LEAN TOOLS APPLICATION FOR PRODUCTIVITY IMPROVEMENT

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

by

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DECLARATION

I hereby, declared this report entitled “Lean Tools Application for Productivity Improvement” is the results of my own research except as cited in references.

Signature : ……..……..

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Date : 9 January 2019

APPROVAL

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

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(Assoc. Prof. Dr. Mohd Rizal Bin Salleh)

ABSTRAK

Line Balancing adalah aplikasi yang biasa digunakan untuk mengimbangi proses dalam industri perkilangan. Aplikasi ini adalah satu cara untuk mengimbangi beban kerja yang diterima oleh pengendali dan stesen kerja. *Time Study* dilakukan di stesen kerja di bahagian pengeluaran. Stesen kerja adalah lokasi fizikal di barisan pengeluaran. Walau bagaimanapun, untuk mengimbangi beban kerja dan agihan tugas yang sama rata menjadi satu masalah bagi pihak pengurusan pengeluaran. Ini adalah kerana; bebeban kerja yang tidak seimbang akan menyebabkan bilangan produktiviti menurun. *Standard work* mesti diselesaikan mengikut *Takt Time* dan mempunyai lokasi kerja yang telah ditetapkan. Kajian ini dijalankan pada *Production Line 2* (P2) di Ain Medicare Sdn. Bhd. Kajian ini meliputi ruang memunggah P2 yang terdiri daripada empat stesen. Pergerakan tambahan dalam pemindahan produk akan menjejaskan masa kitaran stesen kerana reka bentuk stesen kerja yang tidak sesuai. Dalam proses pemerhatian, kaedah kajian masa digunakan untuk mengenal pasti *Takt Time*, masa kitaran, output dan permintaan. Untuk mengurangkan masa kitaran, *non-value added activities* akan dikenalpasti melalui *Yamazumi Chart* dan *Ishikawa Diagram*. Berdasarkan analisa data, cadangan penambahbaikkan telah dicadangkan untuk menghapuskan *non-value added activities*. Perbandingan antara sebelum dan selepas penambahbaikkan telah dibuat melalui perisian simulasi yaitu Witness Horizon. Maka, produktiviti telah meningkat dari 0.33 kepada 0.44 selepas pelaksanaan cadangan penambahbaikkan.

ABSTRACT

Line balancing is the common application to balance the processes in manufacturing industry. This application is a way to balance the workloads of the operator. Time study is performed at the workstation in a production line. Workstation is the physical location in a production line. However, to balance the workload and task equally is the difficult issue for the production management team. The unbalanced task and workload will cause the numbers of productivity decrease. The standard of work must be completed according to takt time and each station must have a designated location. This study was conducted at Production Line 2 (P2) in Ain Medicare Sdn. Bhd. This study covered at unloading room of P2 that consist of four stations. The additional movement in product transferring will affected the cycle time of the station due to inappropriate workstation design. In observation process, the method of time study is being used to identify the takt time, cycle time, output, lead time and demand. In order to reduce the cycle time, non-value added activities will be identify by Yamazumi chart and Ishikawa diagram. Based on data analysis, an improvement idea had been proposed to eliminate non-value added activities. The comparison between before and after improvement had been made by simulation software which is Witness Horizon. Thus, the productivity increased from 0.33 to 0.44 after the implementation of improvement idea.

DEDICATION

I dedicated this report to my beloved parents, family and friends.

ACKNOWLEDGEMENT

In the name of Allah, the most gracious, the most merciful, with the highest praise to Allah that I manage to complete this final year project successfully without difficulty.

During performing the final year project, I had receive the guideline and help from my respected supervisor, who deserve greatest gratitude towards me. I would like to express the deep gratitude to my respected supervisors, Assoc. Prof. Dr. Mohd Rizal Bin Salleh for his great monitoring, patient guidance, enthusiastic, encouragement and useful comments throughout this project. His willingness to spend his time generously has been very much appreciated.

In additional, I also grateful to all the members of Ain Medicare Sdn. Bhd., that allowed me to do my project at their company. A special thanks goes to my parents and all of my friends who was participate and guide me during the final year project. Thankful and indebted to them for sharing expertise, sincere and valuable guidance of the encouragement extended for me.

Finally, I would like to thank everybody who was important to this final year project report, as well as expressing my apology that I could not mention personally each one of you. In the deep of love from the bottom of my heart and with my highest appreciation , thank you.

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CHAPTER 1
INTRODUCTION

This chapter will briefly discuss the background, problem statement, objective and scope of the study. Background of study will elaborate on highlighted the title selected and some fundamental knowledge required in this study. Besides, the carried out issues and analytical data of the problem facing will be stated on the problem statement. The objectives and scope of study also will be discussed clearly in this chapter.

1.1 Background of study

This project is about the lean tools application for the productivity improvement in order to enhance quality, cost and delivering goods in manufacturing companies. The application of lean tools for productivity improvement in industries can help to support their activities in many functions of service such as assembly line, quality control and finished good hardware, it is an on-going procedure of process for the product to pass through their typical life cycles.

The application of lean tools is essential for planning the production quantities and timing for each product by controlling the material, equipment, manpower, and information resources used in production on a recurring basis. Understanding the basis of a production system for planning, scheduling, and controlling production quantities and time has been a fundamental curricular for this study. This study tends to delve more deeply into the analytical aspect of production systems for improvement. Moreover, recent trends such as globalization, lean manufacturing, and integrated supply chain modelling have created new issues and models calling for new generations of productivity improvement.

The positive results of lean manufacturing tools have attracted numerous manufacturing industries to implement it into their system. There are five types of primary elements of lean manufacturing in order to lead the industry becoming a world class competitor to the manufacturing industries. Various facets are represented these five elements to support a solid lean manufacturing tools and programs.

However, there are two different characteristics between five types of primary elements of lean manufacturing and five lean manufacturing principles. The primary element consists of manufacturing flow, organization, process control, logistics and metrics, and it is basically focused on a specific area of accentuation and compartmentalizes activities. While five lean principles also know as lean thinking are based on the Toyota Production System (TPS) approach to eliminate waste in every aspect of the companies and industries which are identify the value, map the value stream, creates flow, establish pull system and lastly is sought for the perfection.

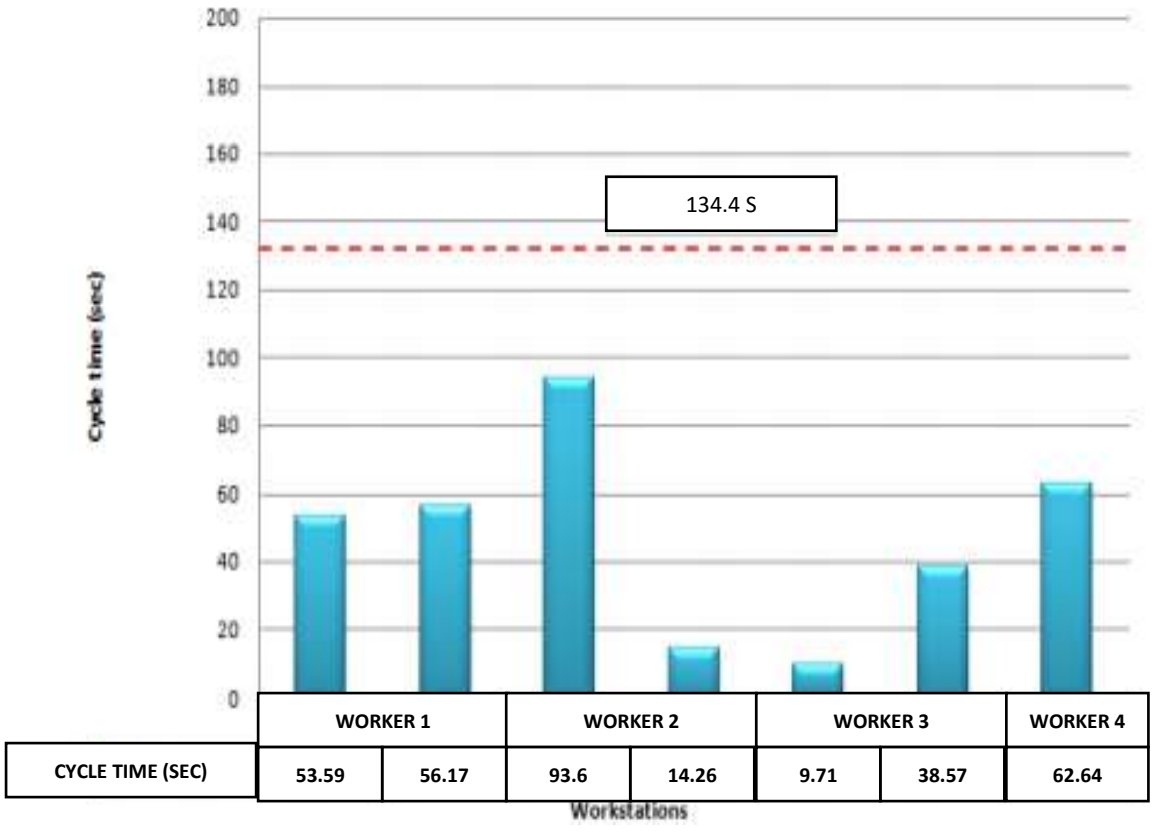

Figure 1. 1: Example of Line Balancing analysis chart

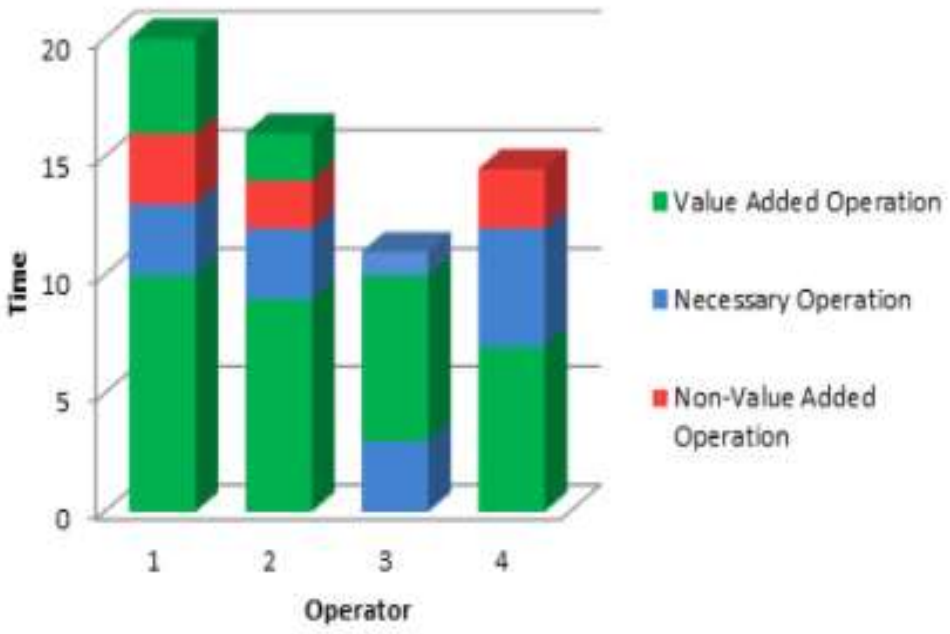

Figure 1. 2: Example of Yamazumi Chart

Figure 1.1 and 1.2 shows the analysis of the line balancing and Yamazumi chart which normally used to enhance the productivity and efficiency. The line balancing shows the work perform and had been assigned to the worker can be completed below the takt time. Besides, the Yamazumi chart shows the value added, non-value added and necessary operation that present for each of the station.

This study will be conducted at Ain Medicare Sdn. Bhd. which is placed at Jalan 6/44 & Kaw. Perindustrian Pengkalan Chepa 2, Kawasan Perindustrian Mara, 16100 Kota Bharu, Kelantan. Ain Medicare Sdn. Bhd., established in Malaysia year 1993, is a trusted name and leading manufacturer of pharmaceutical products, ranging from Large Volume Parenterals, Small Volume Parenterals, Irrigation Solutions, Haemodialysis Concentrates and Peritoneal Dialysis Solutions. Located in Kelantan, on the East Coast of Peninsular Malaysia, Ain Medicare operates from a multi-million dollar state-of-the-art pharmaceutical complex. The complex, inaugurated by former Prime Minister Tun Dr. Mahathir Mohamad in 1997, is fully equipped with production floor, microbiological and chemical laboratories, warehouses and administrative centre.

This company was selected due to its lows productivity at the production line. and to eliminated the waste based on the leans tools and techniques approach. The production line will be observed and monitored thoroughly before proposing the improvement. By identifying the problem at the production line using line balancing, the application lean tools which is Yamazumi Chart and Ishikawa Diagram will be used analyze the problem. Besides, an improvement idea will be proposed to the company based on the problem analyzed. The comparison system of production line and their productivity before and after improvement by the simulation software is the result of this research.

1.2 Problem Statement

Unloading room is the last section of the production line at Ain Medicare Sdn. Bhd. The related operations must be well organized in order to ensure only the quality product with minimum cost will be delivered to the customer. Line balancing is applied to ensure the work elements will be fairly distributed in order to avoid over workload to operators. From the line balancing, the activity of operator will be diffentiated by Yamazumi Chart to identify the value added and non value added activity. Besides, the underlying activity will be analysed by the Ishikawa Diagram. From those analysis, the improvement idea will be proposed and implemented through simulation software.

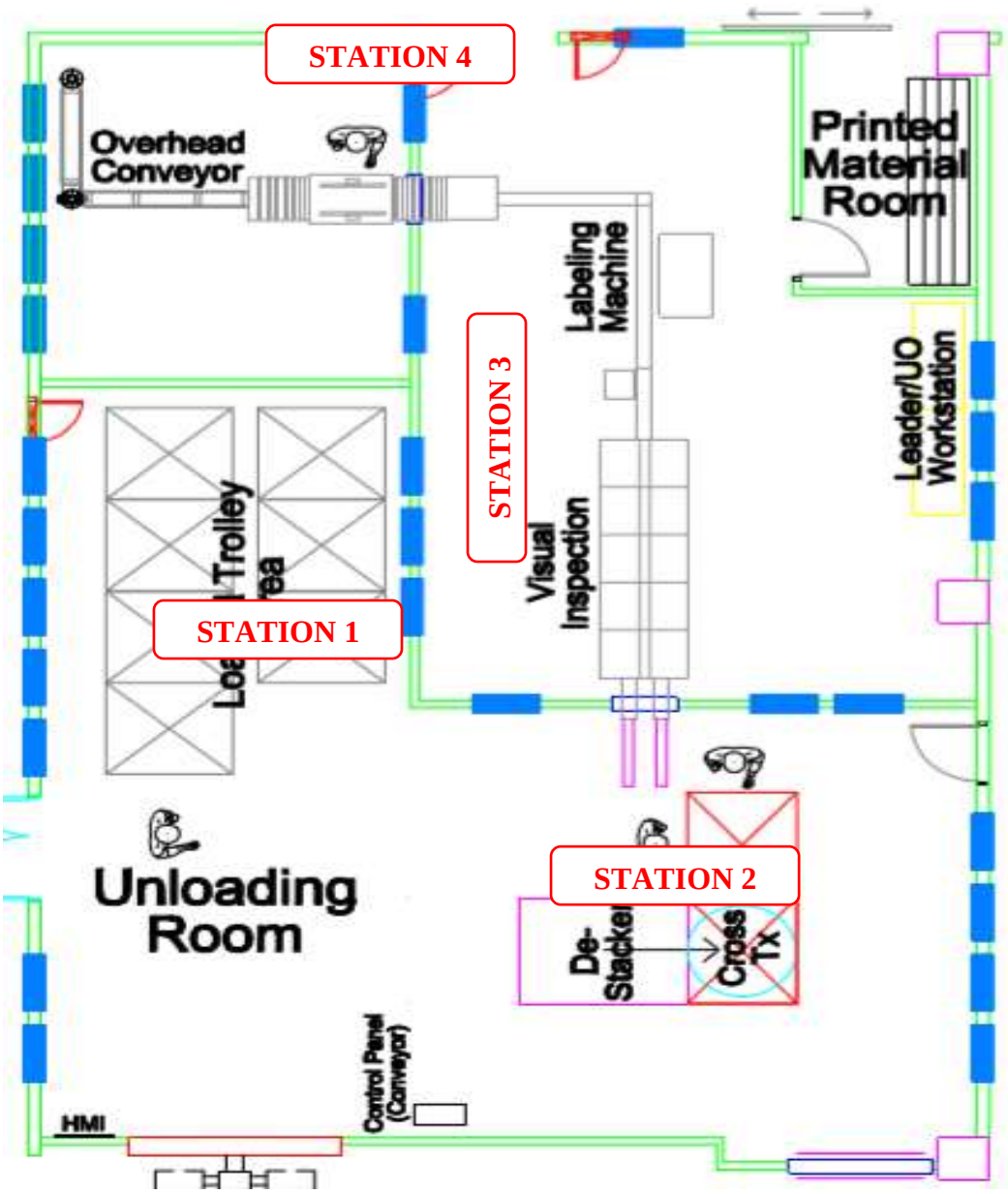

Figure 1. 3: Production Line (P2) unloading room

Through observation that had been made at Ain Medicare SDN BHD, the company has practiced the flexible demand because of the variety of product will pass unloading room. Four stations had been set up for their unloading room. The observation had been made for 7 days to monitor the distribution of workloads across all operators and it was clearly shown that in general the processes were unbalanced.

Table 1. 1: Result of observation for each station

PRODUCT PICK UP FROM TROLLEY TO THE BOX: STATION 1	
$T_{avg,}$ For each bottle	8s
The total time required to finish 1 layer	28 mins 48 s
The total time required to finish 1 trolley	2hrs 24 mins
PRODUCT ARRANGE ON THE CONVEYOR FOR THE PRODUCT INSPECTION, STATION 2	
$T_{avg,}$ For each bottle	6s
Total time for 1 box	2 mins 18 s
Total time per layer	21 mins 36 s
Total time per trolley	1hr 48 mins
PRODUCT INSPECTION, STATION 3	
$T_{avg,}$ For each bottle	6s
Total time for 1 box	2 mins 18 s
Total time per layer	21 mins 36s
Total time per trolley	1hr 48 mins
PRODUCT PACKAGING, STATION 4	
$T_{avg,}$ For each bottle	6s
Total time for 1 box	2 mins 18 s
Total time per layer	21 mins 36s
Total time per trolley	1hr 48 mins

Table 1 shows the workload of operators at unloading room. The cycle time for every operator had been observed. Operator 1 have to spend about 2 hours 24 minutes to finish their task. The operator needs to perform two tasks in one station which is pick up the product from the trolley and arrange the product inside the box before transfer those boxes to station 2. However, the operator need to inspect the product temperature in between the process. This is because, the product temperature must be below than 40 degree celcius for the labelling process through automatic labelling machine in between station 3 and station 4. For station 2, station 3 and station 4, they only required 1 hour 48 minutes to finish their task.

Table 1. 2: Data of line balancing chart

Element	Time average, (min)	Total time per layer, (min)	Total time per trolley, (min)
Station 1	0.133	28.8	144
Station 2	0.1	21.6	108
Station 3	0.1	21.6	108
Station 4	0.1	21.6	108

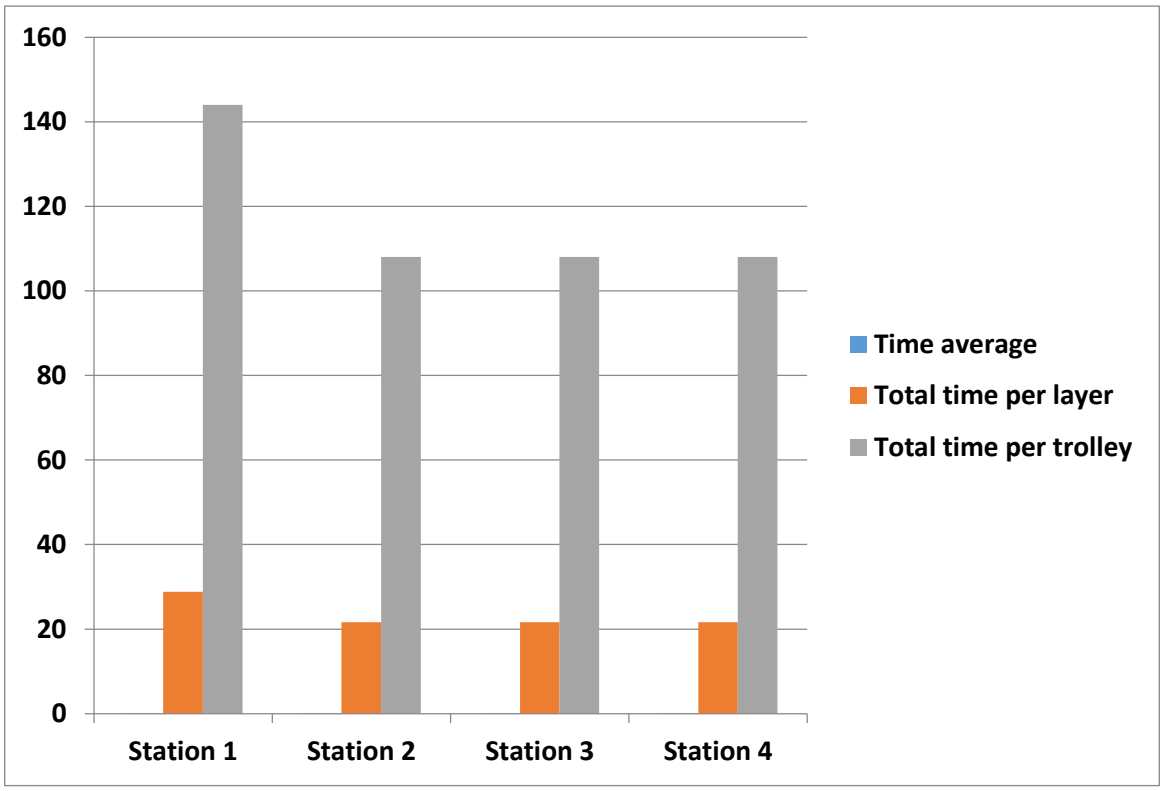

Figure 1. 4: Line Balancing Chart

Table 1.2 shows that the in balance work between station 1 and station 2. By discussing on the total time per trolley, station 1 required longest time to finish their task compared to station 2 that effect the waiting on station 2. As being calculated, the wating occur at station 2 is about 36 minutes before they can proceed their task. However, between station 2, station 3 and station 4 there were balance work process for every station. The chart on figure 1.4 shows the condition for every station based on the data from the table 1.2.

1.3 Objectives

1. To study the process flow at the packaging area of the production line 2 (P2) that exists at Ain Medicare Sdn. Bhd.
2. To propose the improvement ideas for productivity improvement.
3. To compare before and after improvement idea by simulation software.

1.4 Scope of Study

The study is focused on the effectiveness of the unloading room at the production line P2. Because of Ain Medicare Sdn. Bhd. consists of 5 production lines and the study will only focus on one production line (P2). The production is separate into two sections, which are loading room and unloading room. The unloading room is the section on packaging the product before transfering to the finished good hardware. Time study is a tool used to determine the efficiency and productivity of the production line. In the study, the number of station is fixed with four stations. However, the observation is based on the specific product to be observe which is 500ml polypropylene bottle. Besides, each type of product required same number of workstations. To conduct the observation, the method of time study will be used for this study. To get accurate value of data, the observation will be repeat 10 times before come out with time average for each station. In addition, identifying the seven types of waste through continuous observation of the processes involved and measuring the operators' cycle time are significantly important. This study will minimize the idle time by using line balancing approach. By applied the line balancing method, this study will determine which station that spend waste during the process such as waiting, overprocessing and motion. Besides, to figure up the value added, non-value added and option work Yamazumi Chart will be used. The underlying cause from the Yamazumi Chart will be analyse through Ishikawa Diagram. Based on the analysis, the improvement idea will be propose to increase the productivity which is labor productivity. The line condition before and after improvement will be implement by simulation software.

1.5 Report Structure

Table 1.3 will show the structure of the report accordingly during final year project 1 and final year project 2 as the summary for each chapter. The report structure was constructed for a better flow show to each element of the report.

Table 1. 3: Structure of Report

CHAPTER	TOPIC	DESCRIPTION
Chapter 1	Project Background	Project introduction and requirement for overall study consist of lean tools application.
	Problem statement	Describe the issues arise in the selected company
	Objective	The purpose of the study
	Scope	Consist of area covered in the study
Chapter 2	Literature Review	Previous studies from various resources to expose to the concept of study.
Chapter 3	Methodology	Discuss on the method that will be used in the study as well as proposing implementation ideas to solve the issue.
Chapter 4	Result and discussion	Result of the implementation idea.
Chapter 5	Conclusion	Overall achievement of students.

CHAPTER 2
LITERATURE REVIEW

The literature review is the predominant topics comprise of the studies and additionally look for the different distributed material. The materials refer to specific journals, articles, and books are utilized as direction for the following periods of published. All the materials are very useful as guidance for the researched and studies. This for sure is a compelling method for leading the studies on what has been done and what presently can't seem to be finished. Besides, it would distinguish the element of studies whereby any deficiency of the past studies can be resolved. Nevertheless, this chapter would relate to the past and what would be observed on the next stage of the improvement required.

2.1 Productivity

By converting inputs to total outputs is the calculation to measure the firm efficiency productivity as an important factor. In manufacturing system, the output usually could be expressed in the unit of physical volume like tons, pieces and any other measurable units. There is some manner of weighted for these physical units that can be added together. How much the input can be converted to the output is represent on how well the productivity itself. In term of industrial requirement, the productivity would be labour productivity, material productivity, overhead productivity and capital productivity (Rawat *et al*., 2018).

2.1.1 Measuring productivity

$$\textit{Productivity} = \text{Output} \div \text{Input} \qquad \text{(Eq.1)}$$

Productivity measure has no meaning by itself unless to gains meaning when the productivity measures compared to the prior period or comparable facilities producing similar outputs will be measured. By highlight improvements to produce more outputs with fewer inputs in order to maintaining the quality. It's also to motivate and evaluate attempts of product physically. The outcomes are not influenced by changes in relative prices and cost when physical measures are focusing on. When the outputs rise faster than inputs rising, the profits will increase in the short run. However, for the long run the competitive market will force the firm that will prevent from firm-specific, where the cost will increases on to the customers. By having higher productivity than competitors, or offering specialized product or service where the competitor cannot match are the advantages for having sustainable competitive (Banker *et al*., 1989).

In discussing behaviour and achievement, the efficiency, productivity and performance are the terms that tend to use interchangeably. The ratio of outputs to inputs representing the productivity efficiency, a broader term that incorporated efficiency and productivity for the overall achievement is the performance. However, a total basis or on a partial factor basis can be expressed as productivity. The ratio of output to all input is the total factor productivity (Everett and Ronald, 2008).

Productivity measurement is quite straightforward. For example, productivity is measured by labour-hours per ton of specific type of steel. The single factor productivity use when one resource input to measure productivity. Besides, when it includes the all input, is knows as multifactor productivity or total factor productivity (Ram Roy, 2015).

i. Single factor productivity:

$$\textit{Productivity} = \text{Output} \div \text{Input} \qquad \text{(Eq.2)}$$

ii. Multifactor productivity:

$$\textit{Productivity} = \text{Outputs} \div (\text{Labor} + \text{Capital} + \text{Materials} + \text{Energy}) \qquad \text{(Eq.3)}$$

As the productivity is interact with other system properties like consistency and reliability, as customer perceptions of quality as well, than the productivity indicate as a system property. It consists between the variables costs of service and good, with the fixed costs of facilities as well, technology and training. Productivity also work to compare on how well the current system doing compared to other system before and measure as a benchmarks. Besides, productivity will present about the effectiveness over efficiency of work (Sushil and Martil, 2014).

2.2 Toyota Production System (TPS)

In recent decades, while the Toyota Production System (TPS) and its derivations, namely lean production systems, influenced the restructuration of the automobile industry, other industries and the services sector, alternative production systems were developed in Europe and America without harming the perception that the TPS is a world-class production system, or that the car is indeed the machine that changed the world. The review of the literature on Lean published in over a quarter of a century leads to infer that the TPS highlighted the concept of eliminating waste and creating production flexibility in an integrated manner. That was systematically adopted around the world, with its tools, techniques, and best practices to support operational improvement. Its diffusion may be attributed to its focus on reducing waste, increasing delivery speed, reducing costs and improving quality of products and services, making Lean a benchmark in Operations Management.(Nunes *et al.*, 2017).