Faculty of Manufacturing Engineering

MATERIAL FLOW ANALYSIS OF AGV SYSTEM BY USING SIMULATION TECHNIQUE TO IMPROVE PRODUCTIVITY

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A thesis submitted
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DECLARATION

I declare that this thesis entitled "Material Flow Analysis of AGV System using Simulation Technique to improve productivity" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : SELVAGANABATHY A/L SIVAMOORTHY

Date : 30th June 2023

APPROVAL

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

Signature : .....

Supervisor Name : Ir. Dr.-Ing. Azrul Azwan Bin Abdul Rahman CEng

Date : 30th June 2023

DEDICATION

This thesis is dedicated to my family, friends and my Supervisor

for giving me support, encouragement and understanding along this project.

Thank You So Much & Love You All Forever!

ABSTRACT

A production factory's need for efficient material flow is the subject of this Master's project. The purpose of this project is to make the production and assembly process's material flow efficient by improving current AGV system in an effort to reduce line stoppages due to waiting for material supply. Simulation is used in this project due to the complexity of the production and assembly process. By creating a simulation model and executing the simulation technique, the aims are to perform analysis and improvement through simulation and result interpretation. This project makes use of the simulation programme Siemens Tecnomatix Plant Simulation. Based on the findings of the simulation, improvement methods for the material flow are examined and discussed in order to assess the advantages and disadvantages of their application in the manufacturing facility. The outcome of this project is a strategy that may be used to improve material flow throughout the production and assembly process by improving AGV system and making the best use of it. The project's goals are attained by using the simulation approach presented in this report, and proposals to improve the AGV system is elaborated.

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ANALISIS ALIRAN BAHAN SISTEM AGV DENGAN MENGGUNAKAN TEKNIK SIMULASI UNTUK MENINGKATKAN PRODUKTIVITI

ABSTRAK

Keperluan kilang pengeluaran untuk aliran bahan yang cekap adalah subjek projek Master ini. Tujuan projek ini adalah untuk menjadikan aliran bahan proses pengeluaran dan pemasangan cekap dengan menambah baik sistem AGV semasa dalam usaha untuk mengurangkan pemberhentian talian kerana menunggu bekalan bahan. Simulasi digunakan dalam projek ini kerana kerumitan proses pengeluaran dan pemasangan. Dengan mewujudkan model simulasi dan melaksanakan teknik simulasi, matlamatnya adalah untuk melakukan analisis dan penambahbaikan melalui simulasi dan tafsiran hasil. Projek ini menggunakan program simulasi Siemens Tecnomatix Plant Simulation. Berdasarkan penemuan simulasi, kaedah penambahbaikan untuk aliran bahan diperiksa dan dibincangkan untuk menilai kelebihan dan kekurangan aplikasi mereka di kemudahan pembuatan. Hasil projek ini adalah strategi yang boleh digunakan untuk meningkatkan aliran bahan sepanjang proses pengeluaran dan pemasangan dengan meningkatkan sistem AGV dan menggunakannya dengan sebaik-baiknya. Matlamat projek dicapai dengan menggunakan pendekatan simulasi yang dibentangkan dalam laporan ini, dan cadangan untuk memperbaiki sistem AGV dihuraikan.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

2D - 2-Dimension

3D - 3-Dimension

AGV- Automatic Guided Vehicle

CAD- Computer-Aided Design

CPS - Cyber-Physical System

DES - Discrete Event Simulation

EOQ - Economic Order Quantity

EPQ - Economic Production Quantity

FLP - Facility Layout Planning

HMI - Human Machine Interface

ISO - International Organization for Standardization

TOC- Theory of constraints

CHAPTER 1

INTRODUCTION

1.0 Project Background

Material handling tools called AGVs are used to move goods throughout a production facility. AGVs have sensors and guiding systems, like lasers or magnets, that let them move around the facility and stick to pre-planned paths. In order to reduce the need for physical handling and to make better use of labour, they can be programmed to deliver items to certain areas at predetermined intervals. In manufacturing settings, AGVs are frequently used to move materials from one step of the production process to another, such as from raw material storage to the production line or from the production line to finished goods storage. Additionally, they can be used to move items within a facility between various departments, for example, from the engineering department to the production department.

The Printing Device Manufacturing Company installed an AGV system to boost the effectiveness of its assembly line material handling processes. The system's AGVs are outfitted with sensors and navigational tools, like lasers or magnets, that let them move across the production facility and adhere to predetermined paths. Since the AGVs may be programmed to deliver items to precise locations at predetermined intervals, manual handling is unnecessary and labour can be used more effectively. By removing the need for manual material handling, the AGV system at Printing Device Manufacturing Company has improved safety, decreased material handling expenses, and increased production rates.

This report's focus is on how Printing Device Manufacturing Company is enhancing its AGV system by using Tecnomatix Plant Simulation. Users of the factory simulation software Tecnomatix Plant Simulation can create and examine production systems in a virtual setting. Users can find bottlenecks and inefficiencies, improve processes, and assess the effects of changes before they are implemented in the actual system by modelling a manufacturing system.

This study will discuss the application of Tecnomatix Plant Simulation in the context of enhancing Printing Device Manufacturing Company's AGV system. The paper will give a summary of the AGV system before the upgrades, a rundown of the difficulties and problems that the old system presented, and an introduction to Tecnomatix Plant Simulation. Additionally, it will go through how Tecnomatix Plant Simulation was used to evaluate and optimise the AGV system, as well as the simulation's outcomes and suggested adjustments in light of them.

The report will next go into the actions taken to put the improvements into practise, the difficulties encountered, and the outcomes of the implementation, including any advantages realised like increased effectiveness, cost savings, or improved safety. The report's conclusion will include a summary of the major issues raised, a discussion of the advantages of utilising Tecnomatix Plant Simulation to enhance manufacturing processes, and a look ahead to the AGV system at Printing Device Manufacturing Company.

1.1 Problem Statement

The case study that served as the basis for this research was carried out at a factory that produces business printers for the global market. Due to poor material flow, the factory experiences issues with order delays at the assembly workstations. The production line must halt while it awaits the delivery of the part. Unplanned breaks result in lower output

and operating profit. The company's delivery output was insufficient as a result of the rising order demand and the slow AGV production movement. There was a chance that the delivery will be delayed as a result. The AGV system doesn't appear to be able to produce at the necessary rate. However, this AGV system makes sure that there is constant material flow during the manufacturing and assembly processes. Therefore, the AGV system's congestion should be reduced without jeopardising material flow. New strategies to enhance the AGV system for the material flow may barely be evaluated by application in the current production due to the complexity of the production and assembly process. Even minor modifications might have unpredictable results, and unforeseen challenges may force unplanned production halts. A solid understanding of production management, including facility layout planning, inventory management, and material flow, as well as the use of simulation software, are necessary for conducting the material flow improvement. It was necessary to increase the PHASE 4 line's productivity in terms of the volume of products it could process.

1.2 Objectives

The objectives of this project are as follows:

i. To analyse current AGV system at assembly line part supply process for PHASE 4.
ii. To develop proposals for AGV system improvement for PHASE 4.
iii. Evaluate the improvement proposals for PHASE 4.

1.3 Scope

This project's study focuses on the production-related topics of facility design, material flow, and process monitoring. The techniques employed in this research also come from these

academic areas. Siemens Tecnomatix Plant Simulation is used to create a simulation model and analyse experimental runs for the material flow because the project calls for the usage of simulation software. To create the simulation model, the intricate industrial system is abstracted.

The major material flow for the functioning pieces using AGV System is the focus of the simulation's analysis of the factory's material flow. Analyse the current AGV system at the selected printing device manufacturing company. Collect data of the AGV system from the company and interpret the data collected. Produce and design the current AGV model using Technomatix Plant Simulation software. Perform validation on the AGV model design to ensure that the model design represent the current AGV system.

Identify problem encountered and propose for better improvement of the current AGV system Improvement of the current AGV system that have been applied at printing device manufacturing company.

Finally propose and analyse final design of AGV system by make a comparative analysis between the existing system and proposed system in term of efficiency and cost.

1.4 Significance of Project

This project's study focuses on the production-related topics of facility design, material flow, and process monitoring. As is well known, Malaysia is currently placing a strong emphasis on automation, particularly in the manufacturing sector. This is as a result of the industry's shift towards automation and the developed nation. The industries are also concentrating on IR 4.0, where automation is crucial.

Customers are becoming more demanding as the nation and business place more emphasis on automation and IR 4.0. In order to ensure that production doesn't stop owing to a lack of materials, engineers must upgrade the production line by automating guided vehicle

systems. The industry benefits greatly from this, as it keeps us informed about new systems and technologies.

This study's importance lies in its potential to enhance the current automated guided vehicle system. This is due to the fact that the majority of industries' output was insufficient due to the delayed AGV production movement and the rising order demand. The manufacturing industry notably needs this technological advancement as a stepping stone to fully automated production and Industry 4.0.

CHAPTER 2

LITERATURE REVIEW

2.1 Production Management

All planning and controlling tasks required to manufacture a product are included in production management. The planning activities for the factory layout and material flow for the production plant are all included in the production management activities on the one hand. On the other hand, regulating these operations guarantees that the output is productive and efficient. Production management oversees manufacturing and supervises production inputs like raw materials, capital, and labour to produce desired outputs, such as products. Management of production is crucial in manufacturing, regardless of the size of the company. As a business grows and the difficulty of managing projected output rises, this becomes increasingly important.

2.1.1 Functions of Production Management

The most crucial duties include cost engineering, production planning and control, material planning and control, quality assurance, and product development and technology planning (Rolstadas, 2018). Given that these tasks are crucial for the product cycle and the production cycle shown in Figure 2.1, their importance for manufacturing businesses becomes clear. By using a well-structured production management strategy, businesses may boost productivity and cut costs, giving them a competitive edge in the market.

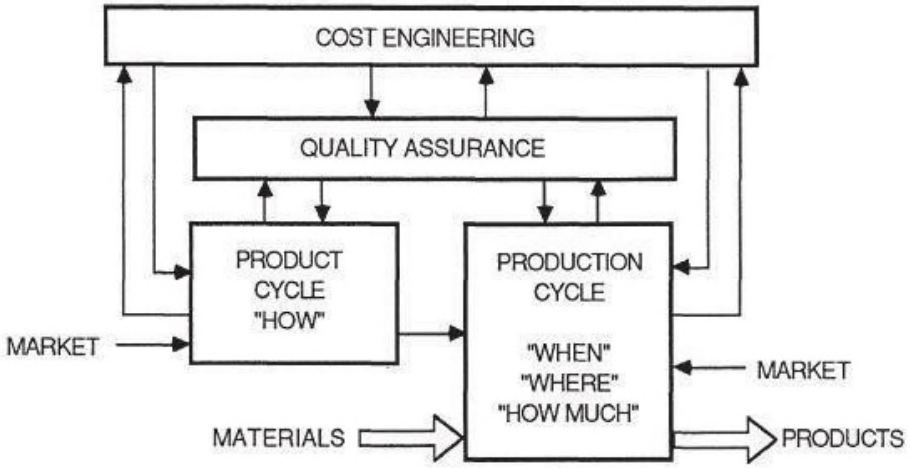

Figure 2.1: Connectance between Production Management Functions (Rolstadas, 2018)

Production management is an essential aspect of any organization. Due to the company's ability to provide high-quality products and services, production management aids in improving process efficiency. Strategies for production management encourage the development of both new, high-quality products and improvements to existing ones. Less time spent on manufacturing processes means there may be more resources available for other areas that require more attention, which can help businesses become market leaders.

2.1.2 Complexity in Production Management

In contemporary production systems, the fundamental connections between the production management functions that (Rolstadas, 2018) depicts in Figure 2.1 have grown more intricate. This development is due to ongoing globalisation, the market's high volatility, and a shift in attitudes toward sustainability and individualization (Horler, 2019). Environmental complexity, service/value complexity, and internal complexity are the three main categories of complexity that have an impact on production management. Table 2.1 provides a description of the types.

Table 2.1: Types of Complexity affecting Production Management (Horler, 2019)

Type	Description
Environmental Complexity	Uncontrollable trends from market, customers etc.
Service / Value Complexity	Diversity and amount of products variants provided
Internal Complexity	Variety of elements and processes in the system itself

It is required to break down the production system into its organisational, technical, and human components in order to analyse the factors contributing to the complexity of production management. In order to accomplish well-executed production management and promote problem-solving in production processes, it is crucial to analyse and systematise these factors (Horler, 2019). Figure 2.2 presents the key causes in graphic form.

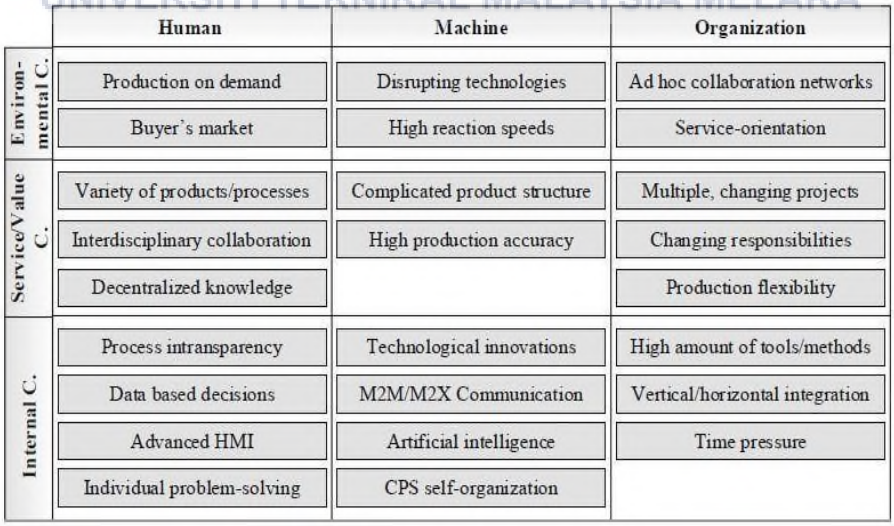

Figure 2.2: Reasons for higher Complexity in Production Management (Horler, 2019)

There are a number of methods used in production management to solve the complexity issues in production systems. The strategy that is most often used is lean manufacturing. The goal of lean manufacturing is to provide the "best quality products, at the lowest cost, with the shortest lead time by methodically and continually eliminating waste, while respecting people and the environment."(United States Environmental Protection Agency, 2018). A production process should only handle the bare minimum of tools, materials, room, and time that add value to the finished good. (Russell and Taylor, 2018). 5S, Standardized Work, and Kanban Systems are the three most popular lean manufacturing tools. (Pinto et al., 2018)

The design and operation of production systems are influenced by both internal and external factors. The complexity of fixing issues in production systems is rising as a result of long-lasting trends paired with subjects like digitalization and artificial intelligence. Additionally, there is a growing risk of poor planning and a decline in long-term competitiveness. In order to enhance problem-solving procedures in the design and management of production systems, this study offers a novel technique.

2.2 Plant Layout

Plant layout is the organisation of physical facilities including machines, equipment, tools, and furniture. As a result, the product can be processed with the least amount of handling and the quickest flow of materials from the reception of raw materials to the delivery of the finished product. (Tak, 2019). The main goal of plant planning, is to create a physical configuration that most economically produces the quantity and quality of output that is required.

The majority of plant layouts are often well-suited to the starting circumstances of the organisation. However, during the expansion phase, these architectures create

numerous bottlenecks. In light of this, when capacity expands, it must adapt to internal and external changes for which a re-layout is required (Shrikant, 2018)

Re-layouts are frequently brought on by changes in manufacturing volume, adjustments to technology and processes, and alterations to the product itself. The frequency of layout changes depends on the needs of the business at the time. Since the restrictions of a dynamic environment change over time, facility layout planning is a constant iterative process. So, optimization of facility layout is situation based requirement of the industry. Shrikant said there are symptoms that allow the need for a re-layout as presented at Figure 2.3:

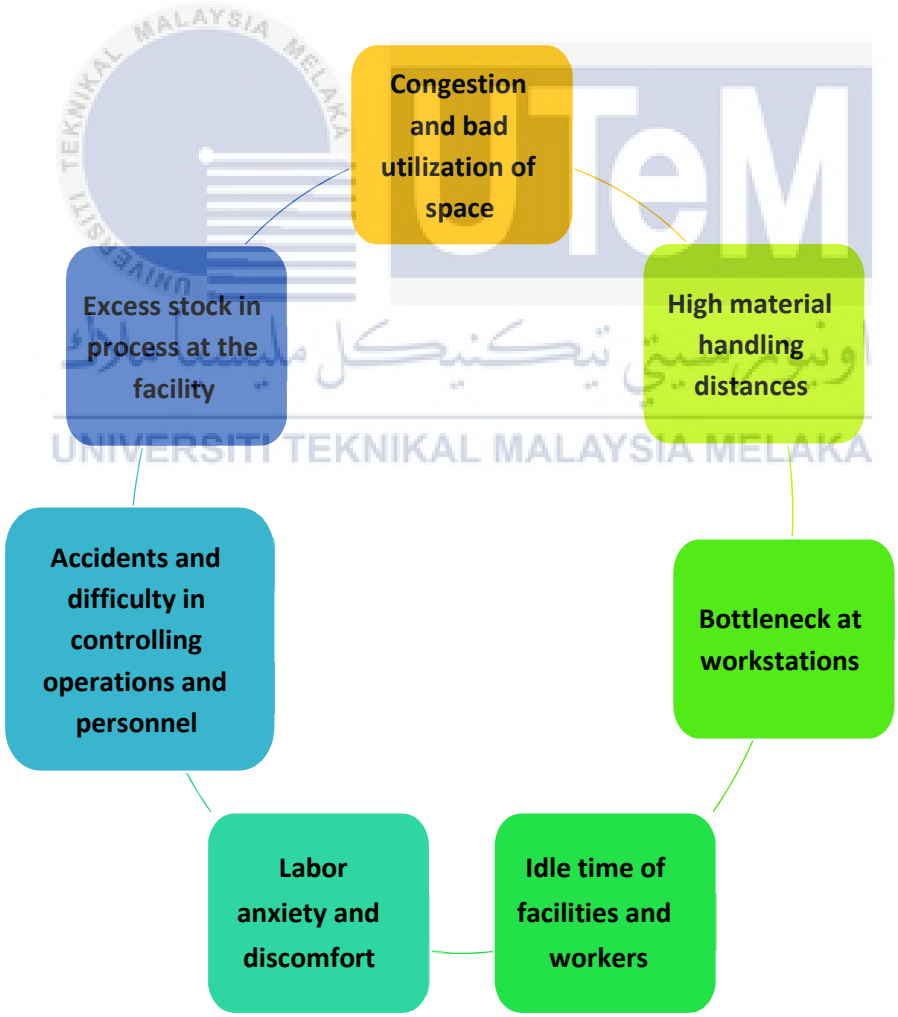

Figure 2.3: Reasons for Re-Layout (Shrikant, 2018)

So, improvement of plant layout is necessary to fix the imbalance in the processes where the entire inefficiency symptom must be removed to optimize the plant and facility usage. By doing this, sooner or later it will give a better result for any production or service line.

2.3 Facility Layout Planning

A facility layout is a set up of all the equipment required for service or product production. A facility is a thing that makes it easier to do any work. It could be a department, a warehouse, a work centre, a production cell, a machine shop, etc. (Heragu, 2018). It can be characterised as a method of placing equipment, procedures, and plant services within the factory to produce the desired amount and quality of output at the lowest production cost. It requires careful planning of manufacturing facilities to ensure direct workflow.

2.3.1 Objectives of Facility Layout Planning

The primary goal of the factory layout is to create a necessary facilities layout plan that is required for cost- and industrial-saving measures (Prasad, 2018). Departments that have a close relationship should be placed close together, but departments without a tight relationship shouldn't. For instance, it makes little sense to put the human resources department adjacent to the raw material receiving department because their processes are so dissimilar. The building's layout must take into account elements like improving worker safety and facilitating communication that may not be obvious at first. Economical requirements like equipment purchases and material handling expenses must be kept to a minimum. (Prasad, 2018).