

Faculty of Manufacturing Engineering

MATERIAL FLOW ANALYSIS AND IMPROVEMENT OF A MANUFACTURING SYSTEM UNDER STOCHASTIC PRODUCT DEMAND

Oluwamayowa Joshua Adeboye

Master of Manufacturing Engineering (Industrial Engineering)

MATERIAL FLOW ANALYSIS AND IMPROVEMENT OF A MANUFACTURING SYSTEM UNDER STOCHASTIC PRODUCT DEMAND.

OLUWAMAYOWA JOSHUA ADEBOYE

A thesis submitted in fulfilment of the requirements for the degree of Master of Manufacturing Engineering (Industrial Engineering)

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Faculty of Manufacturing Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DECLARATION

I hereby declare that this thesis entitled "Materials Flow Analysis and Improvement of a Manufacturing System under Stochastic Product Demand" is the result of my research under the Supervision of Ir. Dr.-Ing. Azrul Azwan Bin Abdul Rahman except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree.

: OUWAMATOWA JOSTHUA ADEBOTE : 9.9.2020

Signature

Date

Name

C Universiti Teknikal Malaysia Melaka

APPROVAL

I hereby declare that I have read this report and in my opinion, this thesis is sufficient in terms of scope and quality for the award of Master of Manufacturing Engineering (Industrial Engineering).

Signature	· Assurtund Som
Supervisor Name	: In. Dr Ing. Azrul Azwan b. Abdul Rahman
Date	: 9.9.2020

DEDICATION

This thesis is dedicated to My Father and my source, Jesus Christ the saviour and lover of my soul and the Precious Holy Spirit helper and comforter. Secondly, my beloved father and mother Mr Abiodun & Mrs Feyisayo Adeboye. Thirdly, my siblings; Adeboye Folu, Adeboye Ebun, Adeboye Seun for their support, prayers and inspiration. Fourthly, Supervisor Ir. Dr.-Ing. Azrul Azwan Bin Abdul Rahman. Fifthly, my partner and wife to be Miss. Margaret Chinwe Molokwu. Also to the Expressing Christian Network (ECCN) Family.

ABSTRACT

Due to increasing competition in the manufacturing sector of haberdashery and handicraft accessories, there is a great need for companies involved in this sector to invest relentlessly in expansion and improvement to meet up the dynamic and growing demand of the customer. Therefore, the worldwide leading manufacturer and supplier in this sector is thereby forced to analyze its material flow system, factory production layout, and production line. Aimed at improving the quality of their production and efficiency in meeting stochastic demand. The concept of improving material flow is majorly accepted as one of the core challenges facing the manufacturing sector in the future. Especially when it has to involve factory expansion and optimization, which is a fundamental goal for the manufacturing industry. This study is conducted in collaboration with Prym Consumer (M) Sdn. Bhd. The objectives of this project are; To analyze different options of improved layout for the factory expansion then select the best factory layout suitable and efficient to run the manufacturing production thereby meeting stochastic demands and enhancing productivity using a systematic layout planning procedure and simulation-based approach. The proposed alternative factory layout will be developed using the Systematic Layout Procedure (SLP), then simulated and analyzed using the Tecnomatix Plant Simulation Software. By developing the various proposed option layout, the distance, total production time, and throughput of the production process are analyzed and improved in comparison with the existing layout and process. The result therefore of this project was very distinctive its outcome. Option 2 as one of the proposed alternative option layout was found to be more efficient to meet stochastic demands if implemented. Its forklift total distance travelled, total manufacturing and production time, and total throughput rate was more improved which will be able to tackle the problem of Prym Consumer (M) Sdn. Bhd in meeting stochastic demands than the existing and the other option 1 layout.

ABSTRAK

Oleh kerana persaingan yang semakin meningkat di sektor pembuatan aksesori barangan dan kraf tangan, terdapat keperluan besar bagi syarikat yang terlibat dalam sektor ini untuk melabur tanpa henti dalam pengembangan dan penambahbaikan untuk memenuhi permintaan pelanggan yang dinamis dan terus meningkat. Oleh itu, pengeluar dan pembekal terkemuka di dunia dalam sektor ini terpaksa menganalisis sistem aliran bahan, susun atur pengeluaran kilang, dan barisan pengeluarannya. Bertujuan untuk meningkatkan kualiti pengeluaran dan kecekapan mereka dalam memenuhi permintaan stokastik. Konsep meningkatkan aliran bahan diterima secara besar-besaran sebagai salah satu cabaran utama yang dihadapi oleh sektor pembuatan pada masa akan datang. Terutama apabila perlu melibatkan pengembangan dan pengoptimuman kilang, yang merupakan tujuan asas bagi industri pembuatan. Kajian ini dilakukan dengan kerjasama Prym Consumer (M) Sdn. Bhd. Objektif projek ini adalah; Untuk menganalisis pelbagai pilihan susun atur yang lebih baik untuk pengembangan kilang, kemudian pilih susun atur kilang terbaik yang sesuai dan cekap untuk menjalankan pengeluaran pembuatan sehingga memenuhi permintaan stokastik dan meningkatkan produktiviti menggunakan prosedur perancangan susun atur yang sistematik dan pendekatan berasaskan simulasi. Susun atur kilang alternatif yang dicadangkan akan dikembangkan menggunakan Prosedur Tata Letak Sistematik (SLP), kemudian disimulasikan dan dianalisis menggunakan Perisian Tecnomatix Plant Simulation. Dengan mengembangkan berbagai tata letak pilihan yang diusulkan, jarak, total waktu produksi, dan keluaran proses produksi dianalisis dan ditingkatkan dibandingkan dengan tata letak dan proses yang ada. Oleh itu, hasil projek ini sangat membezakan hasilnya. Pilihan 2 sebagai salah satu susun atur pilihan alternatif yang dicadangkan didapati lebih efisien untuk memenuhi tuntutan stokastik jika dilaksanakan. Jumlah jarak foklif yang dilalui, jumlah masa pembuatan dan pengeluaran, dan kadar keluaran total lebih baik yang akan dapat mengatasi masalah Prym Consumer (M) Sdn. Bhd dalam memenuhi tuntutan stokastik daripada susun atur pilihan 1 yang ada dan yang lain.

ACKNOWLEDGEMENTS

First and Foremost, I want to appreciate God who was my source, Jesus Christ the saviour and lover of my soul and the Precious Holy Spirit helper and comforter. Secondly, my beloved father and mother Mr Abiodun & Mrs Feyisayo Adeboye for their selfless sacrifice, prayer, love and care. Thirdly, my siblings; Adeboye Folu, Adeboye Ebun, Adeboye Seun for their support, prayers and inspiration.

I would like to also take this opportunity to express my sincere acknowledgement to my supervisor Ir. Dr.-Ing. Azrul Azwan Bin Abdul Rahman from the Faculty of Manufacturing Engineering Universiti Teknikal Malaysia Melaka (UTeM) for his essential supervision, support, and encouragement towards the completion of this thesis. Also the person of Mr Robert and all staff of Prym Consumer (M) Sdn. Bhd for their selfless support.

Fifthly, my partner and wife to be Miss. Margaret Chinwe Molokwu for her prayers, encouragement, inspiration and patience. Also to the Expressing Christian Network (ECCN) Family for their sacrifice, love, fellowship and inspiration. Also, Dr Olawale Ifayefumi and the RCCG Holy ghost House Melaka Family for their prayers and fellowship and my Friends, Miss Dorothy and Mr. Tony for their support, care and love always. Finally, myself for hard work and relentlessness. God bless you all!

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LIST OF ABBREVIATIONS

ALDEP Automatic Layout Design Problem - 1 CRAFT Computerized Relative Allocation Facility Technique -CAD Computer-aided design SDN BHD Sendirian Berhad -(M) Malaysia -Metres m -

CHAPTER 1

INTRODUCTION

This chapter covers the background of the study, problem statement, objectives, and scope of this project. The chapter overview of this project is also included in this chapter.

1.1 Background of Study

Understanding materials flow analysis of a manufacturing system in the manufacturing industry is very paramount for productivity and profitability. Material flow analysis (MFA) is a systematic assessment of the flows and stocks of materials within a system defined in space and time. It connects the sources, the pathways, and the intermediate and final sinks of a material (Brunner and Rechberger, 2016). The concept of improving material flow is majorly accepted as one of the core challenges facing the manufacturing sector in the future. Especially when it has to involve factory expansion and optimization, which is a fundamental goal for the manufacturing industry. There are several advantages to material flow analysis study which include; Reduction in operating cost, streamline material flow, increase productivity, increase profitability, and reduced turnaround time. Vital information that results from a material flow analysis grants the project teams the ability to make decisions objective for the design of a factory layout or expansion of a factory facility. This project tends to focus on the material flow analysis and improvement of a global manufacturing industry providing flexibility to discover more innovative options for improvement.

Factory can be referred to as an industrial site ground usually containing buildings, and machinery where workers operate machines manufacturing and processing goods from one product into another. Factories can either produce discrete or continuous products. The factory layout involves the arrangement of equipment and machines within a factory which includes both the layout of the machine of various departments and individual workplace within the factory site. The two major types of the factory are process-based layout where products being produced follow various routes through job shops in the factory and also product based layout, this consists of the product produced on a single path in the factory (TheFreeDictionary.com, 2019). A Factory may either produce discrete items or some sort of continuously produced material. The factory layout importance is non-negotiable as it represents a long term commitment which helps in facilitating the production process, reduces material handling to the minimal, time and cost, and allows flexibility of operations and smooth production flow. The general objective of the factory layout is to design a physical arrangement that would economically meet up the desired output quality and quantity.

The re-layout of a factory or facility design is aimed at improving the productivity of machines, designing an effective work-flow, workers and material flow (Kovács and Kot, 2017). Re-layout for a factory is important to improving and expanding the efficient production process and addressing the requirements of workers. Also, we see that re-layout, gives a tremendous effect in consistently fluctuating client requests, coming about changes in the item portfolio, production volume, and changes in manufacturing procedure and innovation. In the real-life operation of the manufacturing system, a reduction in manufacturing cost and productivity of the system can be achieved to a greater measure by factory re-layout design. The most commonly used techniques or methods that can be

utilized to design and redesign a facility layout is the Systematic Layout Planning (SLP) by Muther, 1961. Several other techniques that can also be considered are Computerized Relative Allocation Facility Technique (CRAFT), Automatic Layout Design Problem (ALDEP), Quadratic Assignment Problem (QAP) and some more. These techniques are used to formulate a new factory layout or re-layout of an existing factory layout.

This study is conducted in collaboration with Prym Consumer (M) Sdn. Bhd. The factory is located in Tanjung Keling Melaka, Malaysia. A company established in Malaysia for over 44years specialized in manufacturing and supply of diverse, quality and innovative soft and hard haberdashery products. They offer a one-stop solution to swing, knitting, craft, quilting, and garment household accessories to make various creative products. The company's current success is based on a tradition of supplying high quality, precise and long-lasting sewing and handicraft accessories worldwide. They are also responsible for the production, sales, and distribution in Asia and Australasia. Products produced by this industry include; Concorde pins, bra back extenders, braided elastics, snap fasteners tape, safety pins, straight pins, sew-on press fasteners, pearl headed pins, ball pins, and knitting accessories.



Figure 1.1: Prym Consumer (M) Sdn. Bhd Logo (Prymconsumerasia.com, 2019).

Material flow analysis and improvement of a manufacturing system through factory re-layout can be carried out using any kind of software by simulation. The process of imitation of the various operation involved in a real-world process or system over time is called simulation. In simulating a process or a system, it first requires an already established model. The model represents the system itself, whereas the simulation represents the operation of the system over time (Talumis, 2019). Simulation is one of the tools in engineering that can be used to tackle problems relating to size and complexity. It can easily predict any manufacturing system in their complex behaviour by analyzing the movement and interactions of several components within the given system. It also has easy scalability where the impact on productivity and cost of any proposed changes in capacity plan can be analyzed rather than waiting until after implementation.

Based on the facts above, it is clear that material flow analysis and improvement and layout optimization and simulation of a manufacturing system under stochastic demand play a vital role in any facility planning and layout study (Grajo,1995). It must be solved in the earlier stage or otherwise, it will cause a negative impact on the company's intralogistics implication.

1.2 Problem Statement

Due to increasing competition in the manufacturing sector of haberdashery and knitting accessories, there is a great need for companies involved in this sector to invest relentlessly in expansion and improvement to meet up the dynamic and growing demand of the customer. Prym Consumer (M) Sdn. Bhd as a worldwide leading manufacturer and supplier in this sector is thereby forced to analyze its material flow system, factory production layout, and production line. Aimed at improving the quality of their production and efficiency in meeting stochastic demand. For this factory, a well-improved production line and layout can improve their production time, shorten the processing time and cycle time to meet high demands, reduce the frequency of transportation (Forklift movement), to

a great deal minimize the distance between next production process, enhance the quality of product and also, in addition, improve their material handling system. For this factory, they have quite a messy arrangement due to the orientation of their production and total forklift distance travelled about 6689.3m. It is important to make sure the factory has the most convenient arrangement of equipment and machine thereby reducing the total distance travelled during operation to improve productivity. The factory will, therefore, require a simulation model to be done for the improvement of production layout and material flow analysis so accurate decisions can be made before implementation to avoid a costly error.

1.3 **Project Objective**

The objectives of this project are;

- i. To study each material produced and their respective process flow relevant for this project and develop the simulation model for each material flow in identifying improvements of the manufacturing system for Prym Consumer (M) Sdn. Bhd. factory operation.
- To analyze different options of improved layout for the factory expansion in terms of production and improvement in meeting stochastic demand by using Tecnomatix Plant Simulation Software.
- iii. To select the best factory layout suitable and efficient to run the manufacturing production thereby meeting stochastic demands and enhancing productivity using the result from the simulation and systematic layout planning procedure.

1.4 Project Scope

This project will be conducted at Prym Consumer (M) Sdn. Bhd located in Tanjung Keling Melaka, Malaysia. Certain requirements need to be critically considered while doing the project to make sure it is still in the scope. The project will focus on only five products produced by Prym Consumer (M) Sdn. Bhd from their raw materials to the finished product of both knitting and haberdashery products. The products are Safety Pin, Straight Pin, Snapfastener, AluminiumHook Susan Bates, and AluminiumHook Imra needle. Also, this study will focus on improving the facility layout design of the production floor from the storage unit department until the finished product. The layout of the production is processoriented. Systematic layout planning (SLP) will be used to arrange the workplace according to the relationship of every department to produce an alternative of a better arrangement. The existing material process flows and layout design and new process flows and re-layout designs in the production line are both recorded to assist the development of the simulation model. The improved layout will be evaluated by using simulation software such as Tecnomatix Plant Simulation. This project investigates whether the improved layout is suitable and efficient to run the manufacturing production thereby meeting stochastic demands and enhancing productivity.

1.5 Report Overview

This report is organized in different chapters that will tend to address various aspects of the project carried out. Immediately after the chapters organized in the report is the reference and appendix. The summary for each chapter of the report for this project are as follow:

Chapter 1: Introduction

This chapter covers the background of the study, problem statement, objectives, scope of this project and the report overview of this project is also included in this chapter.

Chapter 2: Literature Review

This chapter focuses on the literature reviews and theoretical study of every component to be discussed in this project.

Chapter 3: Research Methodology

This chapter explains the methodologies utilized in carrying out this study.

Chapter 4: Results and Discussion

This chapter deal with the analyzing of data collected, simulation data, the preliminary analysis of several data and discussion on the findings. Analysis and discussion in this chapter are carried out with regards to fulfilling the objectives of the project.

Chapter 5: Conclusion and Recommendations

This chapter is about the recommendation for this further improvement of the study and the conclusion of the study carried out.

CHAPTER 2

LITERATURE REVIEW

This chapter contains the literature review following the objectives and scope of the project. It discusses facility and factory layout, factors affecting factory layout, traditional types of facility layout, and procedures for facility layout design, material flow analysis, and handling system, manufacturing process, simulation under discrete event, the scenario in the production line, and meeting stochastic demand in the manufacturing industry. All the information for this study is from journals, books, case studies, reports, scholarly articles, and other reliable sources.

2.1 Concept of Facility Layout

A facility layout is an arrangement of everything needed for the production of goods or delivery of services. A facility is an entity that facilitates the performance of any job. It may be a machine tool, a work centre, a manufacturing cell, a machine shop, a department, a warehouse, etc. (Heragu, 1997).

Shayan and Chittilappilly (2004) defined the facility layout problem as an optimization problem that tries to make layouts more efficient by taking into account various interactions between facilities and material handling systems while designing layouts.

Azadivar and Wang (2000) defined that the facility layout problem as the determination of the relative locations for, and allocation of, the available space among a given number of facilities.

The facility layout focuses on the physical allocation of space to its optimum level for all economic activity to be carried out. An effective and efficient facility layout always tends to make sure that there is an undisrupted and continual flow of production material, machinery, and labour at an optimal cost. Figure 1 below shows a simulated sample of a facility layout.



Figure 2.1: Simulated sample of a facility layout (Ernst, 2010).

There is a compelling need for manufacturing companies to venture into the vision of expansion and improvement of their manufacturing system to meet the stochastic demand of the customer. Prym Consumer (M) Sdn. Bhd as a worldwide leading manufacturer and supplier in this sector is thereby forced to analyze major aspects that constitute their manufacturing system for drastic actions to be taken of which the factory layout plays a major role for improvement in meeting the desired goal and objective. The need for facility layout to be taken priority for any manufacturing company desiring expansion and improvement is because, amongst others factors, errors and sub-optimal designs will impact the flow of work and materials, production speed, and as well the safety of the workers.