well-established method for process optimization that provides a disciplined and economical methodology. It's been commonly applied not limited to product design RnD and engineering in process improvement all around the world.

The Taguchi approach allows enterprises to drastically cut the time it takes to produce a product while keeping costs down. The processes for Taguchi techniques are given to help us understand better the framework. There are three types of Taguchi robust methods: system design, parameter design, and tolerance design. One of the most crucial design classifications is parameter design, which tries to determine the best mixtures process circumstances for increasing performance attributes. Furthermore, the Taguchi technique employs two key methods in the boundary layout which involve signal-to-noise orthogonal arrays (Menten,2012)

To analyze the major influencing factor without undertaking any substantial amount of assessments, the Taguchi technique advises utilizing a particular design of orthogonal arrays. The Taguchi approach incorporates orthogonal arrays and in the form of signal-to-noise ratio as well. The experimental data are conveyed by Taguchi technique by the use of signal-to-noise ratio in the. Through ANOVA analysis, the signal-to-noise proportion is applied to quantify quality traits as well as relevant process conditions. The signal-to-noise proportion can be categorized into three different categories, firstly categorized as lesser is better, continued by greater is better, and best will be the nominal portion. The final step is to conduct the experiments to determine whether or not they

were successful. The Taguchi robust approach is explored in length in the following sections.

2.4 Lean Six Sigma Optimization Strategy for Sustaining Model

The effectiveness of industrial system maintenance is a crucial economic concern for their company. The biggest challenges and causes of inefficiency are found in the selection of actions, especially when the equipment plays a critical role in the manufacturing process.

Our contribution to this project focuses on using Lean Six Sigma to optimize industrial systems. Lean Six Sigma is an operational style that is centered on a very well-organized organization committed to project management. It is a technique of enhancing quality and profitability based on mastering statically of processes. The approach is built on five main steps, which are abbreviated as (DMAIC): Measure, analyses, improve, and control are the four steps of defining, measuring, analyzing, improving, and controlling. The method's use on maintenance processes along with the use of maintenance methods during the method's five stages will improve costs reduction and defect losses to ensure the best outcomes in positions of profitability, sustainability, and quality goods.

2.5 Six Sigma Model Research Synopsis in Operational Management

As stated by Youssouf et al., (2014) this research contribute to enable this project focuses on using Lean Six Sigma to optimize maintenance for industrial systems. Lean Six Sigma is an operational fashion that is concentrated on a very well-organized organization committed to project or program management. It is a technique of enhancing

quality, reliability, and profitability based on understanding the statically of processes involved. The method is based on the LLS phase involved from DMAIC, which is classifieds as Define, Measure, Analyze, Improve, and Control in the last phase.

In medical industry cited by Ratnaningtyas and Surendro (2013) the majority of hospitals have already implemented a Hospital Information System to aid in the management of data flow. The quality value of healthcare would improve as information quality improved, supporting patient happiness. Six Sigma is a technique for improving data quality. Six Sigma can be operated in healthcare to reduce information variance, particularly information used in hospital information systems.

The study concentrates on the application of Six Sigma to elevate the learning and the incorporation of QMS quality management systems which is a solid framework in the ISO 9000 standard, for the benefit of university academics in the growth and development. In the development and success of a higher education institution, a synergetic approach formed by studying and simultaneously implementing the benefits of Six Sigma and ISO 9000 plays an essential role. This is supported by study in Petruta and Roxana (2014).

According to Rohini and Mallikarjun (2011) the report delves into each stage in-depth, explains the instruments needed, and highlights the obstacles to improvement efforts' success. The article establishes a comprehensive model of DMAIC that may be applied as a guideline to help hospitals improve their Operation Theatre Process. Other programs such as ISO, JACHO, TQM, NABH, and others complement Six Sigma. The

report suggests several OT-related solutions for policy formulation, consultants and support employees, engineers, and IT services.

Mili (2014) in the article looks into how to straddle carriers are routed in port container terminals. This challenge is solved in the context of transportation operations optimization. The work's contribution to the problem is the formulation and subsequent development of a Six Sigma Approach solution. In practice, however, generating and prioritizing the key Six Sigma transportation plans is a major difficulty.

As defined by Lighter (2014) this research report proposes a strategy for enhancing patient care, lowering expenses, and ensuring long-term viability. Besides that the research also elaborates an approach for all the critical indicators in the framework of Lean Six Sigma in enriching high the quality and reliability approach and method.

The team discovered that this problem was primarily produced by side flat as its dominating fault type because of running up the curing duration by not including concurrently rising the temperature using Six Sigma methods. To address this issue, the team suggests that the corporation boost its temperature to 350°C using DOE (Design of Experiment) if it needs to reduce the curing period from 5 to 4 hours. As a result, the quality figure increased, with a lower sigma level of 5.02 and a higher DPMO level of 180. This outcome may not be noteworthy because there were numerous other types of defects discovered in the product that should be followed upon by the company's continuous improvement program. This is well established in the research study by Christyanti (2012).

Mehrabi (2012) has established clearly goal of this article is to look at the evolution, benefits, and problems of Six Sigma methods, as well as to identify the major aspects that influence successful Six Sigma project implementation. The article also addresses future improvements to the methodology used to manage Six Sigma projects, as well as lessons learned as all the effective Six Sigma designs and their possible applicability in overseeing conventional projects.

2.6 Parameter of the study

2.6.1 Tiox

The The most common white pigment used in the coatings business is titanium dioxide (TiO₂). It is frequently utilized because when included in a coating, it efficiently scatters visible light, imparting whiteness, brightness, and opacity. Anatase and rutile are the two crystal forms of titanium dioxide that are commercially available. Rutile TiO₂ pigments are chosen over anatase pigments because they scatter light more efficiently, are more stable, and last longer. Titanium dioxide pigments are insoluble in the coating carriers in which they are distributed; as a result, the particle size of the pigment and the chemical composition of its surface dictate its performance features, such as chemical, photochemical, and physical characteristics. Inorganic and, in certain circumstances, organic surface treatments are used on most commercial grades of titanium dioxide. Precipitated coatings of alumina and silica, which are rigorously controlled for type, amount, and manner of deposition, are the most common inorganic surface modifiers. These inorganic surface treatments increase one or more key performance characteristics, such as dispersibility in water and a variety of organic liquids, hiding power efficiency,

chalk resistance, and resistance to heat and/or photoreduction discoloration. In some coatings systems, organic surface treatments can improve pigment dispersibility. To enhance value-in-use in a variety of coatings compositions, several grades are developed with varied combinations of surface treatment. In the research, the focus is to ensure the finalized material being accessed from the volume factor to ensure the objective of the study has been fulfilled. The component in the factor took place either to use the full volume of the Tiox or half volume of the Tiox to ensure the study does cover the two levels of a factor in each parameter setting.

2.6.2 Plasma

Plasma is a process that involved exposed solid surfaces is one of the hottest subjects in the rapidly growing field of plasma material treatment. Plasma cleaning has already been used in a variety of industries, including semiconductor processing and microchip production, metallurgy, the optical industry, dentistry, medical technology, and food packaging, to mention a few. Understanding the fundamentals of plasma cleaning is crucial for the efficient and effective use of plasma cleaning technologies, as well as their application in new industries. A solid body's surface can be regarded as a stack of material layers at the object's border. The object's surface layer thickness is determined by the material used and the object's (technological) history. Chemical and physical structures on the surface can be complex. The goal of surface cleaning is to get rid of impurities that build up on top of already difficult surfaces. Thus this research paper is the continuation study on the plasma with the non-plasma process that helps to identify the variation in the flux drop as part of the methodological gap study.

2.6.3 Staging Temperature

Two-component materials are becoming more desirable today because they offer a lower cost of ownership and greater process flexibility. However, setting up an application to accurately dispense the correct ratio of part A and part B materials can be complicated. Controlling metering and mix ratios is critical to any two-component dispensing application. To fully address this challenge, staging temperature becomes the major contributor to assist the features to truly streamline the two-component dispensing process. This staging temperature readiness formulates, optimizes, and develops the deposition of Tiox with the application in the particular process. For applications of high-quality in the flux reduction in the process, the uniformity of angular correlated with staging temperature which enables the conformality of the material is conversion efficiency in the Tiox material when it is combined with other material such as metal or PCB. Different types of staging temperature allowed a multiple outcomes which the research will determine the best fit parameter to set with regards to archive the objective of the study.

2.7 Summary

The Six Sigma model is a quality improvement approach that uses multiple statistical analytic techniques to systematically improve organization performance. The greater the sigma level, the lower the chance of problems in products. The Six Sigma approach is used in the quality department to regulate product quality and eliminate rejected parts. All these three critical parameters of the study has been identified as CTQ and indirectly contribute to COPQ in the process. Mehrabi (2012) has identify the input parameter which identified as critical and embark in the performance by identify any

opportunity for improvement by leveraging the framework and tools that's has been established in the Six Sigma model. In the research proposed by Youssouf et al., (2014), the author has indicate to LSS which can be narrow to DMAIC approach in handling any industrial research to improvise the performance of the current state not limited to process, equipment, technology, product and reliability of the goods. The paper also give priority to statistical approach and systemic solution driven for sustainability prospect beside cost saving.

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CHAPTER 3 : METHODOLOGY

3.1 Introduction

The technique and approaches applied in acquiring data and calculations throughout the research are discussed in this chapter. It is critical to use appropriate methodologies because they will reveal the investigation outcomes. According to literature research, numerous characteristics must be considered while creating a methodology modeling device for the Six Sigma modeling. In this study, SSM application will take place into production besides quality associated challenges to improve and monitor product performance into productivity and quality deliverable.

To enhance processes and products, SSM techniques employ a detailed problem-solving approach with expert Six Sigma instruments. This data-driven method seeks to decrease the amount of defect generated or yield losses. The desired engineering objective of the Six Sigma approach is to perform a reduction in the activity of change to the point where there are no more than three fault defects being produced per million components are manufactured.

Six Sigma's goal is to enable goods that enable the satisfaction of the customers at the same time reducing incoming losses to the point that pursuing tighter quality is no longer cost feasible.

3.2 Research Methodology

This case study's methodology is a blend of Value-Stream Mapping and Lean Six Sigma's DMAIC. It is framed as 'DMAIC as part of VSM', as shown in the literature review because the DMAIC process will be the route to transition from the Current VSM

to the Future VSM. This method is especially beneficial in industries that employ VSM as their primary tool for achieving long-term strategic goals. Even if the organization doesn't generally employ the DMAIC model for projects, it will be highly valuable because it provides a roadmap.

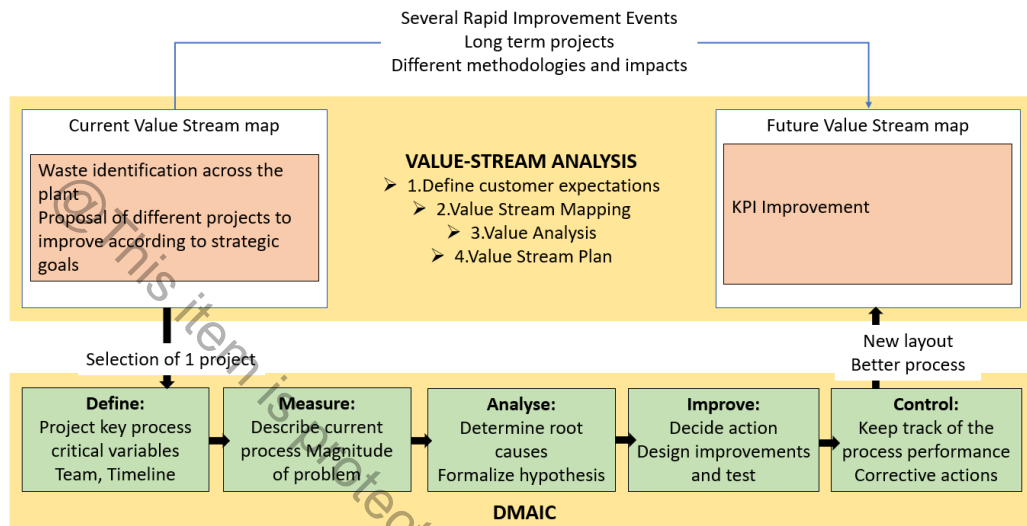


Figure 3.1 Methodology

This chapter discusses the methods and techniques used to collect data and perform calculations throughout the investigation. It's crucial to employ the right methodologies because they'll reflect the outcomes of the study. According to the literature, when developing an experimental instrument for the Six Sigma model, there are several criteria that must be taken into account (SSM). To boost and regulate product productivity and quality, we will use SSM to production and quality-related difficulties in this study.

SSM methodologies use a detailed problem-solving approach whereby it specializes in Six Sigma instruments to develop the processes and products performance. This data-driven process tries to reduce the number of items or incidents that are

unacceptable. The Six Sigma approach's technical goal is to decrease process variation to a level of no more than 3 defects per million components produced. The goal of Six Sigma is to create a product that satisfies customers while minimizing supplier losses to the point where pursuing tighter quality is no longer cost-effective.

3.3 Methodology of Research

The methodology used in this case study is a combination of Value-Stream Mapping and Lean Six Sigma's DMAIC. Because the DMAIC process will be the way to transition from the Current VSM to the Future VSM, it is framed as 'DMAIC as part of VSM', as shown in the literature review. This strategy is particularly useful in businesses where VSM is used as the principal instrument for accomplishing long-term strategic objectives. Even if the organization does not use the DMAIC model for projects regularly, it will be extremely useful because it gives a roadmap.

3.4 Research Design

Methods, Tools, and Techniques are critical to any Six Sigma, DMAIC project's success. These tools and procedures are required at every level of a Six Sigma project. Six Sigma and its tools have had a significant impact on many firms' operations. Six Sigma tools can be used to promote quality improvements systematically and deliberately. Six Sigma is a customer-focused, well-defined process improvement methodology.

Six Sigma tools are used by businesses to ensure that processes are more effective, and flaws are eliminated. Statistical and analytical tools are included in these toolkits. The DMAIC improvement project roadmap includes Six Sigma tools. To be successful

with the utilization of tools and procedures, it is critical to have entire commitment and leadership from top management.

Define: The problem will be defined in this section, along with the project's scope, team, timetable, and goals. Although some portions of the defined phase overlap with the VSM, this phase will produce most of the project management content.

Measure: It entails gathering process data to determine what changes to expect, as well as taking concrete measurements to eliminate the defect. Some KPIs will be chosen and monitored. We can begin to get a sense of the challenges in the existing situation thanks to this phase. There will be highly extensive discussions of the present process as well as certain Kaizen events in this phase.

Analyze: After identifying the defect, the analysis section will include hypotheses to determine the sources of the errors and defect, as well as some ideas that will be produced and tested. Different sorts of errors, bottlenecks, and causes of variation will be discussed. New improvements will begin to develop as a result of the ideas gathered in this section.

Improve: During this phase, the testing ideas will be implemented, and the project will be realized. This phase entails most of the work, as it necessitates putting the various options into effect and directing a huge staff.

Control: A plan will be established for getting data on the new performance, as well as contingency plans to avoid negative outcomes and ensure that the solutions are working.

3.5 Analysis Of Variance (ANOVA)

It aids in the discovery of differences in averages between shifts, as well as investigating and attempting to answer questions. It standardizes shifts, discovers new ways to set up machinery, and evaluates which output will have the biggest impact and which areas should be investigated. ANOVA compares the means of response variables to determine the importance of variables. Data 32 from relatively regularly distributed populations with identical variances between factor levels are required for ANOVA to ensure all the shift, labor, weekday, the weekend has been covered to give the full compilation in the yield computation.

3.6 Implemented of Taguchi Method

Minitab 20 software was used to calculate the number of active OA. All three components and two levels were extracted from the research into the software to enable and guide the statistical method. Table 3.2 lists the Taguchi experiments' design parameters as well as the levels used.

Table 3.1 The process of parameters factor and ratio levels

Process parameters		Level	Level 2
Volume of Tiox (mg)	A	Normal	Half
Plasma	B	Plasma	Non Plasma
Staging temperature (°C)	C	23	60

The volume of Tiox, plasma, and staging temperature was used as important influencing factors in this investigation. All the research data selection range values referred to the control specification which has the maximum threshold, nominal value, and minimum threshold recommended levels for each process. The present production flow's value is also factored into the calculation.

Design Table (randomized)				
Run	Blk	A	B	C
1	1	-	+	-
2	1	+	-	-
3	1	+	-	+
4	1	+	+	+
5	1	+	+	-
6	1	-	-	+
7	1	-	-	-
8	1	-	+	+

Figure 3.2 Minitab Design Table Randomize