ANALYSIS ON THE EFFECT OF PROCESS CONFIGURATIONS ON MANUFACTURING SYSTEM PERFORMANCE

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

by

AMIRA SHAIRAH BINTI MD. YUSOF

B051820082

990120-04-5488

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Disahkan oleh:

Alamat Tetap:
KM. 20, Kampung Paya Redan,
Tiang Dua, 75460, Melaka,
Melaka

Cop Rasmi: DR. NADIAH BINTI AHMAD
Senior Lecturer
Faculty of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka

Tarikh: 27 / 1 / 2023

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I hereby, declared this report entitled "Analysis on the Effect of Process Configurations on Manufacturing System Performance" is the result of my own research except as cited in references.

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Author's Name : AMIRA SHAIRAH BINTI MD. YUSOF

Date : 27 JANUARY 2023

APPROVAL

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

………………………………………………

(Dr. Nadiah binti Ahmad)

ABSTRAK

Sistem pembuatan fleksibel (FMS) ialah satu penyelesaian yang membolehkan mana-mana sistem pembuatan untuk menahan perubahan keperluan pasaran. FMS ialah sistem kompleks yang terdiri daripada beberapa mesin kawalan berangka terkomputer (CNC) yang sangat automatik, sistem pengendalian bahan yang cekap dan pengendali manusia. Kertas kerja ini memberi tumpuan kepada kajian eksperimen berasaskan simulasi tentang kesan faktor seperti permintaan stokastik, bilangan kenderaan berpandu berautomatik (AGV) dan peraturan penjujukan pada prestasi FMS biasa. Dalam kajian ini, dua tahap (iaitu permintaan stokastik) dan tiga tahap (iaitu bilangan AGV dan peraturan penjujukan) dipertimbangkan untuk penyiasatan. Perisian Tecnomatix digunakan untuk mensimulasikan model FMS dalam kertas penyelidikan ini. Tambahan pula, prestasi sistem pembuatan dinilai menggunakan empat ukuran prestasi seperti jumlah pengeluaran, penggunaan mesin,masa menunggu dan penggunaan AGV. Metodologi yang dicadangkan dalam kertas kerja ini membantu dalam menentukan kombinasi tahap faktor terbaik untuk setiap parameter prestasi sistem. Menjelang akhir, skop selanjutnya diserlahkan.

ABSTRACT

A flexible manufacturing system (FMS) is one solution that allows any manufacturing system to withstand the market's changing needs. FMS is a complex system consisting of several highly automated computer numerical control (CNC) machines, an efficient material handling system and a human operator. This paper focuses on a simulation-based experimental study of the effects of factors such as stochastic demand, the number of automated guided vehicles (AGV), and sequencing rules on regular FMS performance. In this study, two levels (i.e. stochastic demand) and three levels (i.e. number of AGV and sequencing rules) are considered for the investigation. Tecnomatix software is used to simulate the FMS model in this research paper. Furthermore, the performance of the manufacturing system is assessed using four measures of performance such as total production, machine utilization, waiting time dan AGV utilization. The methodology proposed in this paper assists in determining the best factor level combination for each system performance parameter. Towards the end, the further scope is highlighted.

DEDICATION

Only
my beloved father, Md. Yusof bin Husin
my appreciated mother, Marzanah binti Sairi
my adored brothers and sister, Azim, Aliff and Atika
for giving me moral support, money, cooperation, encouragement and also understanding
Thank You So Much & Love You All Forever

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

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AGV	-	Automated Guided Vehicles
AS	-	Automated Storage
CAD	-	Computer-aided Design
CAM	-	Computer-aided Manufacture
CIM	-	Computer Integrated Manufacturing
CNC	-	Computer Numerical Control
DES	-	Discrete Event Simulation
DSS	-	Decisions Support Systems
EDD	-	Earlier Due Dates
FCFS	-	First Come, First Served
FMS	-	Flexible Manufacturing Systems
I	-	Input buffer
L	-	Load Station
LPT	-	Longest Processing Times
LCFS	-	Last Come, First Served
NG	-	Number of AGV
O	-	Output buffer
PPC	-	Production Planning and Control
RS	-	Retrieval Systems
SD	-	Stochastics Demand
SPT	-	Shortest Processing Times
SR	-	Sequencing Rules
UL	-	Unloading Station

LIST OF SYMBOLS

min	-	Minute
λ	-	Lambda

CHAPTER 1

INTRODUCTION

There are a few aspects highlighted in this chapter. The background of the study provides vital information regarding the title. Current problems in the research studies are identified. The objectives of the study project are stated to provide clear guidelines for the project which is within certain focus aspects.

1.1 Background of Study

The effect of process configurations on manufacturing system performance cannot be neglected, especially when dealing with flexible manufacturing systems (FMS). This is because different configurations have different effects on a system. FMS is a complex system consisting of several highly automatic Computer Numerical Control (CNC) machines, an efficient material handling system and human operators.

Manufacturing is becoming more flexible in responding to environmental changes; product life cycles are becoming shorter, customer demand is increasing levels of customization at standard product prices, and markets are more global than ever. (Bengtsson & Olhager, 2002). Therefore, an FMS with the importance of manufacturing flexibility in responding quickly and efficiently will benefit customer needs. There are eight types of flexibility. These are machine flexibility, routing flexibility, product flexibility, process flexibility, volume flexibility, expansion flexibility, operation flexibility, and production flexibility (Ali & Ahmad, 2014).

The different manufacturing strategies used in the industry are crucial to the performance of FMS. Several strategies can be considered in evaluating the performance of the system; among them is the problem of manufacturing flexibility, lot size, part type selection, machine grouping, production ratio, resource allocation, machine loading, and scheduling (Ali & Ahmad, 2014). This study examines different manufacturing strategies, namely routing and part mix flexibility and scheduling rules. Different combinations for all these manufacturing strategies are carried out using discrete event simulation.

1.2 Problem Statement

The flexible manufacturing system provides competitive value to the manufacturer and works in making medium-volume direct products. Like any other complex system, a flexible manufacturing system (FMS) may be exposed to many internal and external uncertainties, such as random component failures. (Souier et al., 2019).

Therefore, some problems may be encountered in this FMS. Operational problems, specifically scheduling, are one of the difficulties encountered in decision making in FMS control. An FMS's production management and scheduling issues are more complex than job shops and transfer lines. (Chan et al., 2002). This is because FMS has a versatile machine and can perform different operations and produce different types of products. In addition, changes in demand that may occur rapidly and the random entry of new products with high demand also cause unforeseen events such as machine breakdowns.

In addition, routing flexibility is also one of the most common difficulties and needs to be addressed to achieve the best response in FMS performance. This is because some constraints need to be considered in routing flexibility. Precedence constraints between jobs, random arrivals, stochastic processing times, and machines' reliability levels are among them (Souier et al., 2019). It is always necessary to analyze the system state to determine how parts can be redirected to alternative machines. In turn, alternative machines will cause it to be less efficient and more congested.

Past studies have generally focused on analysing properties that distinguish FMS scheduling problems from problems found in conventional systems based on the above studies. In addition, previous papers have also focused more on the effect of part mix and routing flexibility on FMS performance. However, only a few studies focused on stochastic or random demands on FMS performance. Therefore, this research focuses on studying the effect of the key factor affecting the performance of FMS.

1.3 Objectives

The objectives are as follows:

i) To investigate the key factors affecting the performance of the FMS.

ii) To simulate the FMS model with the help of discrete event simulation.

iii) To evaluate the effect of different combinations of factor levels on the FMS performance.

1.4 Scope

The study's scope focuses on using discrete-event simulation based on experimental research on a system that arrives continuously in a random manner and with stochastic demands.

In addition, this study also examines the effects of process configuration the combination of stochastic demand, the number of Automated guided vehicle (AGV) and sequencing rules with the help of the Tecnomatix Simulator.

The studies focused only four performance measure such as total production, average machine utilization, average waiting time and average AGV utilization.

1.5 Significant of Study

There are several potential benefits that the performance of the FMS layout can gain after the completion of this study. Among them is the effect of using routing decision-making tools in FMS can increase system reliability and minimize the effects of damage without lowering the product quality and productivity of FMS. Because FMS scheduling is very complex, simulation is a valuable tool to cope with FMS scheduling in achieving high efficiency shortest production time in a system. Hence simulation helps in decision making for an optimum solution and is used as a tool for Decision Support systems (DSS) for scheduling real-world manufacturing systems (Arshad et al., 2016).

1.6 Organization of Thesis

The organization of this thesis is as follows:

Chapter 1: Introduction

This chapter begins with the background of the study. This is followed by problem statements identified through previous studies and journals. Next, the objectives to be achieved throughout the study and the scope narrow down the study area. The significance of the study is also one of the most important to improve the current problem of the study.

Chapter 2: Literature review

Supporting information for the research title had been stated. Covering fundamental theories on research topics and previous studies from journals, books and the internet related to the field of research.

Chapter 3: Methodology

The methods cover the discrete event simulation methodology, which is the physical configuration of the FMS and detailed factors that affect the FMS's performance. All the procedures used in this project are based on previous studies. Methodologies took to complete objectives 1, objective two and objective 3.

Chapter 4: Result and discussion

The result was collected by using the methodologies in chapter 3. The analysis of the results after running several experiments using Tecnomatix simulation on the FMS layout had been presented and discussed in this chapter. An optimal factor combination is also identified, which generates the best system performance.

Chapter 5: Conclusion

Discrete-event simulation models have been used to analyze the impact of some factors, i.e. stochastic demand, number of AGVs, and sequencing rule, on the performance of an FMS model configuration. The conclusion and recommendations for possible future directions of this research are examined.

1.7 Summary

The summary of this chapter primarily describes the information related to previous studies extracted as a reference and discussion based on their research on several significant factors such as stochastic demand, number of AGV and sequencing rules on FMS performance. In addition, this chapter also describes some of the constraints or problems encountered that cause the system's performance. Therefore, this study aims to analyze further the effect of process configurations on manufacturing system performance.

CHAPTER 2

LITERATURE REVIEW

This literature review chapter describes all the complications of literature review, theory, and research that various researchers have defined over the past year. Information related to previous studies had been extracted as a reference and discussion based on their research on FMS background, types of manufacturing flexibility, scheduling rules, and the application of discrete event simulation to FMS.

2.1 Flexible Manufacturing System (FMS)

FMS is a flexible industrial process that is "reprogrammable" because it can allow equipment to be used for more than one purpose and automatically produce various products. This is because this FMS has a high-efficiency technique in the production system for multiple types of products or parts. This efficient technique results in FMS being able to fully process members of one or more families parts continuously without human intervention (Mousavi, 2018).

There are two levels of flexibility available in FMS, namely dedicated FMS and random order FMS. Dedicated FMS is a system designed to produce a selection of fixed parts, while a random order FMS is an advanced setup that allows the production of complex designs. FMS is a system developed to respond to changes in production needs. The main objective of this FMS is to approach efficiency, maintain flexibility, and meet the requirements associated with the time and cost generated. The basic outline of the FMS is demonstrated in Figure 2.1.

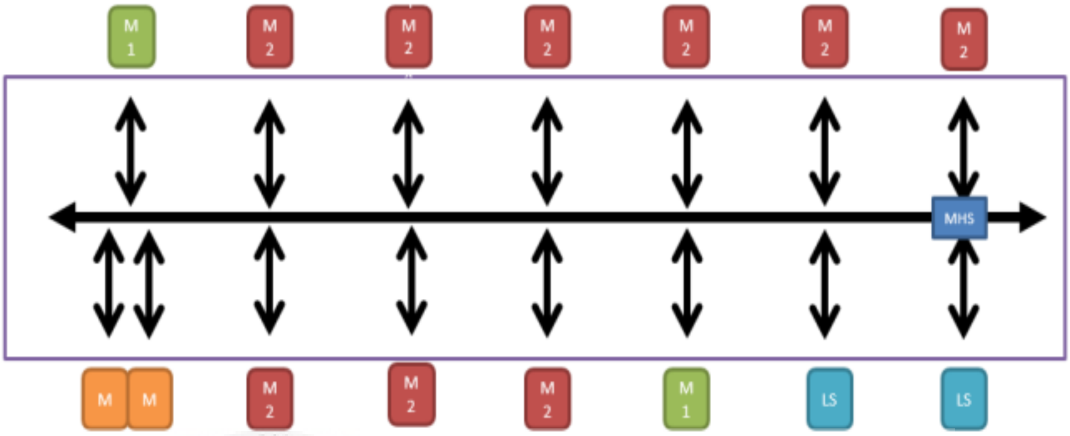

Figure 2.1: The outline of the basics of the FMS. (Rybicka, 2017)

2.1.1 FMS Layouts

Flexible manufacturing systems have different layout configurations established by material handling systems that follow the machine arrangement and part flow. This configuration can be divided into five categories. Among them:

i. In-line Layout
ii. Loop Layout
iii. Ladder Layout
iv. Open field Layout
v. Robot-centred Layout