LAYOUT OPTIMIZATION FOR PRODUCTION LINE USING PRODUCT LIFECYCLE MANAGEMENT

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

by

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APPROVAL

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ABSTRACT

Plant layout or facility layout is the process of designing and constructing workforce, material handling, and equipment systems. It encompasses determining the locations, sizes, and configurations of many tasks throughout the facility. It exemplifies a strategy for arranging, developing, or visualizing the desirable machinery and equipment in the most efficiently. Layout optimization comprises arranging items in the proper locations to facilitate future expansions in order to provide efficient material handling, ensure optimal space utilization, and an excellent work environment. Optimizing layout can increase productivity, product quality, and safety. This project is conducted in Prym Consumer Malaysia Sdn. Bhd. and Teaching Factory University Technical Malaysia Melaka (UTeM). By considering the current layout of the production line, the problem is that the total output of the circular knitting needle does not achieve the target. The aims of this research are to investigate the production line layout of the circular knitting needle packaging process, to simulate, and to propose the most optimum layouts using Product Lifecycle Management (PLM). PLM is broadly and widely used in modern manufacturing systems due to it can effectively manage a product across its lifecycles, from the very first idea until the disposal of the product. This project begins with record and analyze the packaging process of circular knitting needles by conducting time study. Then, analyze the initial layout of the production line for circular knitting needles packaging process. Following that, plan new layouts and simulate it. Tecnomatix Plant Simulation is used to create and simulate the layout. The most optimal layouts are proposed based on the simulation results. The optimal layouts have the highest daily throughput of 2602.01 and 6308.61. It is showed that optimal layout could increase the productivity of a company.

ABSTRAK

Susun atur kilang atau susun atur fasiliti adalah proses merancang dan membina tenaga kerja, pengendalian bahan, dan sistem peralatan. Ini termasuk menentukan lokasi, ukuran, dan yang melibatkan konfigurasi pelbagai tugas dalam semua fasiliti yang terlibat. Ini menunjukkan strategi untuk mengatur, membangun atau membayangkan posisi mesin dan peralatan yang diperlukan dengan cara yang lebih efisien. Pengoptimuman susun atur merangkumi mengatur barang di lokasi dengan tepat untuk memudahkan pembangunan pada masa depan untuk memberikan pengendalian bahan yang efisien, memastikan penggunaan ruang yang optimum, dan lingkungan kerja yang terbaik. Mengoptimumkan susun atur mampu meningkatkan produktiviti, kualiti produk, dan keselamatan. Projek ini dijalankan di Prym Consumer Malaysia Sdn. Bhd. dan Kilang Pengajaran Universiti Teknikal Malaysia Melaka (UTeM). Dengan mengambilkira faktor susun atur barisan pengeluaran semasa, masalah yang dihadapi adalah kadar jumlah keluaran jarum kait tidak mencapai sasaran yang ditetapkan. Tujuan penyelidikan ini adalah untuk mengkaji susun atur pengeluaran proses pembungkusan jarum rajut bulat dan mencadangkan susun atur yang paling optimum menggunakan Product Lifecycle Management (PLM). PLM digunakan secara meluas dalam sistem pembuatan moden kerana ia mampu menguruskan produk dengan lebih berkesan sepanjang kitaran hayatnya, dari idea hingga kepada pelupusan produk. Projek ini dimulakan dengan merekod dan menganalisis proses pembungkusan jarum kait dengan melakukan kajian masa. Analisa susun atur barisan pengeluaran yang digunakan oleh kilang untuk proses pembungkusan jarum kait. Kemudian, rancang susur atur yang baharu dan lakukan simulasi. Tecnomatix Plant Simulation digunakan untuk membangun dan mensimulasikan susun atur. Susun atur yang paling optimum dicadangkan berdasarkan hasil simulasi tersebut. Susun atur optimum mempunyai nilai harian tertinggi, 2602.01 dan 6308.61. Ini menunjukkan bahawa susun atur yang optimum dapat meningkatkan produktiviti syarikat.

DEDICATION

This thesis is dedicated to my mother and my late father. I hope that this achievement will complete the dream that you had for me all those many years ago when you choose to give the best education you could.

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LIST OF ABBREVIATIONS

VSM	-	Value Stream Mapping
JIT	-	Just-In-Time
PLM	-	Product Lifecycle Management
UTeM	-	Universiti Teknikal Malaysia Melaka
Sdn. Bhd.	-	Sendirian Berhad
SLP	-	Systematic Layout Planning
3D	-	3-Dimension
2D	-	2-Dimension

LIST OF SYMBOLS

%	-	Percentage
s	-	Second
cm	-	Centimeter
mm	-	Millimeter

CHAPTER 1
INTRODUCTION

This chapter addressed the background of study and problem statement that is identified in the industry. This is accompanied by the objectives that need to be accomplished throughout the study and the scope that narrows down the area of the study. The significance of the study is also discussed in this chapter.

1.1 Background Study

Modern manufacturing encompasses all intervention processes necessary for the production and integration of the components of a product. Optimizing facility layout is a critical issue for modern manufacturing systems, as it plays a critical role in process and material flow design. Manufacturing facility design is the physical assets of a business that promote efficient resource utilization such as labour, material, time, equipment, and cost. The design of facilities encompasses the location of the plant, the process flow, layout of the plant, and material handling systems. Only a well-designed process flow and layout can ensure the smooth and rapid flow of material from the initial stage to the final stage of the process. Optimizing the flow layout can also significantly minimize waste or non-value added activities in production lines, thereby increasing overall production effectiveness (Guoliang Fan et al., 2017).

Furthermore, there are two major problems that need to be considered in the manufacturing industry. The first problem is a quantitative approach based on a distance function that aims to minimize the total material handling cost between workstations. The second problem is an approach that aims to minimize non-value-added activities. Material handling and process flow are inextricably linked in manufacturing. Material handling costs

a substantial portion of the total manufacturing cost. Waste of time and energy can occur when workers and materials move long distances in the manufacturing process. The process of material handling operations can be minimized or removed utilizing efficient plant layout analysis and design (Azevedo et al., 2017). Additionally, by optimizing the process flow, it will increase the proximity of workstations and significantly reduce cross-flow caused by workers on production lines (Radhwan et al., 2019).

Plant layout can be explained as the method of locating and arranging physical facilities such as machines, equipment, and tools in order to maximize material flow at the lowest possible cost and with the least amount of handling during the processing of the product from raw material receipt to final product delivery. Besides, plant layout would involve allocating space and arranging equipment in such a way that total operating costs are minimized. The term plant layout refers to both new layouts and improvements to existing layouts (Naik & Kallurkar, 2016). There are four types of layouts are product, process, fixed-position, and cellular layout (William, 2020).

Next, implementing lean manufacturing principles has become a prerequisite for global competitiveness. Lean manufacturing is the most frequently associated with the elimination of waste that is typically retained by companies as surplus inventory. Excess capacity is the capacity of machines and human capacity to improve the impact of fluctuations in supply, processing time, or demand. Lean manufacturing tools are fundamental to the design of the layout. For instance, the concept of 5S, Kanban, Kaizen, Value Stream Mapping (VSM), and Just-In-Time (JIT) (Mojib, 2016). Time study analysis is one of the crucial methods for evaluating work in lean manufacturing. The purpose of the time study is to establish the motion study and time standard. Shorter cycle time has become crucial in nowadays manufacturing systems (Cury & Saraiva, 2018).

There are numerous tools and techniques to optimize the layout. Product lifecycle management (PLM) is the tool used in this study to optimize the layout for the production line. PLM is broadly and widely used in modern manufacturing systems due to it can effectively manage a product across its lifecycles, from the very first idea until the disposal of the product. The imagination phase, definition phase, realization phase, use phase and disposal phase are the five phases in the lifecycle of a product (John, 2016).

Prym Consumer Malaysia Sdn. Bhd and Teaching Factory Universiti Teknikal Malaysia Melaka (UTeM) has been selected to modify and improve the existing production line layout. This company, a leading supplier of sewing and handicraft accessories company. It has been established in Malacca for over 44 years. Prym Consumer Malaysia Sdn. Bhd. vision is to initiate the choice that customers' preferred for haberdashery products based on cost efficiency, excellent operational, quality of products, and services. Examples of the products that are produced by the company are straight pins, safety pins, ball pins, sew-on press fasteners, pearl headed pins, Concorde pins, braided elastics, snap fasteners tape, and knitting accessories. UTeM Teaching Factory is a university authority center operating under UTeM cater to students' attachment with industry-related projects. Circular knitting needles are the product that has been chosen in this study.

1.2 Problem Statement

By considering the current layout of the production line in Prym Consumer Malaysia Sdn. Bhd. and Teaching Factory UTeM, the current problem is that the total output of circular knitting needles does not achieve the targeted output. Circular knitting needles are a seasonal product. The high demand from customers is during winter season because at that season, there are many people who started to knit due to the cold weather.

Therefore, this study is conducted to investigate the cause of the problem specifically in terms of layout and apply some tools and techniques to solve the problem also obtained optimum layout. Moreover, this research can be essential as a reference in a layout problem since there is less attention in layout optimization study. Figure 1.1 shows the chart of output data of circular knitting needles from the past six months. There are five sizes of circular knitting needles: 40 cm, 60 cm, 80 cm, 100 cm, and 120 cm. The chart shows the highest demand for circular knitting needle size is 80 cm.

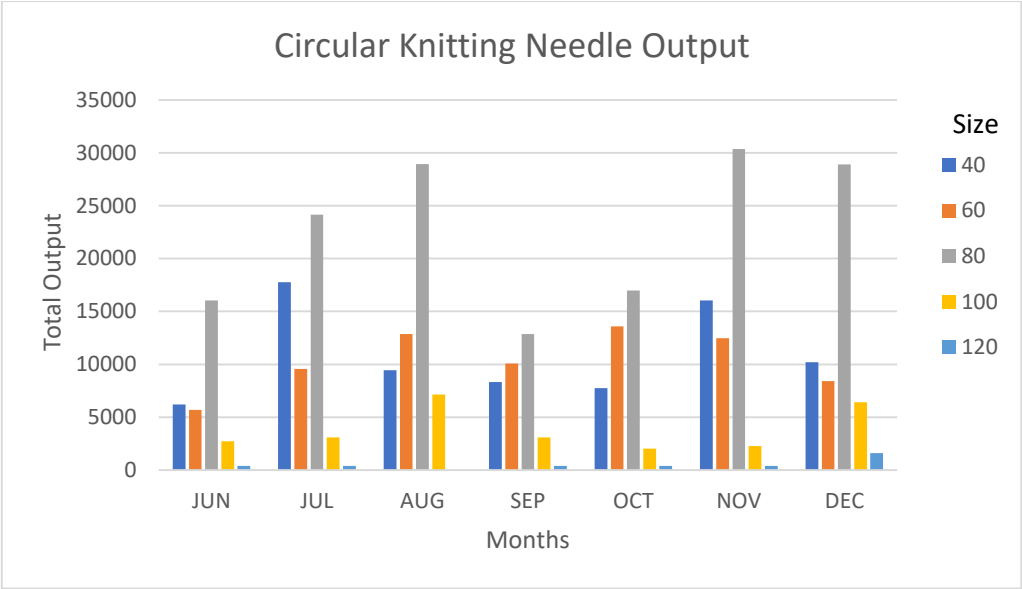

Figure 1.1: Circular Knitting Needles Output Chart of Prym Consumer Malaysia Sdn. Bhd.

1.3 Objective

To perform this project smoothly, several objectives are aimed to achieve its goals. The objectives are:

i. To investigate the production line layout of the circular needle packaging process.
ii. To identify the optimum layouts of the packaging process.
iii. To simulate the proposed layout using product lifecycle management.

1.4 Research Scope

The scope of this research is to investigate and analyze the problem at the production line of the circular knitting needles packaging process in Prym Consumer Malaysia Sdn. Bhd. and Teaching Factory UTeM. A time study analysis is conducted for the circular knitting needle packaging process. This study focuses on improving the existing production line of the circular knitting needles packaging process by redesigning or re-layout. Product Lifecycle Management (PLM) is proposed as a solution to the current layout problem in this research work. The current layout includes four workstations and implemented cellular

layout. Tecnomatix Plant Simulation is the software that will be used in this study. With the help of PLM, a comparison between the existing layout and proposed layouts will evaluate.

1.5 Significant Study

The present study provides comprehensive information on the layout optimization for production lines using Product Lifecycle Management (PLM). There is currently scant information on optimizing layout using PLM. Hence, this study may indispensably contribute industrial guidelines to solve layout problems by performing simulation using PLM. In addition to this, this study can identify the most optimum layout of a production line. Therefore, this study can aid manufacturing industry to improve production efficiency and meet the delivery time requirements.

CHAPTER 2
LITERATURE REVIEW

The chapter consists of a review regarding the objectives and scope of the project. This chapter will describe and discuss the literature reviews that concentrate on previous research relevant to the title of this project. References are focused on journals, previous research, review papers, textbooks, conference and websites. This chapter also discussed the method used to gain information about the study. Each source and information shall be focused on the relationship within the scope of this study.

2.1 Company Background

2.1.1 Prym Consumer Malaysia Sdn. Bhd.

Prym group of companies is a world-leading suppliers of revolutionary and various quality goods in the manufacture haberdashery products. Prym is the oldest family business in Germany owned by Johann Prym. In order to sew, craft, quilt, knitting and household clothing accessories, the Prym Consumer global network offers a single-stop solution. The company has over 400 years of experience providing excellent, precise, and sustainable sewing and craftsmanship accessories worldwide. Prym Consumer Malaysia Sdn. Bhd. is superintendent in Asia and Australasia for the production and distribution of hard and soft haberdashery. It produces and distributes notions of sewing and specialized clothing and accessories in the clothing and household industries, handicrafts and hobbies in high volume. The Prym Consumer Malaysia Sdn. Bhd. logo is shown in Figure 2.1.

Figure 2.1: Company Logo of Prym Consumer Malaysia Sdn. Bhd. (Prym, 2018)

Figure 2.2 below shows the example of products manufactured by Prym Consumer Malaysia Sdn. Bhd. The products are circular knitting pin, circular knitting needle, needle twister, and cable stitch.

(a)

(b)

Figure 2.2: (a) Circular Knitting Pin (b) Circular Knitting Needle (c) Needle Twister (d) Cable Stitch (Prym, 2018)

2.1.2 Universiti Teknikal Malaysia Melaka (UTeM) Teaching Factory

Teaching Factory is structured under Deputy Vice-Chancellor's Office for Academic and International, developed and established in Universiti Teknikal Malaysia Melaka (UTeM) to provide real-life environment simulation of productions and services everyday industrial practices. The objectives of the teaching factory are to provide engineering, technology, education, and promotion services in the field of Advanced Manufacturing and Computing Technology to industry and society. It also offers a training platform and excellent reference centre in Advanced Manufacturing and Computing Technology in the country and region. Teaching factory also functions like planning and organizing business activities through services provided to the industry.

2.2 Lean Manufacturing Tools

Lean manufacturing attempts to find methods and approaches to reduce production costs, eliminate waste, improve product quality, increase productivity, and improve customer satisfaction in manufacturing industries (Mojib, 2016). The purpose of developing lean manufacturing tools is to facilitate manufacturing production systems and intensify quality and productivity in organizations. Lean manufacturing tools have been envisioned primarily for applications in the manufacturing industry. The tools that can be employed to encourage lean manufacturing implementation are:

i. 5S
ii. Kanban
iii. KAIZEN
iv. Value Stream Mapping (VSM)
v. Just-In-Time (JIT)
vi. Cellular Manufacturing