UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Manufacturing Engineering

SIMULATION AND ANALYSIS OF MATERIAL TRANSPORT SYSTEM IN AUTOMOTIVE INDUSTRY

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ABSTRACT

This research presents simulation analysis and suggestions for improvement of a material handling scenario in an automotive industry. The material handling technology studied here is in the form of forklifts movement. The methodology is developed based on the case study of PHN Industry Sdn.Bhd. In order to complete the goal set, the simulation approach was adjusted to the specified task. A simulation model of the existing system was developed and analysed to comprehend the state of the current manufacturing operations. The important aspect of the simulation was to illustrate by solving series of practical tasks to diagnose the problems, evaluate possible solutions and optimize the operations. The utilisation of workforce and waiting time at the various processes were analysed to identify the bottleneck issues in the system. A new proposal based on the findings of the simulation process that would improve the efficiency of the manufacturing activities was made. This will help the industry to determine the appropriate number and capacity to obtain more optimum working time. Based on the simulations, it was found that the use of existing materials transportation still has room for improvement. By adding the use of forklift in the zones that experienced high waiting time, increase in the efficiency of the material transportation system and reduces the waiting time for the movement of the work piece. A reduction time of 23 percent was in the working zones. The simulation improvements is in the productivity and reduction in term of amount time in material handling are more beneficial.

ABSTRAK

Kajiselidik ini membentangkan kaedah dan analisis teknologi pengendalian bahan dalam industri automotif. Metodologi ini dibangunkan berdasarkan kepada kajian kes syarikat PHN Industry Sdn.Bhd. Bagi mencapai matlamat yang dinyatakan, kaedah simulasi telah digunapakai mengikut kesesuaian tugasan spesifik. Suatu model simulasi akan dibangun dan dianalisa bagi memahami keadaan sistem pengoperasion yang sedia ada. Aspek penting pendekatan simulasi ini boleh diperolehi setelah melakukan beberapa diognisis bagi permasalahan yang dikenalpasti, menilai kemungkinan penyelesaian dan juga pengoptimuman operasi. Penggunaan tenaga kerja dan masa menunggu untuk pelbagai proses turut dianalisa bagi mengenalpasti isu sekatan di dalam sistem.

Hasil dari kajiselidik dapat membantu pihak industri menentukan bilangan dan kapasiti yang bersesuaian bagi mendapatkan masa kerja yang lebih optimun. Berdasarkan simulasi yang dijalankan didapati bahawa penggunaan pengangkutan bahan sediada masih mempunyai ruang untuk diperbaiki. Dengan penambahan dalam sistem pengangkutan dapat mengurangkan masa menunggu bagi pergerakan bahan kerja. Pengurangan masa sebanyak 23 peratus dapat dikurangkan pada zon kerja yang mengalami masa menunggu yang tinggi. Simulasi menambahbaikan produktiviti dan pengurangan masa bagi pengendalian bahan memberi banyak ganjaran kepada pihak syarikat.

DEDICATION

This work is dedicated to my beloved wife, son, daughters and parents, without their caring support and the respect for education it would not have been possible.

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To complete a research project of this magnitude requires a network of support, and I am indebted to many people. I am mostly grateful to my supervisor Dr. Zamberi bin Jamaludin for his guidance and support. I lovingly dedicate this project to my wife and children who have supported me each step of the way with tremendous courage and motivation. My heartiest gratitude also goes to Jabatan Perkhidmatan Awam (JPA) for their financial support, Jabatan Tenaga Manusia (JTM) and Japan-Malaysia Technical Institute (JMTi) for their motivation to make this research project a success.

I would like to extend my thanks and appreciation to PHN Industry Sdn Bhd for the opportunity of sharing their work experience and data for this work. Last but not least my gratitude also goes to the lecturers and fellow friends who has direct or indirectly assisted me in completing this project.

DECLARATION

I declare that this thesis entitle "Simulation And Analysis of Material Transport System In Automotive Industry Area" 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 : .....

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Date : .....

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfilment of the requirements for the degree of Master of Manufacturing Engineering (Manufacturing Systems Engineering). The member of supervisory committee is as follow:

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LIST OF ABBREVIATIONS

AGV	-	Automatic Guided Vehicle
AHP	-	Analytical Hierarchy Process
LPG	-	Liquefied Petroleum Gas
ESL	-	Economic Service Life
FG	-	Finish Goods
WIP	-	Works In Progress
IHA	-	In House Assembly
HIS	-	In House Stamping
GUI	-	Graphical User Interface

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CHAPTER 1

INTRODUCTION

This chapter introduces the background of the research project on simulation and analysis of material transport system in automotive industry area. This chapter includes the problem statement, objectives, scopes and the significant of this project.

1.0 Background

This project presents simulation and analysis of material transport system featuring forklift as the main mean of transportation in an automotive manufacturing environment. The simulation and analysis performed are based on actual study at PHN Industry Sdn.Bhd. PHN Industry Sdn. Bhd. is located in Shah Alam, is a major automotive components manufacturing company involves in the production of medium-to-large automotive components for car-makers such as Proton, Perodua, Honda and Toyota.

The simulation will evaluate alternative scheme, especially when the scheme are computer-generated. Human decision on material handling would understand all their details and create a reliable material transport technology. Moreover, computer generated design are obtained from modelling assumptions that can often seem too restrictive in a production line. A well-designed simulation could serves as reference for the decision-makers in production line to compare their own experience with the decision support system-generated and validate its production.

1.1 Problem Statement

Automative industry is very competitive in terms of product designs and development, and manufacturing. Nowadays it's one of the world most important economic sectors by revenue. Due to high demand and market pressure, the industry needs to develop high quality products at lower cost.

Material transport system is selected as a case study for this research. The manufacturing process begins with the assembly of child parts to their respective mother parts at assembly area by welding process. Then these units will go through several welding processes or workstations before progressing to the next section

At PHN Industry Sdn Bhd assembly area, there are many workstations for assembly process. These automotive's part are of variety of shapes and needs specials type of pallet to be carried. Only five units of forklift operated at this area. Each forklift are been assigned for a specifics stations. The movements of forklift are unpredictable as their current operation is dictated only by request by the line leader. There is no fixed schedule for these forklift's movement.

All five units of forklift are located at "parking zone"(outside assembly area) which require the line leader to communicate with the forklift operators each time they need to move the assembly products.

As a result of this inconsistent scheduling, the workload of each forklift's operator becomes irregular resulting in inefficient operations. This research project will proposed an efficient design of an improved material handling process at the manufacturing plant using effective movements of forklifts based on simulation results obtained. The forklift operators would ulitilize it times and movement or transportation of part.

1.2 Objectives

The main objective of this project is to develop a design improvement and analysis of material transport system in Automotive Industry. The specific objective are as follows:

i. To analyze current material handling technology and practices in the work environment.

ii. To simulate and analyze movement of forklifts within the work environment.

iii. To propose alternative routes that will improve the most effective applications of material handling systems.

1.3 Scopes

The scope of project as follows:

i. Analyses cover the determination of current number of forklifts in use, distance covers, travel time, route or pathway and production layout.

ii. Simulations results focus on the most effective number of forklifts and path to be followed resulting in shortest possible distance travelled.

iii. Produce graphical and tabular tools in order to determine the cost of each option. These tools will help in making decisions for the future changes.

iv. This study is based on one working shift per day.

1.4 Significant of Work

This project will benefit the company (PHN Industry Sdn Bhd) itself in terms of utilization such as men power saving, space saving and others if it is successfully executed and produce good result. The non-value added time during load and unload of material from station toward another station could be reduce. As movement of forklift could be in line

balance for production area. Therefore, the potential for cost savings is high and the problem of creating optimization and desicions support tools becomes more accurate.

The design using simulation as to evaluate the alternative for management policies especially when the policies are computer generated and the human decision would have a complete understanding of all the details. This could be obtained from modelling assumptions that can often seem too restrictive in comparison to the complexity of real operations. A well designed simulation tool can be the basic ground where the decision-makers compare their own experience with the decision support system-generated management policies and validate them.

The present project covers the issue of practical applicability of simulation modelling for material handling for optimization and increasing overall productivity.

1.5 Report Structure

This report contains a total of five chapters. Chapter one discuss about problem statement, objectives, scopes and contribution of this research project. Chapter two that follow reviewed results from literature on topics such as material transport system and the optimization of path and efficiency. This is follow by chapter three covered the methodology to implement to research project. Chapter four illustrates the simulation of material transport and results of the project. Finally, chapter five concludes the finding and main results for determine the most effective applications of material handling systems.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The present chapter focuses on the reviews of material handling equipment, material transport equipment, optimization of path and its efficiency in manufacturing plant. This chapter also introduces the simulation methods used in simulation modelling of material transport system.

2.2 Material Handling Equipment

The material handling is the movement, storage, protection and control of materials throughout the manufacturing and distribution process, including their consumption and disposal. James B.D. et. al., (2012) expanded the phases into its desirable characteristics of material handling. It should consist the following;

i. The designed with safety in mind and deliver materials without damage.

ii. It's should been developed for performing efficiently and operate at low cost.

iii. Be developed to operate accurately, delivering the right materials in the right quantities to the right locations.

Coordination and control is required to move materials that act as inputs to the process and remove materials as outputs from the process. The material handling is often overlooked in the general scheme of production. The cost of material handling is significant and averages around 20-25% of total manufacturing labour cost. Generally material handling

principles are introduced, with discussions on material handling equipment and their design considerations. The varieties of material transport equipment are presented. This is followed by the behavior and analysis of material transport systems, which examines quantitative models of vehicle-based systems of transport systems (James B.D et. al., 2012).

The material handling also known as internal logistics in the manufacturing. Its involve the movement and storage of materials in the manufacturing environment. Groover (2001) visualized material handling procedures as below Table 2.1. There are a four categories of equipment are available commercially, these are describe in detail in Table 2.1. The table make it easy to be understood.

Tabel 2.1 Material handling equipment (Groover 2001)

Type	Description
Material Transport Equipment	Five types may be generally identified: industrial trucks; automated guided vehicles; rail-guided vehicles; conveyors; and hoists and cranes.
Storage Systems	Raw materials and work-in-process generally spend time being stored, even if only temporarily. Finished products may also be stored subject to final delivery. Storage methods include bulk storage; rack systems; shelving and bins.
Unitising Equipment	Containers and pallets are used to group and hold individual items during handling. Containers include pallets, boxes, baskets, pails, and drums. Equipment used include: palletisers and depalletisers
Identification and Tracking Systems	Identifying and tracking materials is usually done by affixing an identifier to the item, carton, or unit load. Identifiers include: bar codes, radio frequency identification (RFID) tags, and sensors.

Cerda (1995) had developed a parameters with the consideration for specifying material handling equipment. Table 2.2 shows the detailed in consideration for material handling.

Table 2.2 Design considerations for material handling

Consideration	Description
Material Characteristics	Physical state (solid, liquid, or gas); size (volume, length, width, height); weight (per piece, and per unit volume); shape (long and flat, round, square, etc.); condition (hot, cold, wet, dry, dirty, sticky); risk of damage (fragile, brittle, sturdy); and safety risk (explosive, flammable, toxic, corrosive, etc.).
Flow Rate, Routing, and Scheduling	Quantities and flow rates of materials to be moved; routing factors; and scheduling of the moves. Large dedicated handling systems are appropriate for large quantities. Conversely, if the quantity of a material types is small and variety is large, then the material handling system needs to be general purpose. The amount of material moved must also be considered within the context of time; this gives us the flow rate. Routing factors include pick-up and drop-off locations, move distances, routing variations, and conditions that exist along routes. Scheduling relates to the timing of each delivery.
Plant Layout	Total area of the facility; total area within specific departments; relative locations of departments; arrangement of equipment in the layout; locations of load stations and unload stations; possible routes between locations; and distances travelled.
Unit Load Principle	Unit loads are designed to be as large as the material handling system can practically manage, subject to obvious conditions—such as safety, convenience and access.

2.3 Material Transport Equipment

Material transport system is a medium for moving the raw material from receiving until deliver it to the customer. According to Groover (2001), there are five categories of material transport equipment commonly used to move parts and other materials in manufacturing and warehouse facilities:

i. Industrial truck

ii. Automated guided vehicles

iii. Monorail and other rail guided vehicles

iv. Conveyor

v. Cranes and hoists

Table 2.3 Summarize the principal features and types of application for each equipment category.

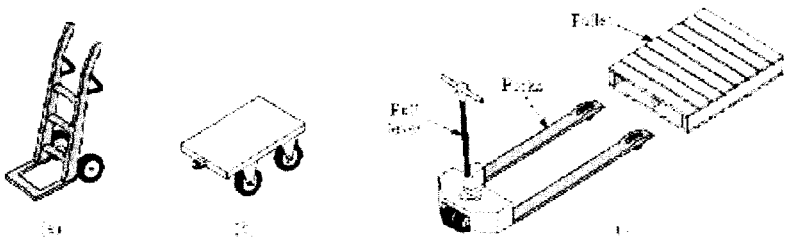
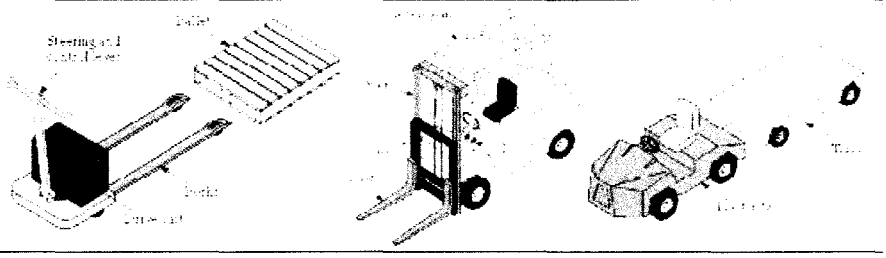
Tabel 2. 3 Summary of features and application of five categories of material handling equipment (Groover 2001)

Material Handling Equipment	*Features*	*Typical Applications*
Industrial trucks, manual	Low cost Low rate of deliveries/hr	Moving light loads in a factory
Industrial trucks, powered	Medium cost	Movement of pallet loads and palletized containers in a factory or warehouse
Automated guided vehicle systems	High cost Battery-powered vehicles Flexible routing Nonobstructive pathways	Moving pallet loads in factory or warehouse Moving work-in-process along variable routes in low and medium production
Monorails and other rail guided vehicles	High cost Flexible routing On-the-floor or overhead types	Moving single assemblies, products, or pallet loads along variable routes in factory or warehouse Moving large quantities of items over fixed routes in a factory or warehouse
Conveyors, powered	Great variety of equipment In-floor, on-the-floor, or overhead Mechanical power to move loads resides in pathway	Moving products along a manual assembly line Sortation of items in a distribution center
Cranes and hoists	Lift capacities ranging up to more than 100 tons	Moving large, heavy items in factories, mills, warehouses, etc.

2.3.1 Industrial Truck

Industrial trucks consist of non-powered and powered categories. The non-power trucks are for the quantity of materials and distances which is relatively low. Powered trucks are self-propelled to ease the worker from manually moving the truck. Three common types used in the industry are walkie truck, forklift rider trucks and towing tractors. Table 2.4 depicts different types of industrial trucks.

Tabel 2. 4 Industrial trucks (Groover 2001)

Type	Figures
Non-powered	
Powered	

2.3.2 Automated Guided Vehicles (AGV)

Automated guided vehicles can be divided into three categories; driverless train, pallet trucks and unit load carriers. Normally AGV application is for moving heavy payloads over large distances. Figure 2.1 shows the types of AGV.

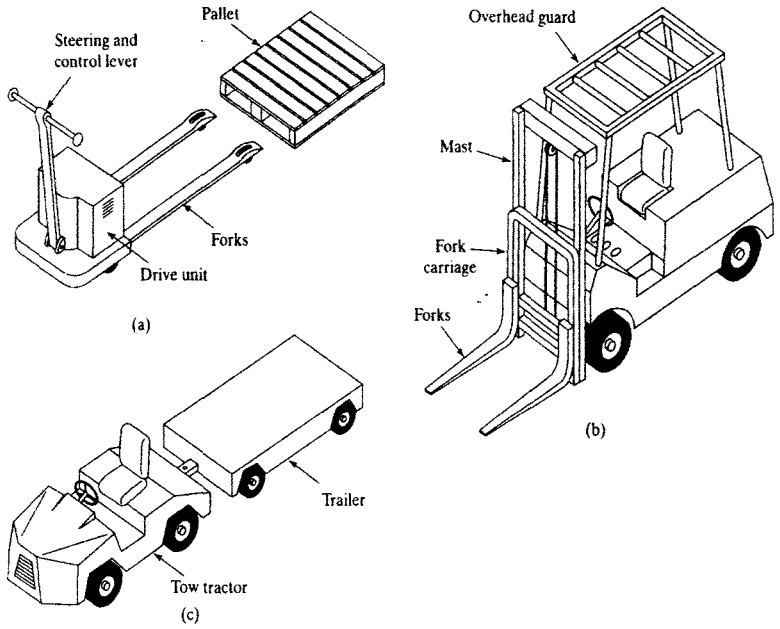


Figure 2. 1 Three Type of Automated Guided Vehicles (Groover 2001)