



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**FLOW PROCESS IMPROVEMENT THROUGH SIMULATION  
IN ELECTRICAL PART MANUFACTURING**

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

by

**NORASHIKIN BINTI ZAINAL**

**B050910197**

**901010-04-5180**

**FACULTY OF MANUFACTURING ENGINEERING**

**2013**

**BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA**

**TAJUK: FLOW PROCESS IMPROVEMENT THROUGH SIMULATION IN ELECTRICAL PART MANUFACTURING**

**SESI PENGAJIAN: 2012/13 SEMESTER 2**

Saya **NORASHIKIN BINTI ZAINAL**

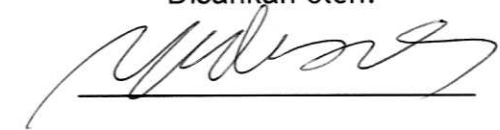
mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **\*\*Sila tandakan (✓)**

- SULIT** (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
- TERHAD** (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
- TIDAK TERHAD**

Disahkan oleh:





Alamat Tetap:

**NO 33, JALAN RU12,**

**TAMAN RAMBAI UTAMA,**

**75250 MELAKA.**

Cop Rasmi:

**PROFESOR DR. ADI SAPTARI**  
*Ketua Jabatan (Pengiraian Pembuatan)*  
Fakulti Kejuruteraan Pembuatan  
Universiti Teknikal Malaysia Melaka  
Hang Tuah Jaya  
76100 Durian Tunggal, Melaka


Tarikh: 20/6/2013

Tarikh: 18/06/2013

\*\* Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

## DECLARATION

I hereby, declared this report entitled “Flow Process Improvement through Simulation in Electrical Part Manufacturing” is the results of my own research except as cited in references.

Signature :   
Author's Name : NORASHIKIN BINTI ZAINAL  
Date : 28 JUNE 2013

## APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Manufacturing Management) (Hons.). The member of the supervisory is as follow:

A handwritten signature in black ink, appearing to be 'M. Yusoff', written over a horizontal dotted line.

(Project Supervisor)

## ABSTRAK

Kajian ini merupakan penilaian prestasi produktiviti industri pembuatan yang menghasilkan bahagian-bahagian elektrik. Penilaian menggunakan teknik simulasi. Objektif kajian ini selain daripada penilaian prestasi sistem semasa, juga akan mencadangkan beberapa peningkatan produktiviti. Simulasi membantu dalam memberi gambaran tentang bagaimana yang baik adalah kerja-kerja sistem sebenar. Ia juga menunjukkan pengukuran prestasi sistem dan keadaan sistem sebenar dalam industri. Terdapat banyak produk di kilang ini. Sistem pengeluaran mengikuti pekerjaan model kedai, di mana pengeluaran bermula apabila terdapat suatu perintah daripada pelanggan. Susun atur pengeluaran berikut susun atur proses, di mana mesin mengatur dalam proses. Oleh kerana banyak produk, projek ini telah memberi tumpuan pada bahagian elektrik produk Panjang Lampu Lurus sahaja. Lain-lain produk berasaskan sebahagian daripada syarikat itu tidak akan dibincangkan dalam laporan ini. Dari simulasi yang dijalankan, ia telah dikenal pasti keadaan kesesakan dalam sistem pengeluaran bahagian elektrik semasa. Untuk memperbaiki keadaan ini, beberapa penyelesaian alternatif telah dicadangkan. Tiga penyelesaian alternatif telah dicadangkan. Alternatif ini adalah: 1) Mengurangkan saiz kumpulan, 2) Menambah satu Mesin Kimpalan; 3) Gabungan meminimumkan kumpulan dan menambah satu mesin kimpalan. Antara alternatif, gabungan mengurangkan saiz kumpulan dan menambah satu mesin kimpalan model telah dipilih kerana dapat mengurangkan masa pemprosesan dan masa menunggu.

## **ABSTRACT**

This study is an evaluation of productivity performance of manufacturing industry which produces electrical parts. The evaluation uses simulation techniques. The objectives of this study other than evaluation of current systems performance, also would proposed some productivity improvement. Simulation helps in giving the overview about how good is the real system works. It also shows the measurement of the system performance and condition of the real system in the industry. There are many products in this factory. The production systems follow job shop modeling, where the production starts when there is an order from the customer. The layout of production follows process layout, where the machine arrange in process. Due to many products, this project was focusing on electrical part of Straight Lighting Long product only. Others part based product of the company will not be discussed in the report. From the simulation conducted, it was identified a bottleneck situation in the current production system of electrical part. To improve the situation, some alternatives solution has been proposed. Three alternatives solution has been proposed. These alternatives are: 1) Minimizing batch size; 2) Adding one Welding Machine; 3) A combination of Minimizing batch and adding one welding machine. Among the alternatives, combination of minimizing batch size and adding one welding machine model was selected due to reduce processing time and waiting time.

## **DEDICATION**

To my beloved parents

I dedicate this technical report to my parents. Without their patience, understanding, support, and most of all love, the completion of this work would not have been possible.

To my faculty supervisor for his guidance throughout the project

## **ACKNOWLEDGEMENT**

I would like to thank my faculty supervisor Prof. Dr. Adi Saptari for his guidance throughout the project and his willingness to spend his time to discuss with me about the project. I also would like to thank my parents for supporting me mentally and physically.



# TABLE OF CONTENT

Abstrak	i
Abstract	ii
Dedication	iii
Acknowledgement	iv
Table of Content	v
List of Tables	viii
List of Figures	ix
List Abbreviations, Symbols and Nomenclatures	xi
<b>CHAPTER 1: INTRODUCTION</b>	<b>1</b>
1.1 Background of Study	1
1.2 Problem Statement	3
1.3 Objectives	4
1.4 Scope and Limitation of Study	4
1.5 Significance of Study	5
1.6 Report Outlines	5
<b>CHAPTER 2: LITERATURE REVIEW</b>	<b>7</b>
2.1 Productivity	7
2.1.1 Factor Influence Productivity	8
2.2 Simulation Modelling and Analysis	9
2.2.1 Basic Simulation Concepts	10
2.2.1.1 Basic Simulation Model Component	11
2.2.1.2 Entities	11
2.2.1.3 Queues	12
2.2.1.4 Resources	15
2.2.2 Type of Simulation Models	15
2.2.3 Purpose of Simulation	16
2.2.4 Advantages of Simulation Models	18

2.2.5	Disadvantages of Simulation Models	18
2.3	Experimentation of Simulation	20
2.3.1	Batch Production	20
2.3.2	Relationship between Batch Size and Waste	20
2.4	Waste Elimination	21
<b>CHAPTER 3: METHODOLOGY</b>		<b>22</b>
3.1	Overall Flowchart of the Project	22
3.2	Flowchart in First Semester of Final Year Project (PSM 1)	25
3.2.1	Project Planning	26
3.2.2	Literature Review and Information Collection	26
3.2.3	Methodology Design	26
3.3	Flowchart in Second Semester of Final Year Project (PSM 2)	28
3.3.1	Observation in Real System	29
3.3.2	Simulation Study	29
3.3.3	Data Collection	29
3.3.4	Model Real System	29
3.3.5	Model Experimentation	30
3.3.6	Result Evaluation	30
3.3.7	Comparison Result Evaluation	30
3.3.8	Recommendations	31
<b>CHAPTER 4: MODELING AND SIMULATION</b>		<b>32</b>
4.1	Introduction	32
4.2	Conceptual Modeling	35
4.2.1	Scope and Level of Detail	38
4.2.2	Model Scope	40
4.3	Input Modeling	41
4.3.1	Data Collection	41
4.3.1.1	Cycle Time	42
4.3.1.1	Model Scope	42
4.3.2	Verification of Model	51
4.3.3	Validation of Model	53

4.3.3.1	Statistical Description	55
4.3.3.2	Determination of Sample Size	56
4.3.3.3	T-Test	58
<b>CHAPTER 5: MODEL EXPERIMENTATION, RESULT AND DISCUSSION</b>		<b>59</b>
5.1	Result	59
5.2	Model Experimentation	63
5.2.1	Minimizing Batch Size Model	63
5.2.2	Adding One Welding Machine Model	64
5.2.3	Combination of Minimizing Batch Size and Adding One Welding Machine Model	65
5.1	Discussion	68
<b>CHAPTER 6: CONCLUSION AND RECOMMENDATION</b>		<b>70</b>
6.1	Conclusion	70
6.2	Recommendation	71
<b>REFERENCES</b>		<b>73</b>
<b>APPENDICES</b>		
A	Gantt chart	
B	Cycle Time	

## LIST OF TABLES

4.1	The total production quantity and its percentage of electrical products produce in Jati Beringin Sdn. Bhd.	33
4.2	Summary of electrical part in Straight Lighting Long product's production flow	38
4.3	Electrical part in Straight Lighting Long product's production system illustration	40
4.4	Sample data of cycle time for first 20 units cutting part Material P3 (Mild Steel Part)	42
4.5	Details for each elements in the simulation	47
4.6	Buffer of the system and its detail	49
4.7	Shift Pattern in the production line	50
4.8	Result summarized of replication of total average output per month for electrical part in Straight Lighting Long product	54
4.9	Statistic description for the total average output per month	55
5.1	The average waiting time in the buffer for each machine	60
5.2	Comparison of current production with the improvement alternatives	67

## LIST OF FIGURES

2.1	Factors Affecting Productivity	8
2.2	Basic simulation model component	11
2.3	Single server – single queue model	13
2.4	Single Servers – Server Queue model	13
2.5	Several Server – Single Queue model	13
2.6	Several Server – Several Queue model	14
2.7	Multiple Server in a series model	14
3.1	The overall flowchart of the project	24
3.2	Process flowchart for research PSM 1	25
3.3	Framework of the step in simulation	27
3.4	Process flowchart for research PSM 2	28
4.1	Pareto diagram for total production quantity of electrical products in Jati Beringin Sdn. Bhd.	34
4.2	Production flow for electrical part in Straight Lighting Long product	36
4.3	Descriptive statistic for cycle time of cutting and marking machine for Material P3 (Mild Steel Part)	42
4.4	Histogram for cycle time of cutting for Material P3 (Mild Steel Part)	43
4.5	Probability plot of the data for normal distribution	44
4.6	Probability plot of the data for exponential distribution	44
4.7	Probability plot of the data for extreme value distribution	45
4.8	Probability plot of the data for logistic distribution	45
4.9	The simulation model in Witness	51
4.10	Verification process flow diagram of electrical part in Straight Lighting Long	52
4.11	The simulation model after run	53
4.12	Statistic description for the total average output per month	55

4.13	Specify values required to obtain the sample size of total average output per month	5
4.14	Result of power and the sample size of total average output per month	57
4.15	Graph of power and sample size required for total average output per month of electrical part in Straight Lighting Long product	57
4.16	T-test for total average output per month	58
5.1	Illustration of simulation model for current system of electrical part	61
5.2	Result of simulation model for current production system of electrical part in Straight Lighting Long product	62
5.3	Result of minimizing batch size	63
5.4	Result of average waiting time in buffer for welding machine	64
5.5	Result of adding one welding machine	64
5.6	Result of average waiting time in buffer for welding machine	65
5.7	Result of combination of minimizing batch size and adding one welding machine model	65
5.8	Result of average waiting time in buffer for welding machine	66
5.9	Combination of minimize batch size and adding one welding machine model	66
5.10	Comparison on the average total cycle time of one complete product	68
5.11	Comparison on the duration to complete the company target	68
5.12	Comparison on the total average output per month	69
5.13	Comparison of waiting time in buffer for welding machine with the improvement alternatives	69

## **LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE**

FIFO	-	first-in-first-out
LIFO	-	last-in-first-out
SPT	-	shortest processing time
LPT	-	longest processing time
JIT	-	just-in-time
WIP	-	work-in-process
JBSB	-	Jati Beringin Sdn. Bhd.

# CHAPTER 1

## INTRODUCTION

This chapter presents the background of study, problem statements, objectives, and scope and limitation of study. In addition, the significance of study and the report outlines are also provided in this chapter.

### 1.1 Background of Study

Productivity is the entire measurement of ability for production of a good or service. In other definitions, productivity is the measurement of specified resources which had been managed to achieve the goals of quality and quantity on its time (Gough *et al.*, 2006). Definition of productivity is also known as an index that shows the measurement of the output (goods and services) relative to the input (labor, materials, energy, etc., used to produce the output) (Gough *et al.*, 2006). Besides that, productivity also can be expressed as the ratio of outputs (good and services) divides by the input (resources, such as labor and capital) (Stevenson *et al.*, 2007).

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$



There are three elements that should be considered for enhancing productivity, which are physical capital, human capital, and technology. The resources that can be made by humans are known as physical capital, while the human abilities and skills are known as human capital. Technology is defined as the technical aspects involved in the production of goods and services. It can be simplified as the improvement of productivity, which will increase due to the increasing of these three elements.

Flow process improvement is necessary for the production of industry in order to enhance the productivity of the product. The process should be continuously improved to increase the effectiveness and efficiency of the process in the production in terms of human and machine. Reduction of variation in the process and elimination of non-value-added activities are the steps that can be taken by industry in order to enhance the improvement of the process flow. Therefore, the productivity of industry can be increased where the process flows on the production run without producing any kind of waste and unnecessary process.

To improve the flow process, simulation can be used as a tool to enhance productivity in industry. By using simulation, the industry can evaluate the behaviour of a manufacturing process with different situations to identify a better flow process. Simulation can increase the understanding of the system's operation and minimize the waste associated with experimenting on the actual system. For example, the application of manufacturing simulation includes implementing new manufacturing concepts, improving existing process production scheduling, and improving resource utilization (George *et al.*, 1999).

Simulation is the imitation of the operation of a real-world process or system over time (Banks *et al.*, 2010). According to Mike Peterman (2000), process simulation has become a particularly important tool where they can eliminate non-value-adding steps from the processes and enhance the efficiency of human and equipment. Many of the manufacturing industries use simulation to represent the dynamic manufacturing process in a computer model graphically and simulate the data collected from the real process to the model. Simulation also allows the industry to predict and forecast their production, then test it with various parameters.

This study is about to develop the simulation model that analyzes the real process for identify production bottleneck and determine where the productivity improvement can be made in the process flow in electrical part manufacturing. Simulation also allows various scenarios to be tested without involving large investment on setting up the line or disrupting the production. The method to collect the data is take the data that recorded in industry that related to the process flow such as machine breakdown, tools availability, machine changeover etc.

## **1.2 Problem Statement**

This study will be conducted at manufacturing industry which produces electric supporting parts. From preliminary observations, the industry wants to improve their productivity by eliminating the problem that affect the production performance. The flow process issues can be divided into several problems as summarized as follow:

- a) The electrical part had to wait in the buffer until they are processed. It always happened in assembly area. It enhances the rate of inventory in the production.
- b) The production need to improve their cycle time of product in order to increase the productivity of company since there are various products is produced by the company.
- c) The worker available is not enough in the welding area. This cause of the bottleneck during the various productions.

### **1.3 Objectives**

This study embarks the following objectives:

- a) To investigate the problems those occur on the current process flow of production area.
- b) To improve process flow of manufacturing production by constructing various alternative scenarios of flow process.
- c) To propose alternative solution for production to reduce queuing and bottleneck problem.

### **1.4 Scope and Limitation of Study**

This study focuses on flow process improvement through the simulation in electrical part manufacturing. WITNESS simulation software is used as the student tool in this study. This study is conducted at Jati Beringin Sdn. Bhd. which had been selected as the manufacturing industries for getting all the data and information for this study. Moreover, the implementation of suggested solution does not covered on this study. This study is to evaluate the performance of the production in the company in form of conceptual model and to identify problem faced and solution for the problems.

## **1.5 Significance of Study**

This study may contribute to help the industry to enhance their productivity focus on the process flow improvement in the production. The industry also can consider all the solution of their problem for improvement in the short time by seeing the evaluation result in different scenarios on the simulation model without interrupt their production.

Moreover, this study can be as future reference and research for the academicians and industrials. The results from the study can be delivered to industry to enhance productivity of the production.

## **1.6 Report Outlines**

This study starts with the investigation of flow process improvement through simulation in manufacturing. After analyse the process flow, the problem on production will be observed.

Chapter one provides background of study, problem statements, objectives, scope of the study and significance of study. The problem that occurs in production is clearly identified with objectives and scopes are set to concentrate on solving the particular problem.

In chapter two, the literature review of application flow process improvement through simulation on the manufacturing are presented. The details of simulation application that be used for design of manufacturing process, process improvement and production control.

Chapter three is all about methodology. It provides the methodology in identifying problem happen in the process flow in production. The definition of problem

formulation, define objective, constraint and scope, model verification and validation, documentation and present result and alternative solution and improvement will be shown in this chapter.

Chapter four explained the conceptual modeling of the electrical part in the production line and the data collected for the project. Besides that, it shows the model scopes, level of detail of the model, validation and verification of the simulation model.

Chapter five presents the results obtained from simulation model and validation from the experiment. The model has been constructed into various scenarios in order to find the optimal solution for the real production. The model must be validated for progress actions.

Chapter six provides the conclusion and recommendation about the improvement on the process flow of production. By observing the output results from previous chapter, the most effective among those suggested alternatives will be proposed to the industry. Further improvement and recommendations for this industry might also be included in this chapter.

## **CHAPTER 2**

### **LITERATURE REVIEW**

This chapter presents the information regarding the literature review which related to the study. The information that related to the study that had been discussed in this chapter will be used in the methodology and discussion of the study in the study in order to assist the author to achieve the feasible results that needed based on the objectives of this study.

#### **2.1 Productivity**

According to Levary (1991), the relationship between the quantity of output and the quantity of input used to produce that output is called as productivity. Basically, the measurement of effectiveness and efficiency of organisation in producing output with the resources provided. Its measurement also used for identification and estimation of the proper output and input measures. In short, productivity is defined as the ratio of output to input.

Productivity is a significant element in economic growth. With expresses the relationship between the output and input in ratio, the production process can be measured in physical terms (Lee, 1987). The measure of productivity is the measures of the efficiency to the resources used. It shows that the productivity can measure every production system within the industry. The measurement of productivity will act as the benchmark for help to ease make improvement on the production of industry (Nachum, 1999).

### 2.1.1 Factors Influence Productivity

According to Buffet (2007), there are two categories of factors that influence the productivity which are:

- a) Controllable (or internal) factors;
- b) Uncontrollable (external) factors.

Figure 2.1 shows the factors affecting the productivity (Buffet, 2007).

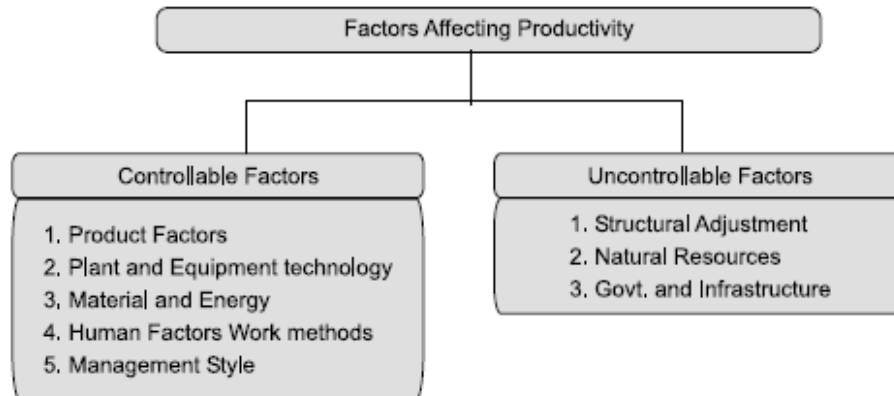


Figure 2.1: Factors Affecting Productivity (Buffet, 2007)

#### Controllable or Internal Factors

- (a) Product factor

In term of productivity, it means the measurement on how the product meets output requirement by its usefulness.

- (b) Plant and Equipment Technology

The availability of the plant increase through the increased of proper maintenance and the idle time reduction will enhance the productivity. The latest technology will help to increase the productivity.

- (c) Material and Energy

Material reductions also enhance the productivity improvement.

- (d) Human Factors Work Methods

To enhance the productivity, the work method must be improved.

- (e) Management Style

Dynamic management style has a better approach to achieve the higher of productivity.

## **Controllable or External Factors**

### (a) Structural Adjustment

It includes economic and social changes which plays significant role in the improvement of productivity.

### (b) Natural Resources

Man power, land and raw materials are vital to the productivity improvement.

### (c) Government and Infrastructure

It significant influences the productivity to the higher extent.

## **2.2 Simulation Modelling and Analysis**

Simulation can be used for assessing the productivity of manufacturing system. Simulation has become important in the past few years and allows designers imagine new systems and enable them to quantify and observed the system behavior. Whether the system is a production line, an operating room or an emergency-response system, simulation can be used to study and compare alternative designs or to troubleshoot existing systems. Several researchers have studied performance by using simulation techniques with the first uses dating back to at least the early 1960's (Hosseinpour and Hajihosseini, 2009).

Simulation modeling tools and techniques has been used numerously to improve manufacturing efficiency over the last four decades. An increasing number of manufacturing system decisions are being made based on the use of models, their use is still sporadic in manufacturing environments (Fowler and Rose, 2004).

Simulation is the imitation of the operation of real-world process or system over time (Banks *et al.*, 2009). Simulation modeling and analysis however is the process of creating and experimenting with computerized mathematical model of a physical system (Chung, 2003). Obaidat and Papadimitrou (2003) define the simulation as the