RELAYOUT THE PRODUCTION FLOOR OF TEACHING FACTORY

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

by

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DECLARATION

I hereby, declared this report entitled "Relayout the production floor of Teaching Factory" is the result of my own research except as cited in references.

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Date : 28 June 2022

APPROVAL

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

……………………….................................

(Professor Dr. Mohd Rizal bin Salleh)

ABSTRAK

Kilang Pengajaran Universiti Teknikal Malaysia Melaka (UTeM) mempunyai bilik pengeluaran di mana pelbagai jenis barangan dibungkus. Bilik pengeluaran mempunyai 6 sel kerja di dalamnya dan salah satu isu utama adalah mengenai jenis pengangkutan sisa yang mungkin memberi kesan kepada keberkesanan bilik pengeluaran (pengangkutan). Aliran bahan yang akan dibawa ke dalam inventori tidak cukup cekap dan menjejaskan sel kerja di dalam bilik pengeluaran. Tujuan penyelidikan ini adalah untuk memastikan pengeluaran dan mencapai kecekapan optimum. Beberapa objektif telah dikenalpasti dan berdasarkan konteks dan pernyataan masalah yang disenaraikan. Objektif utama adalah untuk mengenalpasti sisa yang melibatkan pengangkutan sepanjang proses. Setelah sisa dianalisis, langkah seterusnya ialah mencadangkan susun atur baharu untuk bilik pengeluaran untuk mengurangkan ketidakcekapan pengangkutan dalam barisan pengeluaran dan mengesahkannya menggunakan perbandingan jumlah pengiraan jarak. Mereka bentuk semula susun atur kemudahan di tingkat pengeluaran menggunakan Kaedah Perancangan Susun Atur Sistematik adalah salah satu cara untuk menangani isu yang timbul. Metodologi yang digunakan memerlukan teknik untuk mengumpul data dan langkah untuk membina susun atur untuk memaksimumkan produktiviti keseluruhan. Dalam kajian ini, susun atur optimum baharu untuk tahap pengeluaran yang ideal dicadangkan. Hasil daripada perbincangan akhir, perbandingan jumlah jarak antara susun atur semasa dan cadangan digunakan untuk memilih susun atur tersebut.

ABSTRACT

Universiti Teknikal Malaysia Melaka (UTeM)'s Teaching Factory has a production room where different types of items are packaged. The production room has 6 working cells in it and one of the main issues is regarding the conveyance type of waste that may have an impact on the effectiveness of the production room (transportation). The flow of the material to be brought into the inventory is not efficient enough and affects the working cells inside the production room. The purpose of this research is to relayout the production floor of Teaching Factory and achieve optimum efficiency in the line. Several objectives were developed and based on the context and problem statement listed. The primary objective is to investigate the waste that involves transportation throughout the process. Once the waste is analyzed, the next step is to propose a new layout for the Teaching Factory floor to reduce the inefficient of transportation in the production line and validate it using the comparison of total distance calculations. Redesigning the facility's layout on the production floor using the Systematic Layout Planning Method is one way to address issues that arise. The methodology used entails techniques for gathering data and steps for building layouts to maximize overall productivity. In this study, a new optimal layout for the ideal production level is proposed. As a results of final discussions, the comparison of total distance between the current and proposed layout are justified.

DEDICATION

Only

my beloved father, Baskerran A/L Ramalingam

my appreciated mother, Mageswary A/P Krishnan

my brothers, Vinod A/L Baskerran, Praveen A/L Baskerran, Vanesh A/L Baskerran

my project supervisor, Profesor Dr.Mohd Rizal bin Salleh

my panels of project and friends

for giving me moral support, money, cooperation, encouragement and also understandings

Thank You So Much

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With the greatest praise to GOD, the most generous, the most merciful, that I was able to accomplish my final year assignment effectively and without trouble.

I'd like to express my gratitude to Professor Dr. Mohd Rizal Bin Salleh, my project supervisor, for his advice and assistance during this research, as well as his trust in me.

I owe my parents a debt of gratitude for their continuous love and support throughout my life. Thank you for giving me the courage to reach for the stars and pursue my ambitions. Next, I would want to express my gratitude to my friends for their constructive criticism and suggestions throughout my research. I would never have finished this project if it hadn't been for all your prayers and blessings, as well as your real love and assistance.

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LIST OF ABBREVIATIONS

TPS	-	Toyota Production System
JIT	-	Just In Time
VSM	-	Value Stream Mapping
SLP	-	Systematic Layout Planning
LLL	-	Life Long Learning

CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter covers the context that leads to a new layout for optimal production as well as the problem of manufacturing wastes involving transportation, which has an impact on the efficiency of a production line. The problem statement, objectives, and scope of the study are all included in this chapter. This chapter gives readers an overview of the topics that will be discussed as the study progresses. There will be a thorough examination of layout designs, lean manufacturing tools, and manufacturing wastes.

1.1 Background of Study

In today's increasing global competition, manufacturing environment continuously must change to remain productive and efficient. Almost all manufacturing organisations have issues with plant structure and, as a result, material flow. The present tendency in the manufacturing industry, which, like many others, is going through an extremely competitive period, is to cut manufacturing costs, enhance quality, and increase customer satisfaction. Organizations must design performance measurements to keep track of performance. Materials handling equipment and the facilities in which it functions can account for up to 70% of the overall cost of a finished product. Part of facilities planning includes facility layout designs. It is the organisation of workspace that, in general, makes it easier to access facilities with strong interactions. The primary goal of the planning of facility layout is to lower the cost of materials handling, as bad materials handling can cause problems involves businesses, as well as to lessen transportation challenges. A proper layout will allow the product to be manufactured in the needed volume and variety at a reasonable cost. The primary goal of workstation deployment planning is to create a system that is best suitable for production and saves money. Over the last few years, the manufacturing industry has been confronted with difficulties that have grown in scale and complexity (W. Wiyarat *et al* ., 2010). As a result, procedures, or approaches for resolving various challenges found in today's production environment without lengthy shutdowns or costly adjustments are urgently needed.

Manufacturers are being forced to optimise their manufacturing processes, operations, and all possible ways of supply chains to deliver high-quality products in a short period of time. The development of this improvement has increased the desire for speedier product innovation, productivity improvement, waste elimination, greater process control, effective and efficient use, and global reach to obtain competitive advantages (Crabill, *et al*., 2010). The Toyota production system (TPS), which is based on the lean concept, is one of the efforts that many large organisations across the world have tried to embrace to streamline the production process and achieve resource optimization (Liker, *et al* ., 2011). The goal is to remove waste across the board, including in client relations, product development, and factory management (Gelei, *et al* ., 2015). Another purpose is to minimize effort and time, inventory, product development time, and space to be more responsive to consumer needs while producing high-quality products in an efficient and cost-effective way possible. Manufacturing leanness is a continual process optimization method which helps to get the best production. Manufacturers can reduce waste and non-value added (NVA) activities by applying various lean methods and principles (Steed, *et al* ., 2012). However, not all lean applications have produced the same outcomes.

Over the last few years, the manufacturing industry has been confronted with difficulties that have grown in scale and complexity. As a result, procedures, or approaches for resolving numerous challenges found in today's manufacturing environment are urgently needed.

1.2 Problem Statement

In Teaching Factory, which is located at Universiti Teknikal Malaysia Melaka, there is a production packaging house running with continuous supply and demand. The project will focus on the inefficiency of transportation in the production line and a proper layout to increase the productivity and reduce the wastes involved.

After some observations are being made in the production line, there are some issues that need to be examined. Firstly, the flow of material from the initial stage which is the receiving until the final stage which is the completion of the product. Currently, the flow of the material to be brought into the inventory is not efficient enough and affects the working cells inside the production room. This is because, the flow of the products and the working cells clashes to bring the product inside the inventory room. Besides that, the way of receiving materials is also causing ergonomic issues due to the twisting, bending, turning etc. Hence, there are several factors need to be considered to accomplish the efficiency improvement such as the material handling and smooth flow of the materials. Examples of poor ergonomics are shown in the figures below.

Figure 1.1: Poor Ergonomics (a)

Figure 1.2: Poor Ergonomics (b)

The movement of the materials from the inventory to the working cells is also an issue due to distance from the inventory to the working cells. Based on my observation during the working period, the workers must walk for a certain distance, bend their body, take the material, bend over again, and then proceed to the working cells. Here is shown the current layout of the production house.

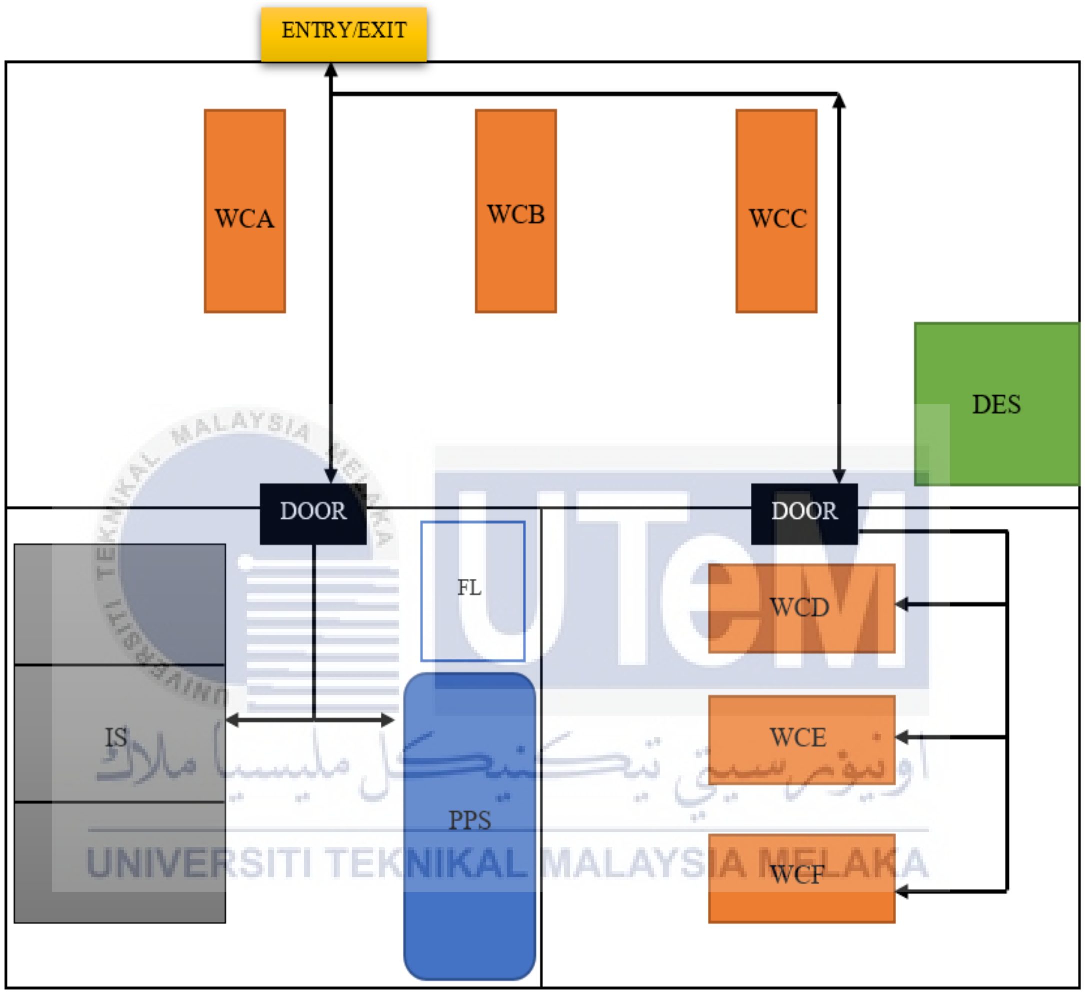


Figure 1.3: Teaching Factory Product Packaging Floor Layout

The current layout is not the most optimum layout for the best performance of the workers because the arrangement is not perfect. Layout plays and important role in any working environment to produce a high efficiency work rate and to reduce wastes in manufacturing. This issue needs to improve because this breakdown time will affect the productivity.

1.3 Objectives

The objectives for this project are:

a) To investigate the waste that involves transportation throughout the process.

b) To propose a new layout for the Teaching Factory floor to reduce the inefficient of transportation in the production line.

c) To validate the layout that has been proposed to improve the efficiency of the production line.

1.4 Scope

This project will be covering:

a) The Lean Management tools to analyse the waste throughout the process.

b) The usage of Systematic Layout Planning (SLP) for the construction of new layout.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter covers the context that leads company background as well as the problem of manufacturing wastes and the tools used to overcome, which can improve the efficiency of a production line. The wastes and tools are all included in this chapter. In addition, facility layout planning will be briefed in detailed in this chapter. This chapter gives readers an overview of the topics that will be discussed as the study progresses. There will be a thorough examination of layout designs, lean manufacturing tools, and manufacturing wastes.

2.1 Company Background

The Teaching Factory was created and built at Universiti Teknikal Malaysia Melaka to provide real-world simulations of production and services in common industrial operations.

Figure 2.1: Teaching Factory Logo

The UTeM main campus in Durian Tunggal Melaka is location for the Teaching Factory. The Teaching Factory building was originally the Faculty of Manufacturing (FKP),UTeM until the faculty was relocated to a new facility next to the Teaching Factory. Teaching Factory is open Monday through Friday from 8 a.m. to 5 p.m.

Figure 2.2: Teaching Factory Building

The Teaching Factory has a safety policy, and it is the obligation of UTeM to implement it as effectively as possible. The safety policy are create and sustain a safe and healthy work enviroment and create and maintain a systematic, effective and active occupation health and safety management system in line with the related laws. Other than that, creat and maintain a safe work system and procedure and ensure the availability of appropriate and sufficient safety equipment at all times and Nurture awareness throught practices, briefings, notifications and educations in order to prevent, face and handle dangers at the workplace. Lasty, create and disseminate information of signages of occupational safety and health at the UTeM and review written policies, programmes and safety and health plans at UTeM as continuos improvements and effective reforms.

Students can also try out some of the Teaching Factory's equipment. Some of the tools that are available are as follows: CNC Machine for turning Material bars, such as wood, resin, and metal blanks, are spun in a chuck while a tool/chisel removes material to make the appropriate form. Furthermore, CNC Milling is a machining procedure that removes material from a workpiece such as wood or steel bars using computerised controls and rotating multi-point cutting tools or drills to produce a custom-designed part or product.

The Teaching Factory was designed with various features that make student training easier. The design studio, monitoring centre, production house, Prym's Packaging Workspace, meeting rooms, and administration office are just some of the amenities accessible at Teaching Factory. The availability of these amenities made training activities including meetings, discussions, and manufacturing activities at the Teaching Factory a breeze. Some of the facilities accessible in Teaching Factory are depicted in the figures as attached.

Figure 2.3: Meeting Room

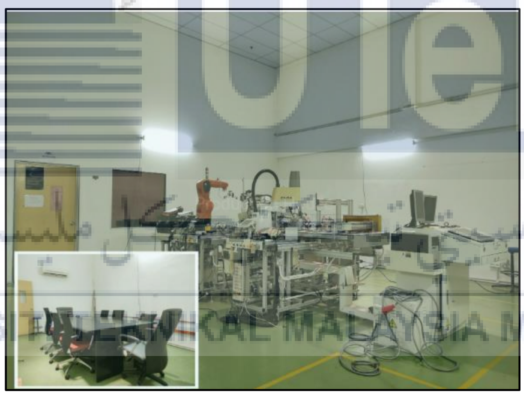


Figure 2.4: Production House

Figure 2.5: Design Studio

Figure 2.6: PRYM's Product Packaging Room

Learning activities were created and structured in the Teaching Factory's teaching plans to ensure that they met the needs of academic programmes without compromising the factory's efficacy. The Teaching Factory is also forming a smart relationship with the industry in order to ensure that the teaching plans can achieve their long-term objectives, as well as providing services to the industry by planning and managing commercial activities.

Students can utilise the experimental approach to find and solve problems in a factory or industrial setting in the Teaching Factory department. Students were able to grow into innovative problem solvers who could see things from a fresh viewpoint thanks to the training they got. As a result, current and future engineers and IT professionals will have a better opportunity of becoming creative thinkers because to this facility.

2.2 Lean Manufacturing

Lean manufacturing is a strategy to manufacturing applications that focuses on decreasing waste while increasing productivity. Everything which customers do not believe has worth and for which they are unwilling to pay is regarded as waste. Lean manufacturing benefits include shorter lead times, cheaper operating costs, and higher product quality. Lean Manufacturing is also a strategy for improving operating efficiency, lowering costs, and reorganising operations. Shorter cycle and lead times, lower work in process (WIP) and expenses, higher quality and revenue, enhanced production and profit, and improved customer service are all benefits of this lean manufacturing (Brundage, 2016). Reduction of waste, pull production, achieving zero defects, minimization of process and continuous improvement have all been implemented and executed by many production or operation managers. Employee participation, sufficient skills and training, and top management commitment are all critical to the success of this lean manufacturing deployment (Godinho Filho, *et al*., 2016). Specifying value, flow, identifying the value stream, pull, and perfection are the five lean principles. These lean concepts have resulted in lower costs, shorter cycle times, and improved quality. There are three activities that must be distinguished in a lean manufacturing method, namely:

a) Activities that offer no value (non-value added) and can be minimised or discontinued.

b) Activities that do not bring value yet are either unavoidable or required (necessary nonvalue added).

c) Additional value-added activities (value added).

When a lean strategy is implemented incorrectly for a given context, it can result in an increase in waste, expense, and production time for a firm. Changes may cause interruptions in the process they were supposed to improve due to poor selection of lean tactics. As a result, having a methodical approach to implementing appropriate lean solutions focused on detecting wastes in manufacturing processes is critical (Sa´nchez, *et al*., 2011). However, there have been few attempts to create a formal framework for implementing effective lean solutions. Since manufacturers seeking guidance on implementing new lean strategies may want some theoretical grounding to guarantee that their acquisitions are logically sound, a methodology for effectively implementing lean approaches, as well as a methodology for evaluating continuous performance improvement, must be evolved (van Dun, *et al*., 2017).

2.3 7 Wastes

The lean concept's core principle is to reduce or eliminate waste. Waste is any activity that adds no value to the process along the value stream. Overproduction, waiting, transportation, inventory, overprocessing, motion, and defects are the seven categories of waste in the manufacturing business that will be discussed in this section.

2.3.1 Waste in Transportation

Transportation waste takes place whilst tools, equipment, or products are moved for longer than needed. Excessive fabric motion can cause product failure and damage. Excessive movement of individuals and instrumentality will waste time, cause wear and tear, and build people tired. Unnecessary product, equipment, and personnel movement. Transport is a necessary component of most businesses, and it adds value that customers value, thus it should be considered a strategic part of any organization. Transportation permits businesses to deliver the suitable merchandise within the correct amount to their customers at the correct time, however an excessive amount of transportation wastes resources and adds to the customer' prices.

2.3.2 Waste in Inventory

Accounting treats inventory as an asset, and suppliers typically provide discounts for big orders. Having a lot of inventory than is needed to sustain the same flow of work, on the opposite hand, may end up in issues like product faults or broken materials, longer producing lead times, inefficient capital allocation, and problem being buried in inventory. On the opposite hand, an excessive amount of inventory will cause longer lead times, broken or defective goods, and inefficient capital allocation. Inventory countermeasures embrace buying raw materials simply once and within the quantities required, removing delays between producing phases, and planning a queuing system to scale back overproduction.

2.3.3 Waste in Motion

The waste of movement, which is often confused with transport waste, is any movement of people that does not add value to the product or service. It is a serial killer of productivity. Waste in motion is defined as any uneven movement of people, equipment, or machinery this includes walking, bending, and twisting to rise up worker efficiency whereas at the same time taking care the health of workers. Wasted motion within the workplace includes walking, reaching for items, sorting out files, browsing through inventory to search out what's needed, excessive mouse clicks, and double entry of data. Manufacturing motion waste includes repetitive movements that don't offer price to the customer, comparable to reaching for supplies, walking to fetch a tool or materials, and readjusting an element once it's been installed.

2.3.4 Waste in Waiting

When components, machines, or other co-workers are idle while waiting for operators, this is known as waiting waste. The scarcity of material in warehouses or the breakdown of processing gear are the most common causes. Whenever people are waiting for materials or equipment, they are wasting their time. Unevenness in production stations may be a common supply of waiting time, which might lead to excess inventory and overproduction waiting for others. Waiting waste at a production plant would possibly consist of such things as looking ahead to resources, looking ahead to the proper commands to begin production, and having device that isn't always as much as the task. Designing strategies to maintain non-stop or single-piece movement, levelling the burden via the usage of standardized directions, and constructing flexible multi-professional teams that can quickly respond to transforming requirements are a few of the countermeasures for waiting. A waste of time is time lost because of a productiveness slowdown. This commonly takes place while employees ought to watch for materials or while output is hampered through unexpected equipment repairs.

2.3.5 Waste in Over-Production

It is needless to produce more than the customer's requirements or to produce it too early. The chance of disintegration and generating the incorrect product increases. It usually results in long lead times and storage times. When a product or a component is completed before it is ordered or asked for, this is termed as overproduction. Nevertheless, rather than producing products as requested using the 'Just in Time' concept, the 'Just in Case' manner of working disrupts productivity and necessitates additional expenses to the firm to fund the production process and increases lead times. Additionally, overproducing a product raises the risk of the product or quantity of things produced falling short of the customer's expectations. There are three methods to overcome overproduction. To initiate with, calculating the 'Takt Time' ensures that output rates are balanced among stations. Second, by reducing setup durations, single-piece flow can be achieved. Finally, to control and manage the amount of work in progress, a pull or 'Kanban' method might be used.

2.3.6 Waste in Over-Processing

Over-processing occurs in situations where simple procedures, such as the use of a large intransigent machine instead of several small flexible machines, find overly complex solutions. Over-processing occurs when a product or service is made with more labor, more materials, or more procedures than the client anticipates. In manufacturing, this could include utilizing more accurate equipment than is necessary, as well as components with higher capacities than are required. Acknowledging the task requirements from the client perspective is a simple way to avoid over-processing. Always start with the client in mind, produce to the customer's desired level of quality and expectation, and only make the number necessary.

2.3.7 Waste in Defects

When a product is unsuited for its intended use, it is called a defect. The product is frequently revised or abandoned because of this. This can include administrative errors, late delivery, inaccurate manufacture, the use of too many raw resources, or excessive scrap formation, in addition to the physical faults that directly add to the cost of the sold goods. These outcomes are inefficient because they raise operating costs whilst also offering little value to the customer. If these things do not satisfy corporate requirements, they must be declined or remade, increasing operational costs while providing no benefit to the client. Here are four options for reaction. Begin by looking for the most common flaw and focusing on it. Second, create a system for detecting abnormalities and guaranteeing that no defective items make it through the manufacturing process. Finally, restructure the procedure to eliminate any faults. Finally, coordinate work to guarantee that the production method is uniform and free from defects.

2.4 Lean Manufacturing Tools

Manufacturing will encompass far more than machining metals, etching wafers, building computers, and regulating bioreactors throughout the next century. Manufacturing operations must be accountable, flexible, predictable, and consistent to compete worldwide, and even locally (Maleszka, *et al* ., 2016). Users can remove waste, save money, and develop their organisation by applying Lean Tools in the manufacturing process. Companies typically integrate Lean techniques with Six Sigma approaches in a range of domains, including manufacturing, engineering, and finance (Salonitis, *et al*., 2017). The Japanese word for waste is muda, which implies "uselessness." Lean tools are designed to reduce Muda and improve quality control in organizations. To put it another way, the goal of Lean tools is to reduce inefficient processes. Despite the fact that there are numerous Lean methods available, this study will concentrate on five of them and how they can be used.

2.4.1 Bottleneck Analysis

Bottleneck method is a tool of assessing the processes and workflows involved in developing a product or service in a methodical manner. Bottleneck analysis can then be used to solve both obstacles along the way by identifying and addressing operational and process restrictions. This Bottleneck Analysis includes its own set of guidelines for implementation. Organizations may save time, energy, and money by identifying and eliminating bottlenecks using Lean concepts. Depending on the sort of bottleneck, individuals can fix it in a variety of different ways. For example, bottlenecks produced by inefficient steps can be controlled by improving those processes which is by, if the bottleneck is caused by resource lacking, users may need to recruit more workers or engage in new technologies to create their available resources go better.

2.4.2 Just-In-Time (JIT)

Just-in-time (JIT) manufacturing is an on-demand production strategy that allows manufacturers to begin creating a product only after a customer has placed an order. This eliminates the need for businesses to stockpile unnecessary goods, lowering the risk of excess inventory or defective products while in storage. This technique has its set of instructions for implementation. If their firm can work on-demand and limit the risk of only carrying inventory when it's needed, Lean experts would choose JIT. JIT can be a helpful paradigm for inventory management, but it can also make meeting consumer demand extremely challenging if the supply chain collapses.

This method is widely used in self-publishing, which prints books exactly as they are ordered. Because of the digital distribution of media items, the cost of extra materials has also decreased. Organizations in industries like manufacturing should properly examine their supply networks before employing JIT to minimize the exposure of interruption. It's vital to have a fallback plan in place if a major supplier, for example, needs to shut down, but the demand can still be completed.

2.4.3 Value Stream Mapping (VSM)

Value Stream Mapping (VSM) is a method adopted from Lean manufacturing (VSM). Businesses use it to create a visual depiction of all the elements needed to deliver a product or service, with the goal of evaluating and improving the overall process. VSM is used in a variety of industries, including manufacturing, banking, and healthcare. This approach uses a flow chart to show all the necessary personnel, processes, data, and inventory to provide an overview of the company. This method has its own set of instructions for implementation. For example, through promoting continuous progress in the development. The next step is to transform an organization's culture. VSM also involves improving the clarity of collaboration and communication. It's a tool that gives practitioners communication solutions and descriptions of theoretical development points, and it's becoming a standard among redesign techniques.

2.4.4 5S

5S is one of the most basic building blocks of Lean Manufacturing and one of the first lean tools users use to get started. It's a cornerstone of Lean, and without it, organizations can't succeed. What is 5S?

5S - Organize the work area:

1. **Sort** - remove anything that isn't required.
2. **Straighten** - assemble the remaining elements
3. **Shine** - clean and examine the work environment
4. **Standardize** - create guidelines for optimization
5. **Sustain** - implement the requirements on a regular basis

2.4.5 Kanban

Kanban is a visual cue-based manufacturing inventory control method that guides goods through the various stages of the production process. It's a lean manufacturing tool that only starts production to replenish empty reserves, attempting to avoid inventory pileup. Kanban is a "pull" method, which means that rather of anticipating demand, it reacts to it. What is Kanban and how does it work? A Kanban system is supposed to control the entire value chain, from the suppliers to end user. As a result, supply interruptions and overstocking of products can be avoided at various stages of the manufacturing process. Continuous process monitoring is a requirement of Kanban. Avoiding bottlenecks that might slow down the manufacturing process necessitates extra caution. The idea is to boost throughput while shortening delivery times. Kanban has become a valuable tool in a variety of manufacturing processes.

2.5 Facility Layout Planning

Due to the sheer market's clear globalization, manufacturing companies are increasingly required to supply cost-effective, high-quality products regardless of where they are manufactured. The layout of a facility considers the relationships that exist between activities, features, and places. A facility layout is a diagrammatic representation exactly everything that is required for the manufacturing of goods, or the delivery of services is organized (Sa'udah *et al*., 2015). A facility is an entity that makes it easier to accomplish any task. A machine tool, a work center, a production cell, a machine shop, a department, or even a warehouse might be it. Interior walls, offices, and rooms, as well as equipment, amenities, employee workspaces, customer service spaces, material storage facilities, walkways, restrooms, and lunchrooms, must all be constructed effectively. A very well facility layout allows for a continuous flow of production resources, equipment, and manpower at a cheap cost (Friedrich, *et al*., 2018). Facility layout refers to the physical arrangement of space in the plant for economic activity. The variety of items and manufacturing numbers are usually the determining factors in layout development.

2.5.1 Objectives of Facility Layout Planning

The primary goal is to organize equipment and work areas in the most efficient and effective way while still being comfortable and safe for the workers (Azadivar, *et al*., 2010). This involves three major points which are:

1. Volume and Product Design

2. Capacity and process equipment

3. Workplace satisfaction

The following facts must be obtained to achieve these key objectives.

i. Reduction of traffic congestion.

ii. Unnecessary occupied regions are removed.

iii. Improvement on supervision and control.

iv. Improved workforce, equipment, and service usage.

v. Material handling activities and stock in process being minimized.

vi. Health risks are reduced, and workplace safety is improved.

vii. Delays and manufacturing time being reduced, and production capacity is enhanced.

2.5.2 Factor Influencing Facility Layout Planning

The layout and design of a given region have a significant impact on the flow of work, material, and knowledge through the system. Linking the needs of people (workers and customers), materials (raw, completed, and in process), and equipment into a unified, well-functioning organization is critical to successful plant design and planning (Ojaghi, *et al*., 2015). Several elements influence the planning and engineering of facility layouts. These characteristics differ by industry, but they all have an impact on facility layout. The factors that influence plant layout can be divided into five categories which are:

1. Materials
2. Machinery
3. Labour
4. Material Handling
5. Waiting time

2.5.2.1 Material

The quality of the system that will be created at the plant, as well as the many parts and materials that will be employed, will influence the structure of the productive equipment. Size, form, volume, weight, and physical attributes are all important aspects to consider since they affect manufacturing techniques, storage, and material handling operations (Siderska *et al*., 2018). Plant layout will be influenced by the sequence and order of processes, as well as the variety and number of products to be produced.

2.5.2.2 Machinery

To create a comprehensive plan, one must be familiar with the procedure, machinery, tools, and other material, as well as their applications and specifications. The plant layout is inextricably tied to the methods and time studies used to enhance processes. The type, total availability for each type, as well as the type and number of tools and equipment, must all be considered in addition to machinery (Teunter, *et al*., 2008). It's also crucial to understand the required space, form, height, weight, quantity and type of workers, personnel hazards, and additional service requirements (Yang, *et al*., 2000).

2.5.2.3 Labour

In the production process, human labour must be organized involving direct labour, supervision, and auxiliary services. Another factor to consider is the environment, which includes staff safety, lighting, ventilation, temperature, and noise levels, among other things. Moreover, another important aspect to consider is process variables, which include human qualifications, flexibility, the quantity of workers needed at any given moment, and the type of job they will be performing (Budianto, *et al*., 2020).

2.5.2.4 Material Handling

The most significant aspects to consider while planning a layout are the design and specifications of materials, the sheer volume of materials, and the combination of materials. Material storage, space, raw material weight, floor maximum throughput, ceiling height, storage system, and so on should all be addressed. This influences the size of the facility as well as the effectiveness of the production process. It will promote cost-effective goods manufacturing, timely material flow, and a well-designed materials management system (Suhardini *et al*., 2017). When applicable, minimize material handling and combine with other operations to eliminate needless and wasteful transfers.

2.5.2.5 Waiting Time

The final section to examine, and one that can be the most difficult to pinpoint, is the amount of time spent waiting during the procedure. Implementing standardized work is the most effective technique to begin finding waste in the process (Mulugeta, *et al*., 2013). Continuous material flow through the operation, eliminating the costs of downtime and activity associated that occur when the flow is interrupted. The material waiting to move through the system, on the other hand, is not always a cost to be avoided. Because stock can be used to protect production, improve customer service, allow for more cost-effective batches, and so on. When designing the layout, it is vital to account for space for the required stock at the facility. Resting period to allow the body to chill down or warm up (Puspita, *et al*., 2017).

2.5.3 Importance of Plant Layout

In any production process, a plant architecture is critical. You'll have an overall strategy for how the plant will be positioned according to this layout**.** The layout of a plant can be changed, and this can have a big impact on the overall efficiency of a production system. In general, the biggest purposes of the plant planning function are to make it possible to create the product in the desired volume and variety at a reasonable cost (Garcia-Sabater, *et al*., 2020). Some of the importance of plant layout are as below:

1. Material handling costs will be reduced.

2. Better visual control.

3. Every part of the approach will be put to good use.

4. Eliminates production bottlenecks.

5. Allows for a higher level of quality control.

Other purposes include making efficient use of people, space, and infrastructure, as well as ensuring the worker's overall health and morale.

2.6 Systematic Layout Planning

Facility layouts can be designed using a variety of tools and approaches (Halicka, *et al* ., 2016). The function of facility layout includes analysis, planning, and execution to improve and attain optimum performance in several linked operations. Systematic Layout Planning (SLP) also widely used and applied for various types of problems such as transportation, production, support services, warehousing and activities found in any production room. SLP consists of 11 main steps which are:

1. Input data and P, Q, R, S, T activities
2. Flow of material
3. Activity relationships
4. Relationship diagram
5. Space requirement
6. Space available
7. Space relationship diagram
8. Modifying considerations
9. Practical limitations

10. Layout developments

11. Evaluation

SLP is a step-by-step planning procedure which allows users to identify, analyze and visualize in detail to produce a new efficient layout which improves the overall performance. For the evaluation, the total amount of distance for the current and proposed layout will be accumulated and compared. The percentage of improvement is calculated by using the Equation 2.1.

$$Percentage\ of\ improvement = \frac{Original - Proposed}{Original}\ x\ 100\% \qquad (2.1)$$

Equation 2.1 will be used for the evaluation and validation of the new layout that will be proposed. The total distance of current and newly proposed layout will be subtracted and divided with the value of the current total distance and multiplied with 100% to get the value in percentage form.

CHAPTER 3

METHODOLOGY

3.0 Introduction

For the aim of gaining an answer to a survey topic, a planned data collection strategy is required. A series of observation visits to the Teaching Factory packaging floor are necessary to collect data. To properly comprehend the process's influence, wastes involved, motion, and delay, we must devote a significant amount of time. As a result, it's critical to plan for the visit. Before visit, a clear idea of needed date to be collected is needed to avoid time wastage.

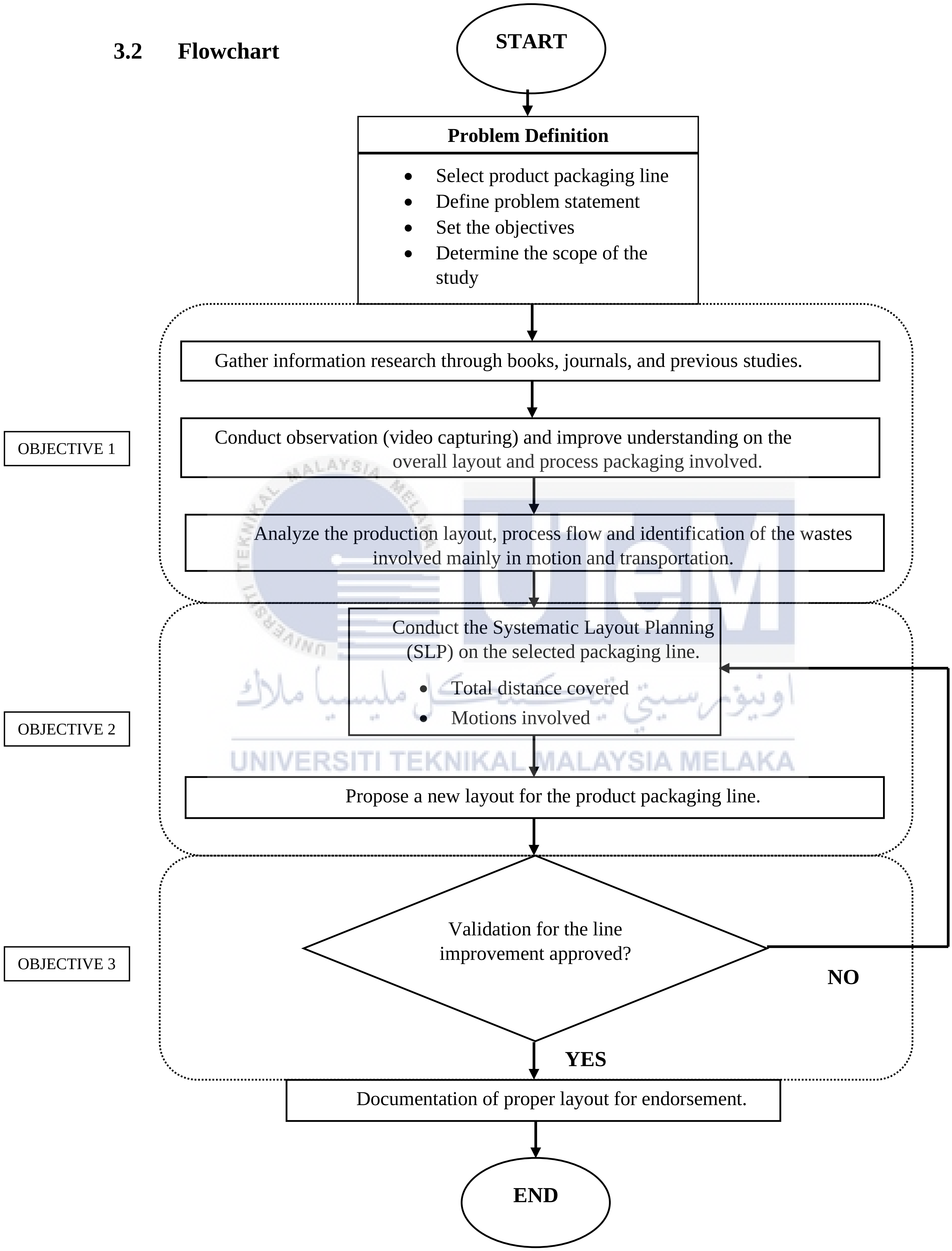
3.1 Project Planning

The project has been divided into two phases in general. **PSM I** is the first phase, while **PSM II** is the second phase.

a) **PSM I**, the first step focuses on identifying difficulties in the chosen location. After identifying the issues, the next step is to set the study's objectives and scope, which are the project's target and focus areas, respectively. Following that, the necessary literature is searched for a thoroughly referenced review that is relevant to this project. Finally, the methodology for carrying out the project is determined.

b) **PSM II,** the project will begin with data gathering, data verification, and layout analysis on the manufacturing floor. Finally, the project is completed, and recommendations are made for future improvements.

3.2 Flowchart



3.3 Data Collection

It is critical to find the appropriate information for the project because it aids in the definition and refinement of the project. This necessitates several tactics and approaches, such as reading the main points, making observations, and scanning which is reading over in detail. The data's that have been collected must be evaluated to see if they meet the project's requirements. The details are then scrutinized for specifics and in-depth information.

3.3.1 Primary Source

Primary source is for the data collected through observation, total distance measurements, and discussions.

3.3.2 Secondary Source

Secondary sources are information's that are gathered from the books, journals, articles, and the internet. The data collected from books are formerly achieved from the university library (UTeM's library) and some public library. The next step is to find internet sources by visiting related websites. This source contributes significantly to the study and obtaining of facts or information. Furthermore, journal sources are obtained from the university library, which has subscribed to the required or related journals or articles so that students can readily locate them. The Z-library and Science Direct websites were used to acquire journal sources for this project.

3.3.3 Discussion

Every week, the findings were discussed with the supervisor. During the meeting, the supervisor revised the entire report to produce a good product with no errors in writing. Selecting the correct tools and procedures for productivity development in the selected manufacturing base, as well as how to use the tools in the industry, are explored during the discusion. During the discussion, the supervisor also taught lean manufacturing concepts and provided periodic updates on the next steps to ensure that the project ran successfully. In addition, when discussing the project, the supervisor gave some advice on how to write a decent report.

3.3.4 Production Line (Teaching Factory, UTeM)

Since this is an industrial sub-con project, the valid information was acquired through the line. The relevant data is gathered for the research approach. The data will then be used to create the greatest picture of the assembly line's present performance in the production area. Some essential data or information from the industry is also collected to define the project. Other methods and approaches will be used to meet the goal of reducing waste and increasing manufacturing business productivity for the linked product line assembly which are:

a. Production line observation

b. Total distance measurement

c. Video capturing method

3.4 Resource of Information

To execute the project, information was obtained from two different sorts of sources. For data collecting, data verification, and data analysis, primary sources such as observation and total distance measurement are used. On the other hand, the secondary sources indicated above, such as books, journals, and Internet sources, are used to better comprehend and carry out this activity. Then, SLP will be utilized for the construction of the new optimum layout.

3.4.1 Observation

The observation was made by observing the flow of the production line during work is going on. The total distance was measured from the entrance door until the inventory room. Besides that, the distance between the cells were also measured by using a measuring tape to get the exact dimension for the layout construction. Video capturing was also one of the methods utilized to get the exact timing of the material flow from load out until the inventory.

3.5 Systematic Layout Planning (SLP) Procedures

Analysis of layout using the Muther's Systematic Layout Planning (SLP).

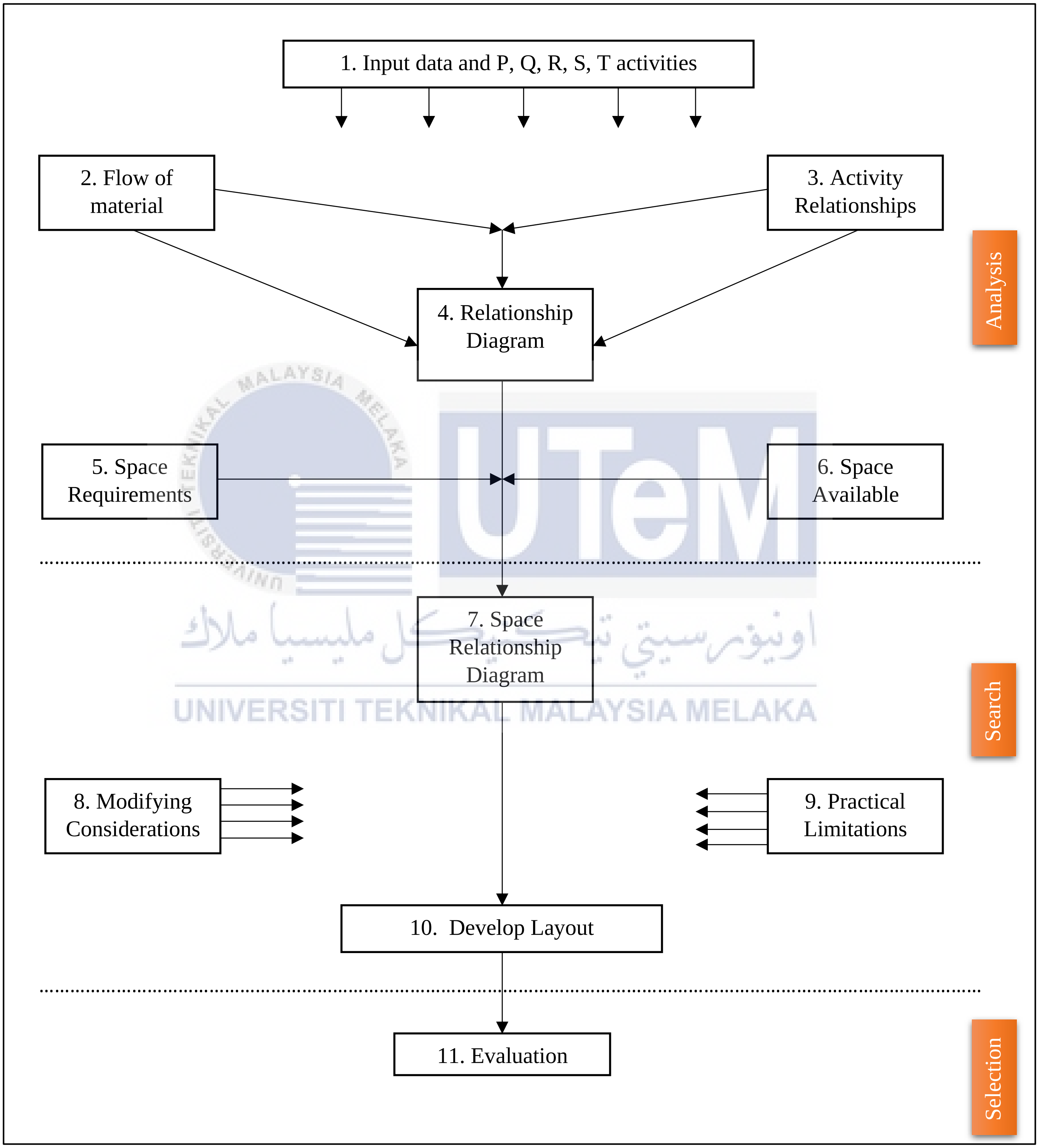


Figure 3. 1 Framework of Systematic Layout Planning

By referring to framework of SLP, the procedures can be divided into four stages that contains 11 steps.

PART 1: INPUT DATA

Step 1: The overall production activities (PQRST activities)

Product (P), Quantity (Q), Routing (R), Supporting (S), Time (T) activities

Step 2: Flow of the material

The material flow or process flow of the product in the target area which is from the entry-exit point or from the inventory to the working cells and vice versa.

Step 3: Activity Relationships

Perform analysis towards the closeness relationship decision among different departments. The relationship chart will be constructed for the analysis.

Step 5 & 6: Space Requirements & Space Available

This step is to determine the amount of floor space to be allocated to each department. The space-relationship diagram will be constructed for the analysis.

Step 8 & 9: Modifying Considerations & Practical Limitations

This step considers the additional design for constraints and limitations before the executions of layout construction begins.

PART 2: PROCEDURE PROCESS

Step 4: Relationship Diagram

This relationship diagram allocates the department spatially. The departments are placed in proximity of the departments have a strong closeness rating relationship.

Step 7:Space Relationship Diagram

This step is to add department's size information to the relationship diagram from step 4.

PART 3: OUTPUT

Step 10: Develop Layout

This step is to develop proposed layouts.

PART 4: VALIDATION

Step 11: Evaluation

The calculations will be made by comparison of the accumulated total distance of current and proposed layout.

3.6 Summary

As a conclusion, the project planning itself, the way the data was collected, and the Gantt Chart of this study, which is inserted in the Appendix section, which shows how the study is going weekly, are all approaches used to complete this study. For this study, project planning is critical because it aids in the collection of data step by step. The purpose of the Gantt Chart is to ensure that this study is completed in a timely manner each week. Moreover, by utilizing SLP, the layout will be fully analyzed, and the new optimum layout for the production room will be constructed.

CHAPTER 4

RESULTS & DISCUSSION

4.0 Introduction

This chapter shows about the statistical data, comparison of the current and proposed layout of the production room for the optimum production. The data gained will be analyzed using the Systematic Layout Planning (SLP) method. The observation also has been used to determine all data such as total distance, and process involved. The comparison between the current layout and the proposed layout will be conducted to ensure the production level improve.

4.1. Current Layout

The production floor has various sections such as inventory section, 6 working cells, data entry section, and pre-production section. Working cell, A, B and C placed at one same segment meanwhile working cell D, E and F placed at another segment together. Currently, data entry section is located at the same segment with working cell A, B and C. The forklift is currently placed at same segment with the inventory area alongside the pre-production section. Figure 4.1 shows the current layout of the production room.

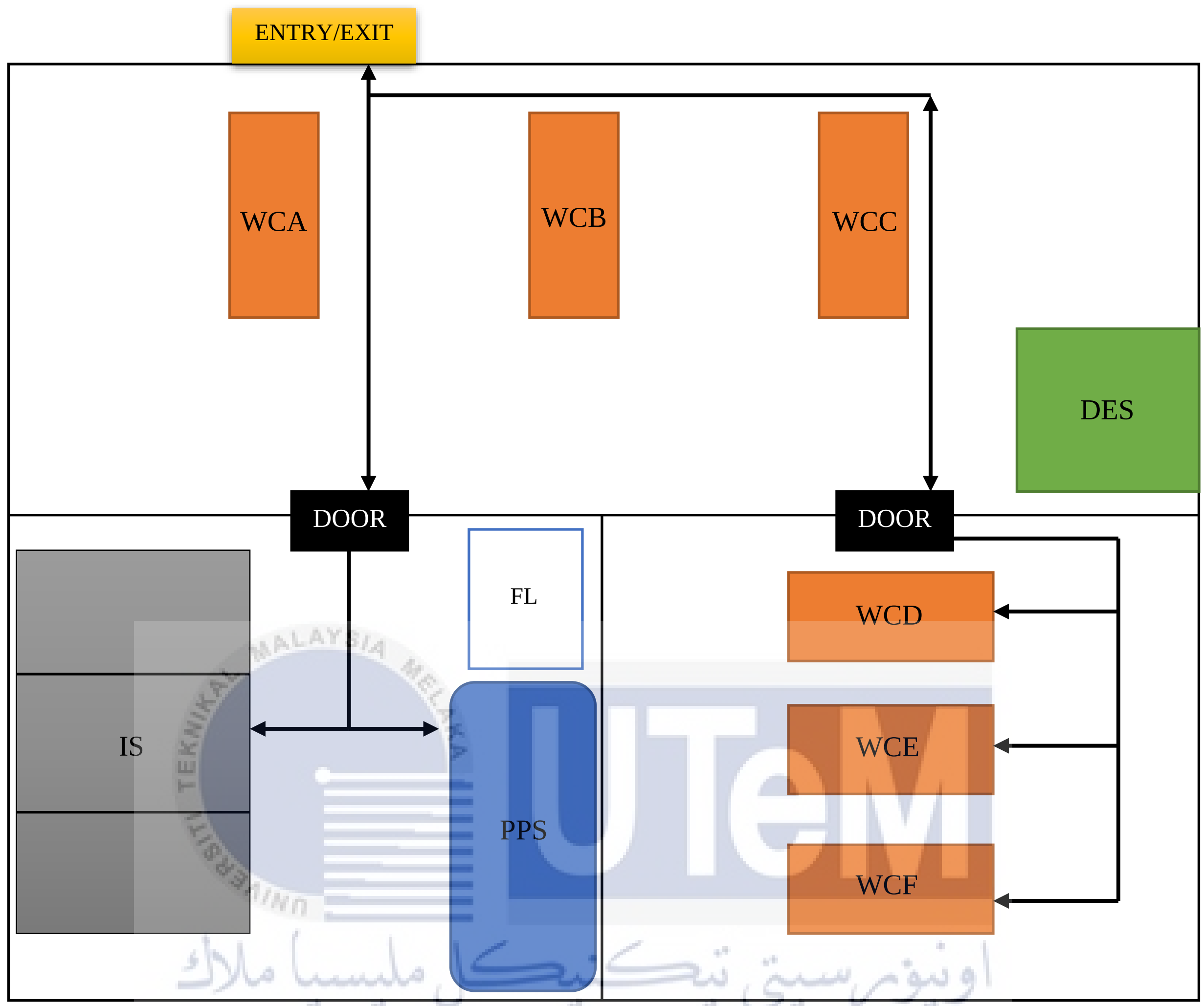


Figure 4. 1 Current Layout

4.1.2 Input data of current layout

The current layout consisted of few sections such as inventory, few working cells, pre-production, and data entry section. Every section has their own parameters and contribute to the process flow. Table 4.1 shows the abbreviation and area of each respective sections.

Table 4. 1 Input Data

No	Section	Abbreviation	Parameter	Area (m^2)
1	Inventory Section	IS	2.0 x 1.0	2.00
2	Working Cell A	WCA	1.2 x 0.95	1.14
3	Working Cell B	WCB	1.2 x 0.95	1.14
4	Working Cell C	WCC	1.2 x 0.95	1.14
5	Working Cell D	WCD	1.2 x 0.95	1.14
6	Working Cell E	WCE	1.2 x 0.95	1.14
7	Working Cell F	WCF	1.2 x 0.95	1.14
8	Pre-Production	PPS	2.0 x 0.75	1.50
9	Data Entry Section	DES	0.9 x 1.1	0.99
10	Forklift	FL	3.6 x 0.97	3.49

4.1.3 Problem identification of current layout

Currently, the flow of the material to be brought into the storage area is not efficient enough and affects the performance of working cells inside the production room. The movement of the materials from the storage area to the working cells is an issue due to long distance. The flow of the product and the working cell oppose during the movement of the product from the entry point to the inventory room. Due to no proper pathway for the material movement, it also disturbs the operation and impacts the efficiency.

4.1.4 Evaluation of current layout

The flow patterns within the workstations or sections of this product packaging room are more to the I-flow. I-flow pattern is included in the line flow pattern. There are several primitive flow structures or patterns such as:

Note: Marked ✓ means selected for this study.

i. I-flow (straight line flow) ✓

ii. U-flow

iii. S-flow

iv. W-flow

v. O-flow

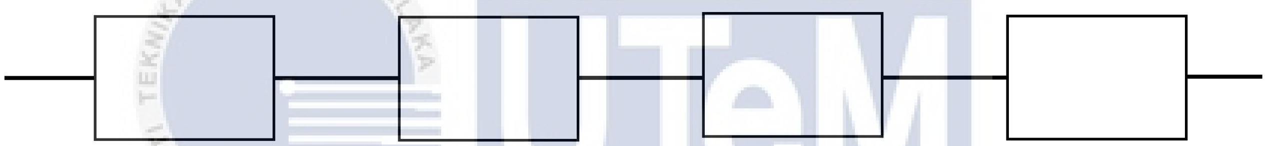


Figure 4. 2 (I-Flow) Single Line flow

The flow shown is the flow that is applied in the production house currently. The flow of the process is perpendicular.

Besides that, observing the workstations, flow that occurs between the work cells to the aisles. In this study, the flow of the process is perpendicular. Figure 4.3 shows the illustration of perpendicular flow pattern.

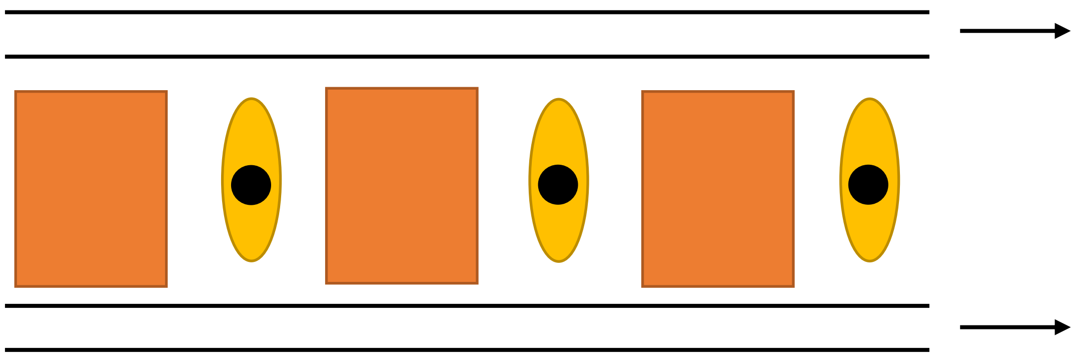


Figure 4. 3 Perpendicular Flow Pattern

4.2 Analysis data using Systematic Layout Planning (SLP)

Step 1: The overall production activities (P, Q, R, S, and T) activities.

Input data and activities (P, Q, R, S, and T) are an early step that needed to be taken into consideration when utilizing the SLP method. These are the detailed explanation of (P, Q, R, S, and T) activities.

Product (P)

This element includes the product, machine components if involved, raw materials, and projects of the service. This element is vital whereby it affects the composition and relationship of all facilities, equipment's category, and material handling method.

Quantity (Q)

This element includes amount of production, supply, or service workload. All the information is provided by statistics of production, and design represented by weight, piece, price, and volume. This element affects the layout scale, amount of equipment, and working area.

Routing (R)

This element can be represented by the plant layout diagram, process flow diagram, flow chart etc.

Supporting (S)

This element includes supporting services such as tools, maintenance, deliveries etc.

Time (T)

This element refers to when and how long the duration of production is, in which includes the operating time for every procedure.

Therefore, based on the study, this product packaging room is packing products within few processes. The quantity of the product is based on the customer demand. Table 4.2 shows the PQRST data table.

Table 4. 2 PQRST Table

Data	Details
Product (P)	Varies
Quantity (Q)	Based on customer demand
Routing (R)	Flow of layout
Supporting (S)	-
Time (T)	Based on customer demand

Step 2: Flow of material

The material flow of the products is based on how many processes that needed to be completed. For this study, the arrangement of the sections is not systematic. Flow chart below explains the process from the beginning until the finishing of the product packaging. There also included the travel distance from one process to another process. The arrangement of the workstations needs to be relocated because it is not systematic. Figure 4.4 shows the process flow of product packaging.

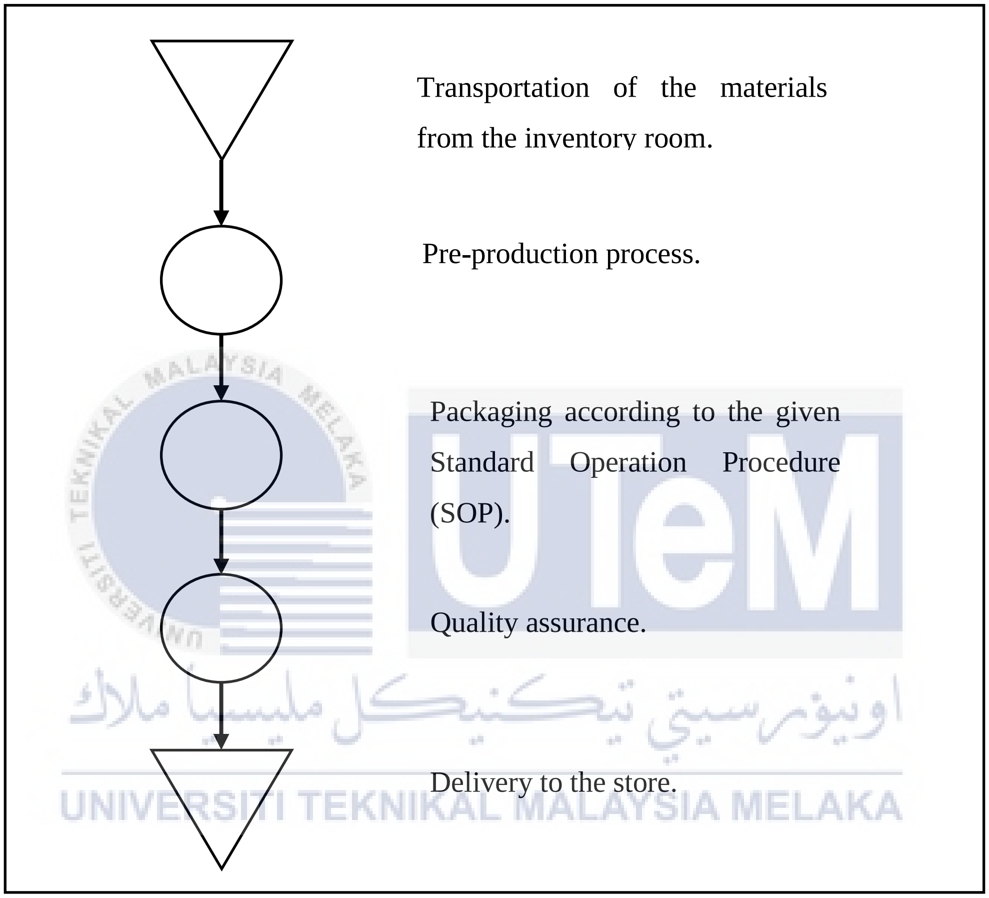


Figure 4. 4 Process flow of the product packaging

Table 4. 3 Detailed process flow

Details of current method	Operation	Transportation	Inspection	Delay	Storage	**Distance(m)**
1. Material in the inventory room.	○	⇨	□	D	▽	-
2. Move the material to the pre-production section.	○	⇨	□	D	▽	**1.60**
3. Start the process at the pre-production section.	○	⇨	□	D	▽	-
4. Move to the database key-in section.	○	⇨	□	D	▽	**2.60**
5. Move to the packaging workstation.	○	⇨	□	D	▽	**1.50**
6. Proceed packaging process according to SOP.	○	⇨	□	D	▽	-
7. Quality assurance conducted.	○	⇨	□	D	▽	-
8. Move to the database key-in section.	○	⇨	□	D	▽	**1.50**
9. Key-in completed data and check remaining inventory.	○	⇨	□	D	▽	-
10. Move to the storage room.	○	⇨	□	D	▽	**2.60**
11. Store the product at storage room.	○	⇨	□	D	▽	-
12. Deliver the finished product to the company.	○	⇨	□	D	▽	-
Total Distance						**9.80**

Based on Table 4.3, the total distance for current process is 9.80 m. Based on the distance, it shows that there is a lot of movements involved and the total distance is high to complete the process flow of the product. The current layout has a weakness in terms of arrangements of the sections, workstations, and departments. The calculation of total distance for each process starts from the material at the inventory room until the finishing which is for shipping. In the current layout, there are more movements involved, hence there is more waste generated. Thus, the current layout needs an improvement to minimize the distance travel to complete the process.

Step 3: Activity relationship analysis

The activity relationship analysis, which is concerned qualitative analysis are investigated and it produces a relationship chart. It gives an overview more on the qualitative relationship and limitations between the department, sections, and workstations. The activity relationship analysis shows as follows:

1. To ensure great efficiency, the workstations must be located side by side to minimize the waste and enhance the productivity.

2. Pair of sections with higher interaction must be located as close as possible in case of material handling and reduction of total distance.

Table 4.4 shows the closeness rating that are used and assigned a specific letter code.

Table 4. 4 Closeness rating table

Code	Closeness
A	Absolutely important
E	Especially important
I	Important
O	Ordinary
U	Unimportant
X	Undesirable

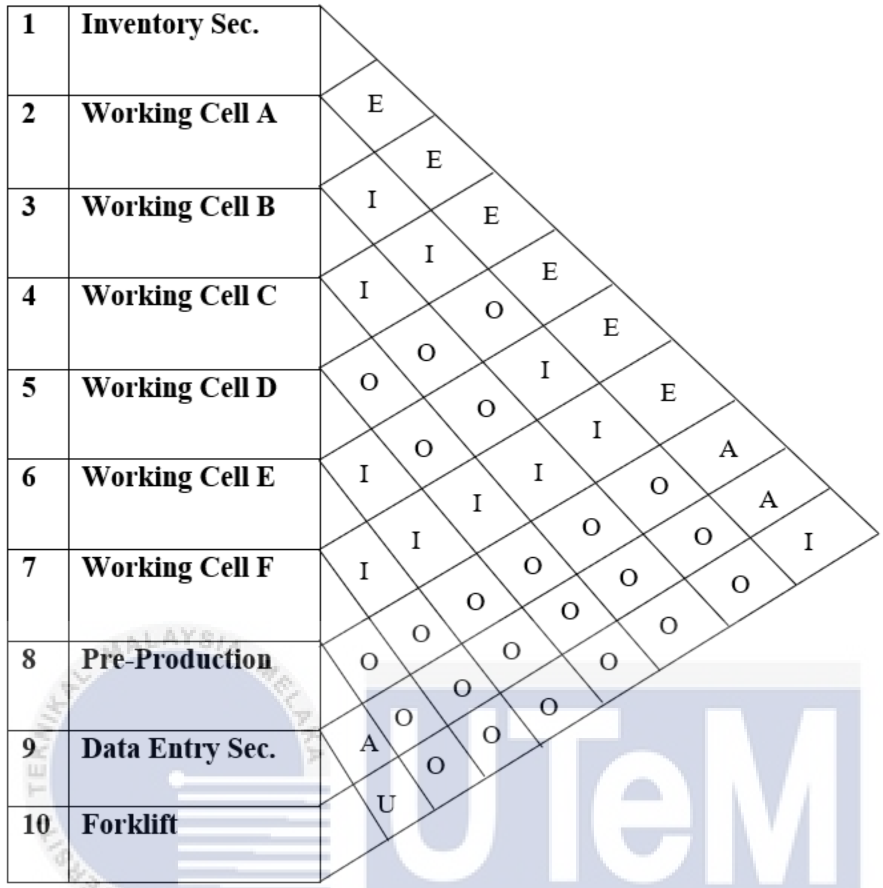


Figure 4. 5 Relationship Chart Analysis

Figure 4.5 shows the relationship chart analysis and how close the rating of the sections or departments involved. This closeness rating will be used to construct relationship diagram and will be utilized to construct a layout with the optimum spaces available.

Step 4: Relationship diagram

Relationship diagram reveals a potential good relative positioning decision among the sections or departments. It provides an overview of the potential closeness relationship between the sections. The relationship diagram is developed through the result of the activity relationship chart as in the previous figure as shown in Figure 4.5. Next, Table 4.5 shows the code and indicator to build the relationship diagram.

Table 4. 5 Code and indicator for relationship diagram

Code	Indicator
A	━━━━━━━━
E	────────
I	— · · — · · — ·
O	- · - · - · - · -
U	— — — — —

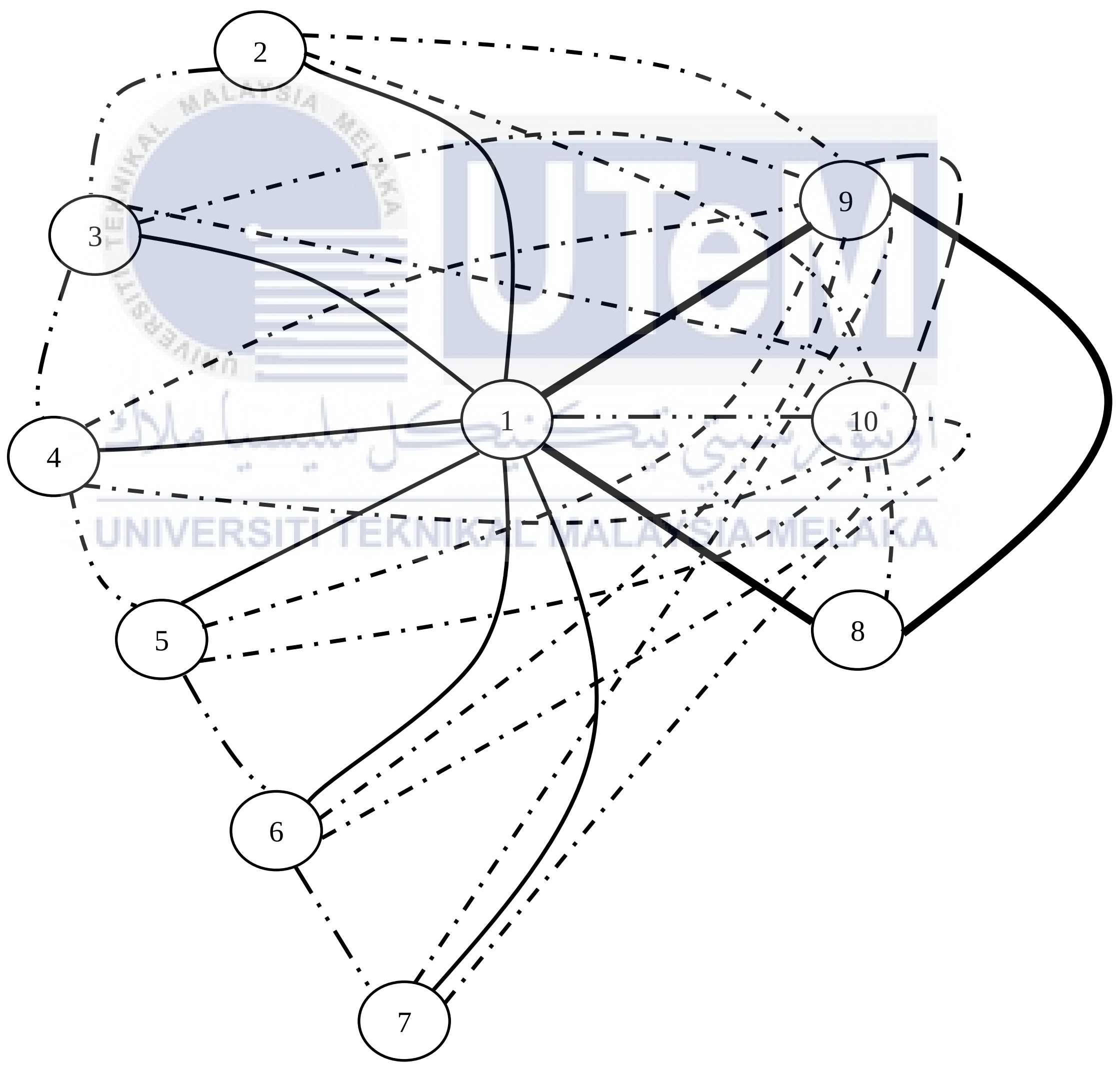


Figure 4. 6 Relationship diagram

Step 5 & 6: Space requirement/availability analysis

These steps are to determine the floor space required for each department including support activities such as material handling, machines if involved, and maintenance. Since this study is on existing layout therefore the measurement on existing sections will be conducted. The size of all departments or sections will be measured to design the proposed layout. The size for all sections is shown in Table 4.1 above. The proposed layout will be constructed.

Step 7: Space relationship diagram

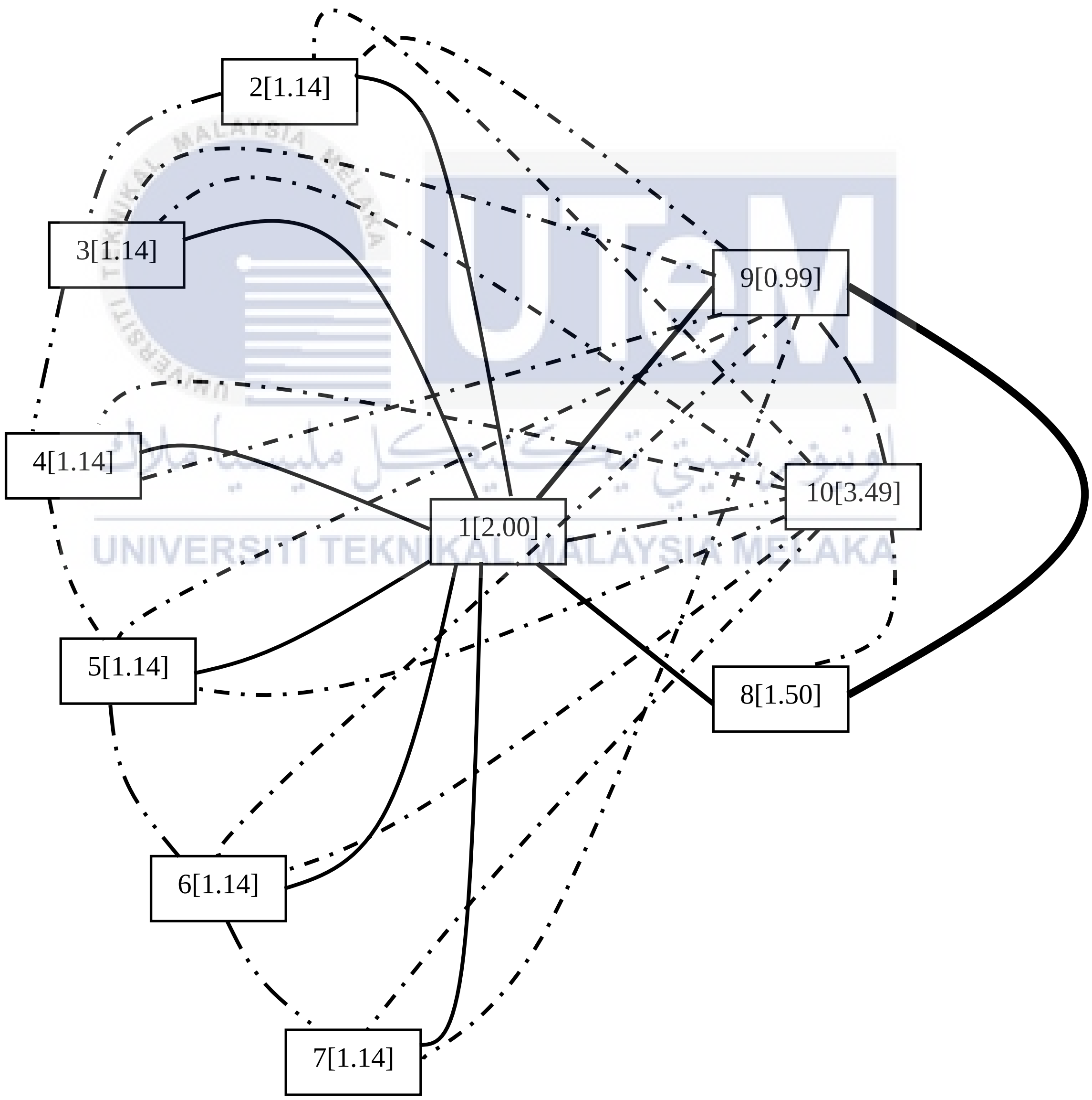


Figure 4. 7 Space relationship diagram

Step 8 & 9: Practical limitations/constraints

These steps are to be defined practical limitations and constraints of the layout to incorporate the limitations and constraints of the constructed layout.

There is unused space in the working area of production room. This unused space will be utilized for the construction of the new proposed layout. These unused spaces will be considered when generating the new layout. In other word, any sections that needed to be changed, will be changed based on the priority to solve the problem, and reduce the total distance travelled.

In addition, there are few practical limitations for layout design as follows:

1) The inventory section must be located as close as possible to the working cells or must have easy access to the working cells.

2) The data key in section must be located as close as possible to the inventory room to ease the flow of the process.

3) Rearrangement of the main route of the workers between the working cells and other sections.

4) Aisle of the sections must be at least 2-meter width for the forklift movement.

Step 10: Develop new layout

After the consideration of the practical constraints & limitations, and the activity relationship chart, the new layout will be constructed for optimum efficiency. The layout will be constructed based on the closeness and priority and then followed by space diagram measurements. Figure 4.8 shows the proposed layout of the production room.

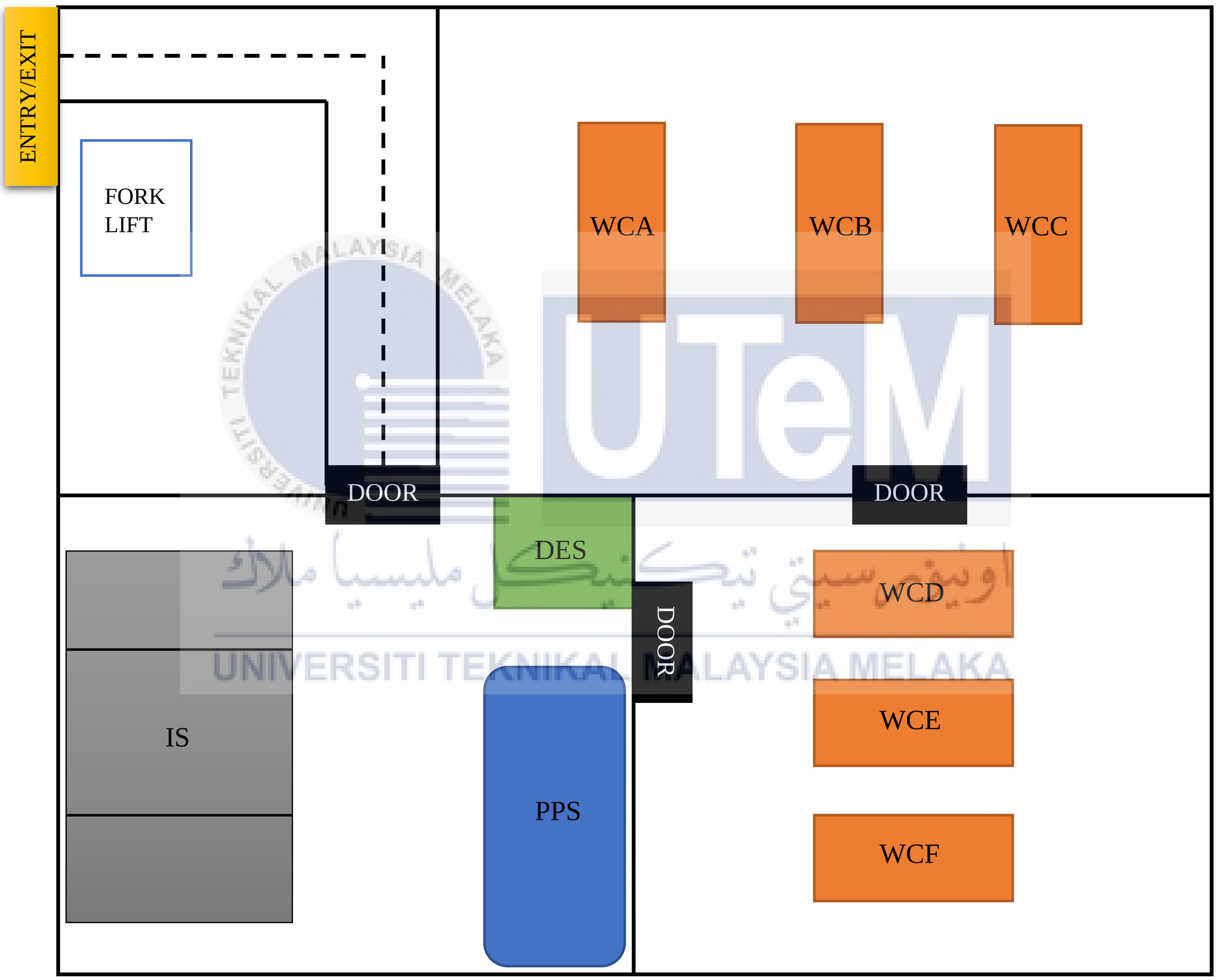


Figure 4. 8 Proposed Layout

Table 4. 6 New detailed process flow

Details of current method	Operation	Transportation	Inspection	Delay	Storage	Distance(m)
1. Material in the inventory room.						-
2. Move the material to the pre-production section.						1.50
3. Start the process at the pre-production section.						-
4. Move to the database key-in section.						0.60
5. Move to the packaging workstation.						1.40
6. Proceed packaging process according to SOP.						-
7. Quality assurance conducted.						-
8. Move to the database key-in section.						1.40
9. Key-in completed data and check remaining inventory.						-
10. Move to the storage section.						1.50
11. Store the product at storage room.						-
12. Deliver the finished product to the company.						-
Total Distance						**6.40**

Step 11: Evaluation and validation

Calculations for evaluation and validation are as below referring from the detailed process flow for the existing and new layout.

a) Existing layout

Process 2 + Process 4 + Process 5 + Process 8 + Process 10

Total Distance = (1.60) + (2.60) + (1.50) + (1.50) + (2.60) = 9.80 meters

b) Proposed Layout

Process 2 + Process 4 + Process 5 + Process 8 + Process 10

Total Distance = (1.50) + (0.60) + (1.40) + (1.40) + (1.50) = 6.40 meters

The evaluation of proposed layout is difficult in that multiple objectives, including quantitative and qualitative are involved. Therefore, proposed layout is designed respecting to the constraints and limitations to confirm that the proposed is valid and the work for the process flow between the sections are optimized. The percentage of improvement of total distance will also be calculated. Finally, the value of the total distance was calculated and shown below.

Based on the Equation 2.1,

$$\text{Percentage of improvement} = \frac{Original - Proposed}{Original}\ x\ 100\%$$

$$= \frac{9.80 - 6.40}{9.80}\ x\ 100\%$$

= **<u>34.70 %</u>**

Table 4. 7 Comparison total distance for existing and proposed layout

Description	**Layout**		**Percentage of improvement (%)**
	Existing	**Proposed**	
Total distance (m)	9.80	6.40	34.70

Therefore, according to Table 4.7, the total distance for existing layout is 9.80 meters, meanwhile the total distance for the proposed layout is 6.40 meters. Thus, a reduction of 3.40 meters which is 34.70% overall percentage of improvement in terms of total distance.

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.0 Conclusion

Facility layout is one of important aspects in manufacturing industry especially for new developing companies or industries. This study has achieved following as listed below:

i. It was identified the weakness of current facility layout om terms of arrangement of the sections, the process flow in the line production and material handling.

ii. The flow of the process was redefined.

iii. The proposed layout was developed based on minimizing distance by using Systematic Layout Planning (SLP) method.

iv. The proposed layout developed was compared to the existing current layout. The total distance was measured and compared in terms of percentage, and it shown that the total distance has reduced by 34.70% and was reduced by 3.40 in meters.

5.1 Recommendations

Future investigations or study should be covering for facilities layout planning such as following:

i. This study outline detail procedure for the relationship chart execution. This procedure will be more practical if they are being computerized, so that the automatic execution can be conducted.

ii. Relationship chart method can produce better layout compared to the current layout. However, it cannot produce the best result. Hence, other technique such as generic algorithms and mathematical modelling may produce the best layout.

iii. Aside from data inputs, obtain information's from the experienced ones will be helpful to potentially improve the design process.

5.2 Sustainability Design & Development

Sustainable in manufacturing involves products or processes that conserves the energy and resources and minimize the negative impacts to the environment. In terms of layout, sustainability involves by reducing the materials used and improve the serviceability. For instance, the usage of the conveyer should be practiced. This is because it eliminates or minimizes the manual labor. Besides that, it also reduces the possibilities of accident or injuries to the labor. Addition of conveyer in the layout design will also increase the productivity and efficiency of a process. Moreover, when it comes to sustainable in design, reducing physical volume can reduce the machine time and the energy consumption. Smaller or lighter parts produces fewer fuel emissions during the transportation which is very good for the environment and ecological equilibrium.

5.3 Complexity

A methodical approach to conducting and carrying out layout planning is the Systematic Layout Planning (SLP). The framework of phases, pattern of methods, and set of conventions for recognizing, rating, and visualizing the areas and elements involved in the building of a layout make up the project's complexity. The relationships, space, and changes are the most challenging aspects of any plan creation. Number of the procedure, the product, or the project size, these three components constitute the core of each layout project or research. These foundational concepts are intricate but crucial to the creation of a new layout. The two key components of every designing challenge, the product and quantity, are another challenging aspect of the study. These two components directly or indirectly underpin all other aspects or circumstances in layout work and are essential. Facts, estimates, or any other kind of knowledge about these two elements are therefore crucial. The location of service areas, the desired degree of flexibility, the order of operations, and many other criteria can also affect how a plan flow. For the study to be completed and a new plan to be built, these are some of the most complicated study components that required to be addressed in detail.

5.4 Life-Long Learning (LLL)

An education that is self-initiated and developmentally oriented is lifelong learning. A well-planned layout reduces travel time, total distance, labour costs, material costs, interruptions to work activities, accidents, and guarantees that work positions are not hindered by the careless storage of supplies at these locations. Thus, the strategic framework can either positively or negatively impact productivity and advancement. Systematic Layout Planning, also known as SLP, is a tried-and-true technique for designing any physical business operations to their maximum potential. The proper method which begins from research, investigations, usage of proper tools, calculation and evaluation is vital for any future recommendations or project construction.

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APPENDICES

A - GANTT CHART OF PSM I

PROJECT PLANNING PSM 1

~Duration 4 October 2021 to 12 January 2022~

List major activities involved in the proposed project. Indicate duration of each activity to the related week(s).

Project Activities	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
Overview PSM 1	■	■													
Visit Teaching Factory Product Packaging Line	■	■	■	■	■	■	■	■	■						
Set Problem Statement, Objective & Scope	■	■													
Articles & Journal reading	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Data collections			■	■	■	■	■	■	■						
Prepare Draft Report			■	■	■	■	■	■	■	■	■	■	■		
Presentation														■	
Submission PSM 1															■

B - GANTT CHART OF PSM II

PROJECT PLANNING PSM 2

~Duration: 7 March 2022 to 30 June 2022~

Project Activities	**W1**	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**	**W10**	**W11**	**W12**	**W13**	**W14**	**W15**
Overview of PSM 1															
Preparations of the needed data and information's															
Conduct the SLP methodologies															
Propose the new layout															
Thesis writing of Chapter 4															
Thesis writing of Chapter 5															
Slide preparation															
Presentation															
Submission of PSM 2 report															