DESIGN AND SIMULATION OF THE MATERIAL HANDLING SYSTEM IN AUTOMOTIVE INDUSTRY

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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Robotics and Automation) (Hons.)

by

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2014

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **DESIGN AND SIMULATION OF MATERIAL HANDLING SYSTEM IN AUTOMOTIVE INDUSTRY**

SESI PENGAJIAN: **2013/14 Semester 2**

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ABSTRAK

Pembangunan Sistem Automasi dalam sektor pembuatan terutama dalam sistem pengendalian bahan telah berkembang dengan pesat kerana permintaan yang tinggi dalam bidang industri terutamanya untuk sistem pengendalian bahan.Laporan ini membentangkan hasil projek bertajuk "Simulasi sistem pengendalian bahan didalam industri automotif". Projek ini memberi tumpuan kepada analisis pergerakan forklift dalam persekitaran pembuatan kilang sebenar. Analisis ini bertujuan untuk mengkaji kecekapan semasa dalam penghantaran barang menggunakan perisian simulasi Arena yang kemudiannya akan digunakan untuk mencadangkan peningkatan bagi kecekapan yang besar. Keputusan simulasi yang dijalankan menunjukkan peningkatan kecekapan di skalar 100m jarak susun atur yang dicadangkan. Dalam peningkatan, nilai bukan tambah telah berubah 20% kepada nilai tambah iaitu dari 0.05 minit 0.04 minit. Jadi, hasil daripada simulasi adalah lebih baik. Kajian ini menyimpulkan bahawa cadangan itu, telah meningkatkan kecekapan pengangkutan bahan di kilang. Sebagai penambahbaikan di masa hadapan, simulasi akan menjadi lebih menarik dan mengurangkan kerumitan jika bilangan stesen dan forklift terlibat adalah di tambah.

ABSTRACT

The development of automation system in manufacturing especially in material handling system is growing rapidly due for high demand. Demands amount of material handling systems will likely increase due to large number of production operation in Malaysia. This report presents the outcome of a project titled 'Design and Simulation of Material Handling System in Automotive industry'. This project focuses on the analysis of movement of forklifts within actual manufacturing assembly environment. The analysis intends to study current efficiency in parts delivery using Arena simulation software that would then be used to propose additional improvement for greater efficiency. The results of the simulations performed shows efficiency improvement at a scalar of 100m of the proposed layout distance. This improvement is indicated by a 20% reduction in the non-added value from 0.05 minutes to 0.04 minutes. So, the result of the simulation is better. This study concludes that the proposed changes to the current material transport activities has resulted in improved efficiency at the assembly line. As a suggestion to improve the quality for future development, the quality of the simulation process could be further improved by increasing the number of stations and forklift involved.

DEDICATION

Very special and love appreciaton to my beloved mother Salina bt Md Said, father Jasmi bin Matsih, to my beloved siblings Abdul Hafiz, Nur khairunnisa, Nur Syafiqah and to all my friends that very supportive to me through completion this report and for my supervisor Dr. Zamberi who guides me in completing this project. And for my loved ones, this success can never be achieved without your support and we shared this success together. Thanks for your caring and loving.

ACKNOWLEDGEMENT

I would never have been able to finish my final year project without the guidance of committee members,help from friends, and support from my family

I would like to express my deepest gratitude to my supervisor, Dr Zamberi Bin Jamaluddin, for his excellent guidance, caring, patience and providing me with an excellent atmosphere for doing this project.

I also would like to thank for my fellow course mate for their support during my difficult situation. My sincere appreciation also extends to all my colleagues and others that provided assistance at various occasions. Their views and tips are useful. I am grateful to all my family members

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FR	-	Front
GA	-	Genetic Algorithm
IHA	-	In-house Assembly
HIS	-	In-house Stamping
LH	-	Left Hand
MBR	-	Member
RH	-	Right Hand
SD	-	Side
UML	-	Unified Modeling Language
WIP	-	Work in Progres

CHAPTER 1
INTRODUCTION

1.1 Background

In global market today, an ideal system of work, human, machines and materials comes together in coordinated and efficient process in safe and productive environment. What actually happens depends from management decision about the equipment, process and facilities, material handling , logistic systems, space and safety of working environment. The key success in production line depends on how the basic layout in factory were carry out especially in material handling system.

The computer simulation analysis helps visualize the changes in layout and process as well to utilized the layout of material handling before implementating an automation technology, information management system and procedural changes. Computer simulation models can be used to help technician or engineers to evaluate potential new automation investment or even changes to current operations. Result of computer simulations can help determine throughput rates, number of employees needed to pick orders, design problems and system bottlenecks.

The main focus on this project is to simulate the forklift movement in factory by using ARENA software. ARENA is a discrete event simulation software mostly used in automotive industry for material handling systems. By using this software, the user builds an experiment model by placing modules (box, circle and different shapes) that represents process or logic. Connector lines used to join these modules together and specifies flow of entities. While modules have specific actions eleted to entities, flow, timing, the precise representation of each module and entity related to real-life object is subject to modeler. Statistical data such as cycle time and work in process can be recorded as reports.

1.2 Problem statement

Today, most of the products to produced on the market for highly competitive environment, as related to the globalization marketing strategy, which will demands from companies more agility, better performance and the constant search for cost reduction. The present study focused on improvements in internal materials handling system, approaching the case of a large company in the automotive industry which plays a major role in material handling process in factory. Materials handling is basically associated with production flow. Because of this, it has direct influence on cycle time, resources usage, and service levels. The objective is to evaluate, in a systematic way, alternative movement of material handling workflow and the impact of implemented changes in materials handling management on the internal customers' perceptions of cost, safety in service, service reliability, agility and overall satisfaction. Analyzing the answers, it was possible to suggest that internal customers understood that the new materials handling system will enlarged service agility, reliability, efficiency and the most important part is to reduced costs, which caused an improvement in overall satisfaction by both the company and the customer.

1.3 Objectives

The aims of this project are:

1. To determine the current movement of material in production line work flow.
2. To design a proposed system of forklift's movement to be used in the process flow and to prevent the bottlenecks by identifying the shortest path and using most efficient movement of forklift using simulation
3. To simulate and validate the proposed movement of forklifts

1.4 Project Scope

The scope for this project are :-

1. This project consist the programming of simulation using ARENA software
2. Forklift is being used as material handling transportation in this project.
3. This project focuses on determines the cycle time and production rate when the process simulation is applied.
4. Focused on proton part, which is Front Side Member Left, and Right Side (MBR LH/FH)
5. Validation of forklift movement is based on the parameter (input vs output, distance, man vs machine, working system flow)

1.5 Report Outline

Overall, This report contains five chapters. Chapter 2 focuses on literature review which includes primary and secondary sources. Chapter three explains about the methodology use in this project while chapter four will present the result and discussion that being found in this project. Lastly, Chapter five will discuss about the conclusion and future improvement.

CHAPTER 2
LITERATURE REVIEW

2.1 Overview of Material Transportation

Material transportation (for example industrial trucks) refer to different kind of transportation items and vehicles used to move materials and product in material handling. These transportation devices can include small hand operated trucks, pallet jacks and forklift. These material transportation have variety of characteristics to make them suitable for different operations. Some trucks have forks as in forklift or a flat surface to lift the items while some trucks require a separate piece of equipment for loading. The material transportation can be manual or powered lift and operation can be walk or ride, require the user to push or ride along the truck. A stack truck can be used for stack item while non stack truck is typically used for transportation and not for loading.

2.2 Material Flow

From the past researchers**,** There are several point that is possible to determine the best material flow based on process method which is the best to ensure the process work inside factory run smoothly. According to Stock and Lambert (2001), material handling makes production flow possible and, as it gives dynamism to static elements such as materials, products, equipments, layout and human resources. Groover (2001) highlights that despite its importance, material handling is a topic that frequently treated officially by any organisation especially in factory. However, difference author has different opinion as well such as Shingo (1996) which has developed the

production function mechanism that propose to explain on how the production happens.

Shingo (1996) indicated that in the west, production was treated as process of sequence of operations. In the production function mechanism, the concepts is directly related to a production analysis focus. A process analysis consist of an observation of production flow that turn raw materials into final product. From this concept, the author highlighted the main analysis which is associated with process and come out with production project. The analysis of operation comes later because it focuses on production subject. This distinction will contribute the relevance of material handling.

2.3 Elements and characteristics of Material Handling System

Material handling study also requires that several elements can be considered to develop a system which is can operated effective and efficienly. The first one is project layout, which coers actiities of sequencing, layout and routing (Groover, 2001). In order to compete the analysis, Groover (2001) recommends that analyze the material itself for object is much necessary to be transported. Therefore, it suggest that classification of Muther and Hagan (Groover, 2001) which considers (i) physical state (solid,liquid,gas) ; (ii) size (volume, length, width, height) ; weight ; (iv) safety hazard (explosive, flammable, toxic, corrosive, etc.).

According to Chan, Ip & Lau (1999), a key factor in material handling system design process is the selection and configuration of equipment for material handling transportation. This is directly related to this study. According to Gurgel (1996), the equipment should be selected based on several primary consideration, the utilization of factory floor and its load capacity ; examine the dimensions of doors and corridors; pay close attention to ceiling height, identify the environmental condition and their nature enironment, prevent use of combustion engines traction equipment for food product, meet all safety standards to protect humansn and to eliminated the possible of criminal incurring and ciil liabilities arise from accidents, and examnine all kinds of available energy option and their capability to supply required movements.

Bowersox and Closs (1996) state that critical factor in positioning stock in process is a balance between convenience and consolidate to create efficiencies when the stock flows along the value chain. The right choice of equipment and location of work-in process is a fundamental for optimization of a company. The layout plays important role as it will defies the placement of equipment and consequently restricts possible routes and sequence of production process in factory. The analysis beteween the layout studies and material handling however does not receive much attention in same literature. This lack of attention already describe in the Gaither and Frazier (2002), Chase, Jacob an Aquilano (2006) and Slack, Chambers, Harland, Harrison and Johnston (1997). Lastly, the information system is essential factor for material handling management. This can be seen in Stair and Reynolds (2006), Laudon and Laudon (2006 and O'Brien and Marakas (2007) which is the author elaborate the importance of study of fundamentals and general principles of information systems.

2.4 Performance and Efficiency of Operation

In order to improve the performance of distribution of operation especially in material handling process, it is important to consider both human and technical factor (Chakravorthy, 2008). In this sense, this study assesses the internal customer's perception of material handling process improvement. With common attributes in material handling system, according to Kulak (2005), effective use of labor, providing system flexibility, increasing productivity, decresing lead times and cost are some of most important factor infulencing selection of material handling equipment. These factor dirctly related to some attributes found in present study.

Based on research that have been done before, performance measure is an important key which also contribute well in material handling system. According to Neely et al (1995) a performance measure may be defined as a metric for quantifying efficiency and or effectiveness. As applied to material handling systems, the effectiveness of a material handling system describes to what extent the system performs the required handling tasks, whereas efficiency describes how economically these tasks are performed. Thus, it is possible for an effective system to be inefficient; it is also possible for an efficient system to be ineffective.

Based on experiments performed by Ozden (1993), Performance measures may be categorized on the bases of quality, time, cost, resource utilization, operating efficiency and flexibility measures. The majority of performance measures used in manufacturing, however, are time-based. Time-based performance measures may be further categorized as: (1) direct measures of the activity at a particular point in time, (2) cumulative measures, where the most recent measurement is compared to previous measurements, and (3) benchmarking measures.

Choosing adequate and relevant performance measures is critical in accurately analyzing any system. Globerson (1985) suggests some guidelines for selecting performance measures. These guidelines state that: (1) methods of calculating the performance criteria must be clearly defined, (2) objective performance criteria are preferred to subjective performance criteria, and (3) ratio performance criteria are preferred to absolute numbers, since ratios provide a comparison of two or more factors.

2.4.1 Vehicle Travel : Response Time

According to Kim (1995) and Egbelu (1993), they use response time for a pick-up call as a performance measure. The authors define response time for a pick-up call as the time from when the pick-up request is made until the vehicle (starting from an idle and empty condition) arrives at the pick-up location. This measure differs from the total empty. Vehicle transportation time in that it consists of only empty vehicle travel when the vehicle starts from an idle position and does not include empty vehicle travel from a drop station to a pick-up station.

2.4.2 Handling Time Per Job

The handling time per job is comprised of the time directly associated with material handling. This time includes: (1) the time the job spends in queues waiting for the material handling vehicle, (2) the total travel time, and (3) the total loading and unloading times, and (4) total vehicle blocking times. As stated by Gaskin and Tanchoco (1987), The total handling time per job includes the time from when a job