



**OVERALL LABOUR EFFICIENCY IMPROVEMENT USING  
MAYNARD OPERATIONAL SEQUENCE TECHNIQUE AT SME  
AEROSPACE MANUFACTURING COMPANY**



**BACHELOR OF MANUFACTURING ENGINEERING  
TECHNOLOGY WITH HONOURS**

**2023**



**Faculty of Mechanical and Manufacturing Engineering  
Technology**



**OVERALL LABOUR EFFICIENCY IMPROVEMENT USING  
MAYNARD OPERATIONAL SEQUENCE TECHNIQUE AT SME  
AEROSPACE MANUFACTURING COMPANY**

**Siti Khadijah Binti Ismail**

**Bachelor of Manufacturing Engineering Technology with Honours**

**2023**

**OVERALL LABOUR EFFICIENCY IMPROVEMENT USING MAYNARD  
OPERATIONAL SEQUENCE TECHNIQUE AT SME AEROSPACE  
MANUFACTURING COMPANY**

**SITI KHADIJAH BINTI ISMAIL**



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

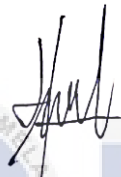
**2023**

## DECLARATION

I declare that this thesis entitled “ Overall Labour Efficiency Improvement using Maynard Operational Sequence Technique at SME Aerospace Manufacturing Company” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature

:



Name

:

Siti Khadijah Bt Ismail

Date

:

10/1/2023



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Manufacturing Engineering Technology (BMMW) with Honours.

Signature :



Supervisor Name : Ts. Dr. Rohana Binti Abdullah

Date : 10/1/2023



اوتيمر سیتی تیکنیکل ملیسیا ملاک

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## DEDICATION

This appreciation is dedicated to my beloved parents, siblings, friends and my special friend that is always been there for me spiritually and emotionally. Not to be forgotten, my supervisor, Ts. Dr. Rohana Binti Abdullah for her guidance and encouragement that motivate me to complete this thesis.



## ABSTRACT

In the era of Industrial Revolution 4.0, the current levels of competition in the manufacturing industry make the organizations continue to meet the customer demand but due to the problems like process delays caused by labor, it has become difficult in meeting customer demand on time that will affect the productivity of an organization. This study used a tool quality management which is DMAIC (Define-Measure-Analyze-Improve-Control) to have clearer detail on the process that will lead to a reduction of defects and cycle time as well as improve the capability of processes. To boost productivity in Aerospace Manufacturing Industry (SME Aerospace Sdn Bhd), a thorough time study research was conducted to ensure the productivity is enhanced since there is a lack of exposure to other alternatives of time study measurement methods to be applied other than the conventional stopwatch study. The research therefore also aims to improve productivity by analyzing the standard time and analyzing the labor utilization in each process at the Assembly 6C Overwing Beam Section workstation using Maynard Operational Sequence Technique (MOST). Indirectly, the impact of MOST time study over the performance in the assembly line will automatically be known and the improvement is easily proposed due to the Non-Value Added (NVA) activities detected based on the highest standard time in a process. Based on throughput time analysis, it involves monitoring and standardization of cycle time for all processes using MOST and the huge differences between MOST data and SMEA data are proven. Work is further extended to identifying labour utilization based on the compliance of workers towards their work and whether their action influence production or otherwise. Due to the analysis that has been done, the focus then on the bottleneck process which is at Stage 3 (Secure IB/OB Brackets) that contributes to the highest cycle time. In stage 3 (Secure IB/OB Brackets), the cycle time is 0.38 hours lower than SMEA data which is 0.93 hours which shows the huge gap. Furthermore, the utilization of labor in stage 3 (Secure IB/OB Brackets) should approximately achieve 82% which is known as the target of labor utilization in this study. To improve the throughput time at Stage 3 (Secure IB/OB Brackets) process, the Fishbone Diagram and Why-Why Analysis were implemented. Through both methods, the root cause towards the huge gap in cycle time between SMEA data and MOST data is detected. In summary, the optimum labour utilization at the bottleneck process is achieved by 81.12% and throughput time increases by 33% due to a great reduction of cycle time. The control action using certain tools will be made towards the proposed improvement to ensure long-term organizational effectiveness and sustainability. The main contribution this article makes is that it provides SMEA organization with a user-friendly technique (MOST) to improve organizational effectiveness and productivity with minimal capital expenditures.

## ABSTRAK

*Dalam era Revolusi Perindustrian 4.0 kini, tahap persaingan dalam industri pembuatan telah menjadikan sesebuah organisasi terus berusaha memenuhi permintaan pelanggan tetapi disebabkan masalah seperti kelewatan proses yang disebabkan oleh pekerja, ia menjadi sukar untuk memenuhi permintaan pelanggan tepat pada masanya dimana ianya telah menjejaskan produktiviti sesebuah organisasi. Kajian ini menggunakan pengurusan kualiti alat iaitu DMAIC (Define-Measure-Analyze-Improve-Control) untuk mempunyai perincian yang lebih jelas tentang proses yang akan membawa kepada pengurangan kepada masalah dan masa kitaran sesuatu proses serta meningkatkan keupayaan proses. Bagi meningkatkan produktiviti dalam Industri Pembuatan Aeroangkasa (SME Aerospace Sdn Bhd), sebuah kajian berkaitan dengan kajian masa telah dijalankan untuk memastikan produktiviti dipertingkatkan memandangkan terdapat kekurangan pendedahan kepada kajian masa yang lain selain daripada kajian masa melalui jam randik konvensional. Oleh itu, penyelidikan ini juga bertujuan untuk meningkatkan produktiviti dengan menganalisis masa standard dan menganalisis penggunaan pekerja dalam setiap proses di stesen kerja 'Assembly 6C Overwing Beam Section' menggunakan 'Maynard Operational Sequence Technique' (MOST). Secara tidak langsung, kesan kajian MOST time ke atas prestasi stesen kerja akan secara automatik diketahui dan penambahbaikan mudah dicadangkan kerana aktiviti Tanpa Nilai Tambah (NVA) dikesan berdasarkan masa standard tertinggi dalam sesuatu proses. Berdasarkan analisis masa pemprosesan, ia melibatkan pemantauan dan penyeragaman masa kitaran untuk semua proses menggunakan MOST dan perbezaan yang ketara antara MOST data dan data SMEA adalah terbukti. Kerja diperluaskan lagi untuk mengenal pasti penggunaan pekerja berdasarkan pematuhan pekerja terhadap kerja mereka dan sama ada tindakan mereka mempengaruhi pengeluaran atau sebaliknya. Oleh kerana analisis yang telah dilakukan, tumpuan kemudiannya kepada proses yang menyumbang kepada kelambatan proses (Bottleneck) iaitu pada Peringkat 3 (Secure IB/OB Brackets) yang menyumbang kepada masa kitaran tertinggi. Pada peringkat 3 (Secure IB/OB Brackets), masa kitaran adalah 0.38 jam lebih rendah daripada data SMEA iaitu 0.93 jam yang menunjukkan jurang yang besar. Tambahan pula, penggunaan tenaga buruh di peringkat 3 (Secure IB/OB Brackets) sepatutnya mencapai lebih kurang 82% yang dikenali sebagai sasaran penggunaan buruh dalam kajian ini. Untuk menambah baik masa pemprosesan pada proses peringkat 3 (Secure IB/OB Brackets), Gambarajah Tulang Ikan dan Analisis Mengapa-Mengapa telah dilaksanakan. Melalui kedua-dua kaedah, punca ke arah jurang yang besar dalam masa kitaran antara data SMEA dan kebanyakan data dikesan. Secara ringkasnya, penggunaan pekerja optimum pada proses kesesakan dicapai sebanyak 81.12% dan masa pemprosesan meningkat sebanyak 33% disebabkan pengurangan masa kitaran yang banyak. Tindakan kawalan menggunakan alat tertentu akan dibuat ke arah cadangan penambahbaikan untuk memastikan keberkesanan dan kemampanan organisasi jangka panjang. Sumbangan utama artikel ini ialah ia menyediakan organisasi SMEA dengan teknik mesra pengguna (MOST) untuk meningkatkan keberkesanan dan produktiviti organisasi dengan perbelanjaan modal yang minimum.*



## ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the Universiti Teknologi Malaysia Melaka (UTeM) for providing the research platform.

My utmost appreciation goes to my main supervisor, Ts. Dr. Rohana Binti Abdullah of the Faculty of Mechanical and Manufacturing Engineering Technology for all her support, advice and inspiration. Her constant patience for guiding and providing priceless insights will forever be remembered.

Last but not least, I would also like to thank my beloved parents and to my special friend for their endless support, love and prayers. Finally, thank you to all the individuals who had provided me the assistance, support and inspiration to embark on my study.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## TABLE OF CONTENTS

	<b>PAGE</b>
<b>DECLARATION</b>	
<b>APPROVAL</b>	
<b>DEDICATION</b>	
<b>ABSTRACT</b>	<b>i</b>
<b>ABSTRAK</b>	<b>ii</b>
<b>ACKNOWLEDGEMENTS</b>	<b>iii</b>
<b>TABLE OF CONTENTS</b>	<b>iv</b>
<b>LIST OF TABLES</b>	<b>vii</b>
<b>LIST OF FIGURES</b>	<b>ix</b>
<b>LIST OF SYMBOLS AND ABBREVIATIONS</b>	<b>xi</b>
<b>LIST OF APPENDICES</b>	<b>xii</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>13</b>
1.1 Project Background	13
1.2 Problem Statement	14
1.3 Research Objective	15
1.4 Scope of Research	15
1.5 Structure of Report	15
1.6 Summary	18
<b>CHAPTER 2 LITERATURE REVIEW</b>	<b>19</b>
2.1 Introduction	19
2.2 Manufacturing	20
2.3 Waste in Manufacturing	20
2.4 Productivity	21
2.4.1 Factors of Productivity	22
2.4.2 Labour Productivity	24
2.5 Work Study	25
2.5.1 Method Study (Work Method Design)	26
2.5.2 Time Study (Work Measurement)	28
2.6 Maynard Operation Sequence Technique (MOST)	32
2.6.1 Basic MOST	33
2.6.2 TAKT Time in MOST	35
2.7 Case Study	36
2.8 DMAIC	42

2.9	Summary	44
<b>CHAPTER 3            METHODOLOGY</b>		<b>45</b>
3.1	Introduction	45
3.2	Project Planning	46
3.2.1	Research Scope	47
3.2.2	Literature Review	47
3.2.3	Factory Visit	47
3.2.4	Case Study	47
3.2.5	Data Collection	48
3.2.6	Analysis and Improvement	48
3.2.7	Conclusion	48
3.3	Case Study	49
3.3.1	Define Phase	50
3.3.2	Measure Phase	51
3.3.3	Analyze Phase	53
3.3.4	Improve Phase	54
3.3.5	Control Phase	56
3.4	MOST Elements	56
3.4.1	Time Measuring Unit	57
3.4.2	Standard Time	57
3.5	MOST Index Table	58
3.6	Summary	59
<b>CHAPTER 4            RESULTS AND DISCUSSION</b>		<b>60</b>
4.1	Introduction	60
4.2	Define phase	61
4.2.1	Background of company	61
4.2.2	Job Scope	62
4.2.3	Type of Parts involved	62
4.2.4	Labour Engagement	66
4.2.5	Process Layout	66
4.2.6	Process Mapping	66
4.3	Measure phase	69
4.3.1	Data collection	69
4.3.2	SMEA data	70
4.3.3	MOST Data	70
4.4	Analysis of Result	71
4.4.1	Justification on comparison between SMEA data and MOST data	72
4.4.2	Data analysis on Throughput Time	74
4.4.3	Data analysis on Utilization of labour	86
4.5	Data analysis for improvement	89
4.5.1	Fishbone Diagram	90
4.5.2	Why- Why Analysis	90
4.6	Improvement	93
4.6.1	Improvement for Man Factor	93
4.6.2	Improvement for Material Factor	96
4.6.3	Improvement for Method Factor	97

4.7	Control	98
	4.7.1 SOP	98
	4.7.2 One Point Lesson	99
4.8	Summary	99
<b>CHAPTER 5 CONCLUSION AND RECOMMENDATIONS</b>		<b>101</b>
5.1	Conclusion	101
5.2	Recommendation	103
<b>REFERENCES</b>		<b>104</b>
<b>APPENDICES</b>		<b>108</b>



## LIST OF TABLES

<b>TABLE</b>	<b>TITLE</b>	<b>PAGE</b>
Table 2.1	MTM basic movements	30
Table 2.2	Sequence model of MOST	34
Table 2.3	Parametric notations	35
Table 2.4	Basic MOST at Volvo Eicher Commercial Vehicles (VECV)	40
Table 3.1	Sequence model of basic MOST	52
Table 3.2	Phases of general move	53
Table 3.3	Example of why-why analysis template	55
Table 3.4	MOST elements	56
Table 4.1	Name of parts	63
Table 4.2	SMEA Data	70
Table 4.3	MOST Data	70
Table 4.4	Standard time of work activities at Stage 3	74
Table 4.5	MOST analysis data of Drill and Deburr process	76
Table 4.6	Standard time of work activities at Stage 1	79
Table 4.7	MOST analysis data of Rivet process	80
Table 4.8	Standard time of work activities at Stage 4	81
Table 4.9	MOST analysis data of Touch-up process	82
Table 4.10	Standard time of work activities at Stage 2	83
Table 4.11	MOST analysis data of Cleaning process	85
Table 4.12	Standard time and Working hour in Stage 3	87
Table 4.13	Working hour and standard time in Stage 1	87

Table 4.14 Working hour and standard time in Stage 4	88
Table 4.15 Working hour and standard time in Stage 2	88
Table 4.16 Why-why Analysis	91
Table 4.17 The root cause and propose action	93
Table 4.18 Differences movement of operator to reduce wastes	96
Table 4.19 MOST comparison data based on working posture	98



## LIST OF FIGURES

<b>FIGURE</b>	<b>TITLE</b>	<b>PAGE</b>
Figure 1.1	Project framework	18
Figure 2.1	Factors of productivity (Darmadi, 2019)	22
Figure 2.2	Work study (Gujar & Shahare, 2018)	25
Figure 2.3	Example of flow process chart (C, 2016)	27
Figure 2.4	Process chart symbol (C, 2016)	28
Figure 2.5	The DMAIC cycle (Terry, 2010)	42
Figure 3.1	Flowchart for project planning	46
Figure 3.2	Flowchart for case study	49
Figure 3.3	Example of fishbone diagram	55
Figure 4.1	Process layout at Assembly 6C Overwing Beam Section	66
Figure 4.2	The main flow process at Assembly 6C Overwing Beam Section	67
Figure 4.3	Detailed flow process at Assembly 6C Overwing Beam Section	68
Figure 4.4	Comparison between SMEA data and MOST analysis data	72
Figure 4.5	Demand and Output performance data for Beam Package – September 2022	73
Figure 4.6	MOST data analysis in descending order	74
Figure 4.7	Percentage of work activities at Stage 3	75
Figure 4.8	Drill and Deburr process analysis	78
Figure 4.9	Percentage of work activities in at Stage 1	79
Figure 4.10	Rivet process analysis	80
Figure 4.11	Percentage of work activities in at Stage 4	81

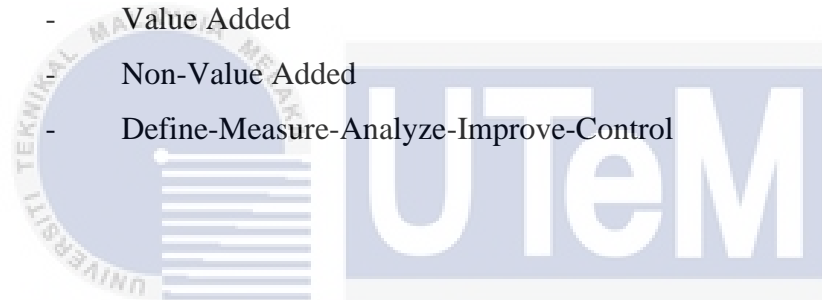
Figure 4.12 Touch-up process analysis	83
Figure 4.13 Percentage of work activities at Stage 2	84
Figure 4.14 Cleaning process analysis	85
Figure 4.15 Cause and Effect Diagram	90
Figure 4.16 Process Layout at Assembly 6C Overwing Beam Section	93
Figure 4.17 Improved Process Layout at Assembly 6C Overwing Beam Section	94
Figure 4.18 The suggested movement of the new Process Layout at Assembly 6C	95





## LIST OF SYMBOLS AND ABBREVIATIONS

PMTS	-	Predetermined Motion Time System
MOST	-	Maynard Operation Sequence Technique
MTM	-	Methods Time Measurement
MODAPTS	-	Modular Arrangement of Predetermined Time Standards
sec	-	Seconds
rf	-	Repeat frequency
cf	-	Cycle frequency
TMU	-	Time Measuring Unit
VA	-	Value Added
NVA	-	Non-Value Added
DMAIC	-	Define-Measure-Analyze-Improve-Control



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## LIST OF APPENDICES

APPENDIX	TITLE	PAGE
APPENDIX A	Gantt Chart for FYP 1	108
APPENDIX B	Gantt Chart for FYP 2	109
APPENDIX C	MOST Index Table for General Move	110
APPENDIX D	MOST Index Table for Controlled Move	111
APPENDIX E	MOST Index Table for Tool Use	112
APPENDIX F	MOST Template	113
APPENDIX G	Data Collection at stage 1 (Secure clipping and beam plates)	114
APPENDIX H	Data Collection at stage 2 (Overcoat Sealing)	118
APPENDIX I	Data Collection at stage 3 (Secure IB/ OB Brackets)	119
APPENDIX J	Data Collection at stage 4 (Fillet Sealent)	124
APPENDIX K	ILO Recommended Allowances	126
APPENDIX L	Turnitin	127
APPENDIX M	Thesis Status Verification Form	128
APPENDIX N	Thesis Classification Letter	129

## CHAPTER 1

### INTRODUCTION

#### 1.1 Project Background

Manufacturing is a critical aspect of the production chain from raw materials to a finished product that has existed since the 19th century and contributes to global employment in today's competitive manufacturing environment. However, in the field of manufacturing, there must be 8 types of waste produced along with the product. The most significant loss as a result of inefficiencies was not monetary, but rather a waste of human effort. Due to that, the implementation of productivity is being done. Bhatti and Qureshi (2017) in Pourmola et al. (2019) stated that productivity is normally considered to be a performance indicator, which consists of efficiency and effectiveness.

Therefore, the aim of this study is to conduct a time study investigation in a manufacturing industry which was conducted in the assembly department work station of a selected aerospace manufacturing organization (SME Aerospace Sdn. Bhd.). More importantly, this research study offers the organization a globally accepted, user-friendly technique for improving the effectiveness and overall efficiency which is MOST that divides tasks done into categories of Value Addition (VA), Essential Non-Value Addition (ENVA) and Non-Value Addition (NVA).

The information on the current manufacturing performances of SMEA is gathered as preliminary data for this study such as the background of the company, job scope, components involved, assembly process and facility layout. However, through the factory visit, a quick

observation of the assembly department indicated ineffective operational processes. The problem that has been identified is the utilization of the workers. There is no proper study is being done to know the accurate utilization of these workers based on standard time and labor utilization. In addition, the standard time of the processes is being identified using a conventional stopwatch study that will affect the preciseness of the data obtained. Through literature review, this can be overcome by performing MOST analysis to analyze each method described in a detailed way with every single motion (Puvanasvaran et al., 2019). This establishes the aim of this study which is to obtain the overall labor efficiency at the selected aircraft assembly line which is the Assembly 6C Overwing Beam section.

## 1.2 Problem Statement

Recently, companies are becoming more concerned with achieving leaner manufacturing and increasing productivity. To secure maximum profit and to sustain in the dynamic market, being able to produce to outperform the competitors is the only key for any organization (Kaka et al., 2019). Performing time study at the problematic assembly work station areas would help to increase the productivity.

For the selected work station at SME Aerospace, there are some issues with workers' utilization when performing their work. This is due to the lack of exposure to other time study measurement methods to be applied other than the conventional stopwatch study. This is a critical thing to be achieved to move along achieving drastic changes in the method of performing work. Failure to address the wastes that might arise from workers themselves will result in loss to the organization since it is affecting the production line. This happens due to the unwanted movements made by workers that might increase the inefficiency.

A thorough study must be carried out to determine non-value-added activities by implementing MOST. This vital information will be used to determine the accurate utilization

of the workers and improve the labor productivity based on standard time and their labor utilization for Aerospace Manufacturing Industry at the selected assembly work station.

### **1.3 Research Objective**

The primary objective of this study is to improve labor efficiency in the assembly department of the 6C Overwing Beam section to have an effective required level of manpower. In regard to the primary objective, there are several specific objectives that need to be accomplished in this study.

- i. To perform MOST time study at the Assembly 6C Overwing Beam Section work station of SMEA.
- ii. To identify standard time and operator utilization using MOST time study.
- iii. To propose improvement opportunities at the bottleneck process with the aim to achieve higher labor productivity.

### **1.4 Scope of Research**

This research will concentrate on individual operations of labors that can affect the efficiency of the production system. Their performance is measured using the MOST standard time to increase productivity by defining the proper working method and the way of maximizing the labor's utilization. In addition, the involvement of machine or material processes is not a priority in this research scope. Thus the result of before and after productivity improvement will be present.

### **1.5 Structure of Report**

The report structure explains the flows involved in this research study. All chapters presented in this report show a steps flow in achieving overall labor efficiency. The first chapter known as the Introduction chapter is all about elaborations detail of the study conducted at

SMEA Manufacturing Industry including project background, problem statement, objective, research scope and structure of the report. This study's expected outcome and the study's summary will be presented.

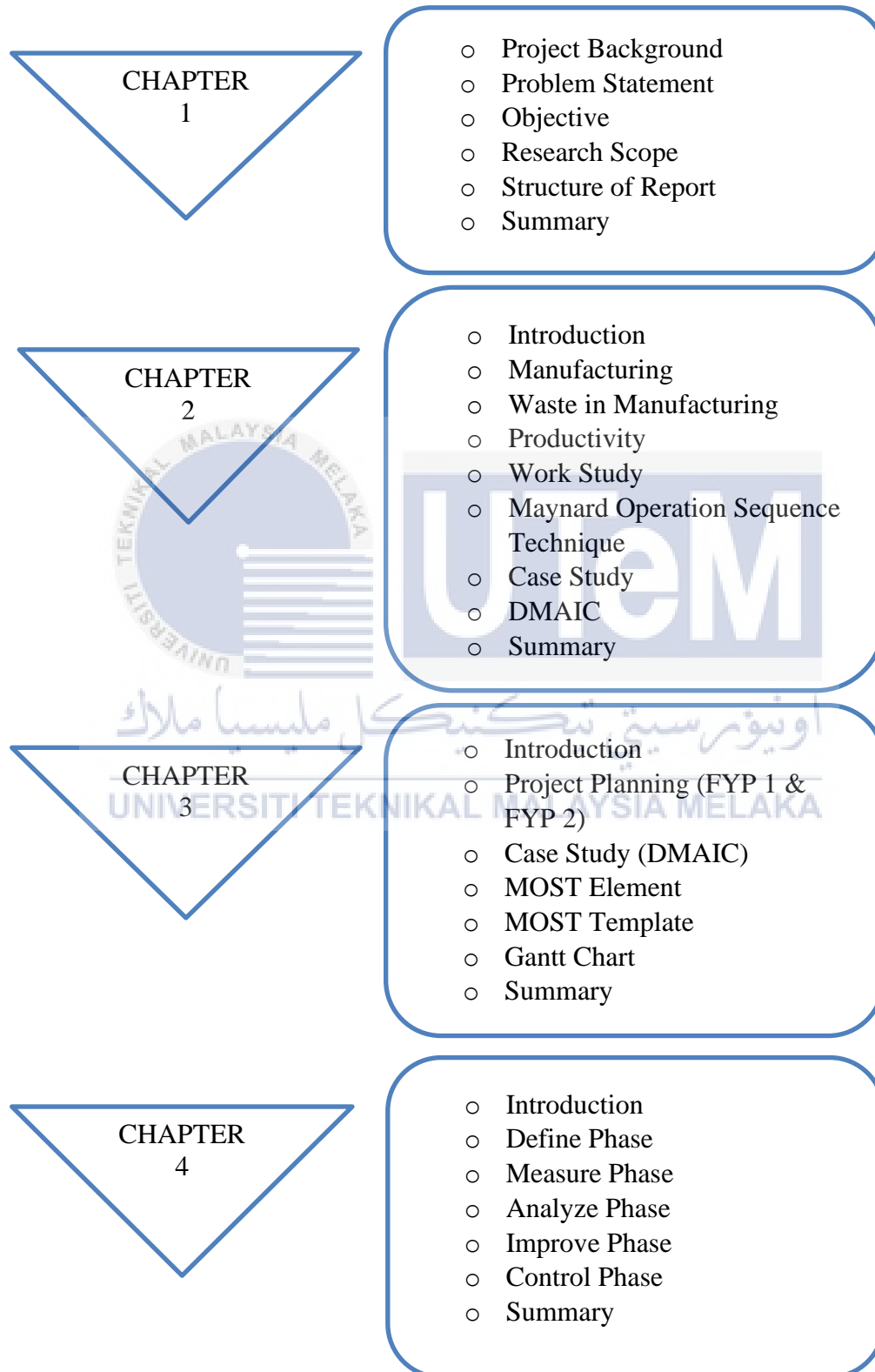
Chapter 2 is all about preparing all research journals for literature review to identify the suitable methodology to be used in this study. To prepare for this chapter, all relevant theories and information regarding manufacturing, waste in manufacturing, productivity, work-study, Maynard Operation Sequence Technique and DMAIC as a problem-solving approach should be explored. Furthermore, selected case studies on the implementation of MOST need to take into account to have a better insight in a further chapter which is about research methodology.

Furthermore, chapter 3 refers to the methodology of this study that detailed the techniques and tools used for problem-solving and achieving the objectives. The guideline of the research is then presented in a flow chart form for both project planning (FYP 1 and FYP 2) and case study using DMAIC (Define-Measure-Analyze-Improve-Control) as a guideline throughout the chapter. The conclusions and recommendations of this analysis will be presented in chapter 4.

Subsequently, in chapter 4 the preliminary results obtained from SMEA is present in this chapter to provide insights into the factory process and expected result to be achieved at the end of FYP 2. This phase will utilize the techniques described in chapter 3 and one of it is the MOST template to be used during the data gathering phase of this study. Once results are gathered, a discussion is made based on the result to tell on the effect of implementing the tools and technique for this study.

Lastly, in Chapter 5 the overall studies and findings will be summarized in this chapter. The standard time and labour's utilization will be discussed. To improve the framework, the data gathering technique from the MOST template was shown as a supporting document. The

improvement will be proposed and the accurate understanding as mentioned in the thesis will be described. All of the project frameworks involved in this thesis are explained in Figure 1.1 below.



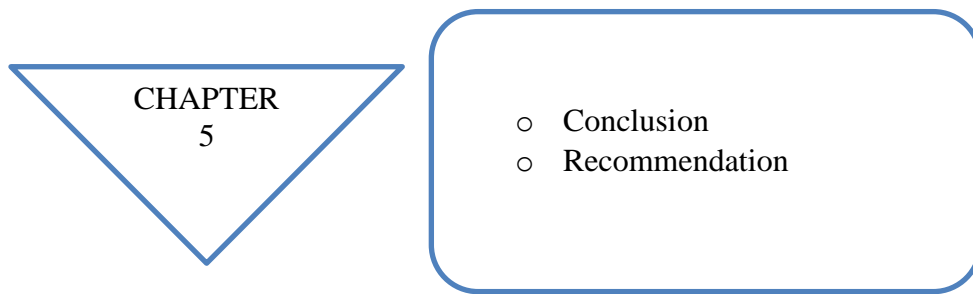


Figure 1.1 Project framework

## 1.6 Summary

In summary, due to tight competition in the manufacturing industry, every organization has to do re-engineering which is one of the established options that could be adopted to increase productivity and outperform the competitors. However, in this research study, the re-engineering is being done by investigating the standard time and labor utilization when performing their task in the assembly department at SMEA to detect any non-added value wastes. Due to that, it became an objective to be achieved in this research study which the scope is to implement MOST to increase the productivity by defining the proper working method.