Faculty of Manufacturing Engineering

OPTIMIZATION OF MATERIAL TRANSPORTATION SYSTEM FOR FACTORY LOGISTIC

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OPTIMIZATION OF MATERIAL TRANSPORTATION SYSTEM FOR FACTORY LOGICTIC

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DECLARATION

I declare that this thesis entitled “Optimization Of Material Transportation System For Factory Logistic” is the result of my own research except as cited in the references.

Signature : .....

Name : .....

Date : .....

APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfillment of Master of Manufacturing Engineering (Manufacturing System Engineering).

Signature :…….....

Supervisor Name :…….....

Date :…….....

DEDICATION

I dedicate this report to my beloved parents (Hi. Mohamad and Hjh Siti Hawa) who have always been my supporter and so close to me that i found them with me whenever needed. It is their unconditional love that motivates me to set higher targets. I also dedicate this report to my brothers (Mohd Rashdan and Mohd Zahid), sisters (Nor Akmaliah, Nor Latifah, Nor Azimah, and Nor Jalilah) and my fioncee (Mohd Lutfan Bin Abd Latib) who are my nearest surrounders which have provided me with strong love shield that never lets any sadness enter inside.

ABSTRACT

Material transportation system (MTS) often being used to move materials inside a factory, warehouse, or other facility. The five main types of equipment are industrial trucks, automated guided (AGV) vehicles, rail-guided vehicles, conveyors, and hoist and cranes. This report focused on AGV where the optimization of MTS is further studied. Applying an AGVs in logistic factory may help in improving the efficiency in material flow and distribution among workstation at right time and right place. The main objective of this project is to study transportation requirement in a factory which consist of dynamic factors. The used of dynamic system in modelling gives an advantages in term of flexibility for changes of orders, unexpected machine or equipment failure, production delays, and other decisions then feedback to alter inventories and backlogs. This report present the method to organize and analyze the movement of AGV in warehouse area to obtain the optimum number of AGVs required in the warehouse to fulfill all the task given by simulation software. Anylogic software is being used to build a simulation model and analyzed the system performance. The obtained results was the optimization of MTS for factory logistic which produce effective material handling system and creates the systematic handling system in warehouse. By manipulating number of AGV, system throughput and cycle time being observed. Data obtained from simulation being compared as number of AGV had change. Minitab 17 software are used to create statistical graph in 2D and 3D surface in order to analyze and evaluate the results.

ABSTRAK

Material Transportation System (MTS) sering digunakan untuk bahan yang bergerak di dalam sebuah kilang, gudang atau kemudahan lain. Lima jenis peralatan yang utama adalah *Industrial Trucks*, *Automated Guided Vehicles (AGV)*, *Rail-Guided Vehicles, Conveyors,* dan *Hoist and Cranes*. Laporan ini memberi tumpuan kepada AGV di mana pengoptimuman MTS dikaji dengan lebih mendalam. Penggunaan AGVs di kilang logistik boleh membantu dalam meningkatkan kecekapan dalam aliran bahan dan pengedaran antara stesen kerja pada masa yang tepat dan tempat yang tepat. Objektif utama projek ini ialah untuk mengkaji keperluan pengangkutan di sebuah kilang yang terdiri daripada faktor-faktor dinamik yang digunakan dalam pemodelan yang memberi kelebihan dalam fleksibiliti untuk perubahan dalam pesanan, mesin yang tidak dijangka atau kegagalan peralatan, kelewatan pengeluaran, dan keputusan lain juga maklum balas untuk mengubah inventori dan tunggakan. Laporan ini membentangkan kaedah penyusunan dan analisis pergerakan AGV di kawasan gudang untuk mendapatkan jumlah sebenar AGV diperlukan dalam gudang untuk mengisi penuh semua tugas yang diberikan oleh perisian simulasi. Perisian Anylogic digunakan untuk membina model simulasi dan prestasi sistem di analisis. Keputusan yang diperolehi adalah pengoptimuman MTS untuk kilang logistik yang mengeluarkan sistem pengendalian bahan yang berkesan dan mencipta sistem pengendalian yang sistematik dalam gudang. Dengan memanipulasi bilangan AGV, pemerhatian di buat pada sistem pemprosesan dan kitaran masa.

Perbandingan dibuat pada data yang terhasil daripada simulasi apabila bilangan AGV berubah. Perisian “Minitab 17” digunakan untuk menghasilkan graf statistik dalam bentuk 2D dan permukaan 3D untuk membuat analisis dan penilaian kepada keputusan yang terhasil.

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CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays, manufacturing system within factories become more complex. In order to design and redesign the system, it is good to use computer simulation approach to simulate the design for practicing purpose, (Baines, 1999). Baines states that, there are two principle type of computer simulation techniques which is discrete event and continuos. The used of Discrete Event Simulation (DES) is for designing the phase of the production line for controlling and monitoring the line in manufacturing industry, (Leonardo, 2013). In the continuos simulation technique, it is quite similar to System Dynamic (SD) for industrial modelling. According to Lane, David C and Sterman, John D, (2011), there are several factor in SD such as changes in orders, unexpected machine or equipment failure,production delays, and other decisions then feedback to alter inventories and backlogs.

The material transport system (MTS) is one of the basic categories in material handling system (MHS). The MHS includes the activity, equipment, or procedure that relates to the moving, storing, protecting and controlling of material in a system (Groover, 2008). According to Tompkins, et al.(1996), MHS can be classified into several categories which is conveyors, industrial vehicles, automated storage/retrieval systems, carousel, automatic guided vehicle systems, cranes and hoists and robots. Even though the material handling does not add

value in the product, it facilitates the production flow (Heilala, 1999). Material handling also affects positively on workers more than any other area of work design and ergonomics besides gaining the flexibility in efficiency of production.

Automated Guided Vehicle System (AGVS) has become an important strategic tool for automated warehouses, (Sai-nan,L. 2013). In a very competitive business scenario, they can increase productivity and reduce costs of FMS (Flexible Manufacturing System) transportation systems. The AGV System provides efficient material flow and distribution among workstations at the right time and place. Besides that, the applications AGVS in production and logistic is in the storage and distribution also in the assembly line application. This AGVS used for the transportation of raw materials, work in process (WIP) or finished goods. This paper deals with the systems of multiple AGVS used for automated factory logistic whereby the simulation-based vehicle requirement analysis for multi-load MTS are proposed.

Logistic is the management of the flow of resources between the origin point and the last point of destination when the order meets the requirements. The resources managed in logistic involved physical items, such as equipment, food, materials, liquid and staff. Other than that is abstract item such as information, time, energy and particles. Physical item in logistic usually involved information flow, packaging, production, inventory, material handling, transportation, warehouse and of course security. Therefore, AGVS in the factory logistic plays important mechanism which effecting production efficiency and energy consumption. It takes care of moving raw materials or finished goods from or to warehouse and the production shop floor because any bottleneck or inefficiency in the factory can increase productivity of the whole factory.

Nowadays, automation is marginally applied in the factory logistic. In fact, transportation

of raw materials and finished goods from/to storage and shipment point usually requires the use of manually operated forklifts. Therefore, factory logistic is not well integrated into modern manufacturing processes and it results inefficiency in the factory and high energy consumption. In addition, the application of forklifts is not safe for the workers because forklifts operations are list among the most frequent causes of severe accidents in factories.

In order to design an AGVS, there are several requirement which need to be considered. The important factor in designing AGVS is design factors and operational factors. In design factor involved fleet size, loading capacity and guide path design. Besides that, in operational factors include vehicle dispatching and routing, utilization rate, conflict resolution approach and positioning of an idle vehicle. The number of vehicles heavily influences the performance of AGV system (Yifei, 2010). An expensive of AGVS is the factors cause number of vehicles required in a factory is important to be determined.

1.2 Problem Statement

Factory logistic could not bring its advantages into its full capacity transportation system. A good material transport system in logistic activities can contributes to the logistic efficiency, minimize operation cost, and promote high quality of services. A dynamic system makes logistic activities becomes more flexible by considered its factor. Simulation approach is a one of good method to observe the system performance. Material transport system and logistics systems have interdependent relationships that logistics management needs transportation to perform its activities and meanwhile, a successful logistics system could help to improve traffic environment and transportation development. In this cases, material transport system

need to be optimized, in order to satisfy demand of customers and bring benefit to the service quality and also to company competitiveness. Without linking of each transportation and the right number of vehicles needed in logistic area, a powerful logistic strategy cannot bring its capacity in a full play.

1.3 Objective

The objectives of this objective are:

1. To study transportation requirement in a factory which consist of dynamic factors.
2. To propose a simulation-based optimization analysis of AGVS in the factory logistic area.
3. To investigate the performance of the system used when MTS design and operational parameter are varied.

1.4 Scope of Study

This study focused on simulation based on System Dynamic Modeling where this system is perspective and set of conceptual tools that enable the organization to understand the structure and dynamics of complex systems. The idea in applying system dynamic in this study is to design effective logistic material transportation development. In System Dynamics the real-world processes are represented in terms of stocks (e.g. of material, knowledge,

people, money), flows between these stocks, and information that determines the values of the flows.

CHAPTER 2

LITERATURE REVIEW

In this chapter, section 2.1 will explain the application of AGV system as transportation system in various manufacturing environment. Section 2.2 covered about optimization of AGVs that related to number of AGV required, walking route of AGV and transporting capacity of AGV in job shop dispatching. Section 2.3 regarding to method used in AGV system where dispatching rule and simulation approach is studied further.

2.1 AGVs as Material Transport System

Efficiency of moving product is determined by the operation of transportations. In study of Warangal, (2011), through the technique and management principle, it can improves a moving load, service quality, delivery speed, operation costs, the usage facilities, and energy saving. AGV provides a flexibility in routing parts among element present in the system (Mehdi, K. & Venkatesh, K., 1993). The material flow is the main task for the whole operational system in the manufacturing system. It includes operational units, likes machines, plants and work areas. The problem face in material flow might cause a material undersupply or material hold up. AGVs is a transportation system that can reduce the problem related to the material flow since AGVs was proved for a years they are suited for a wide range of tasks in

the area of material flow. That applies equally to transport indoor in buildings and outdoor in the plant area (Schulze, L., & Wullner, A, 2006).

Even though the material handling does not add value in the product, it facilitates the production flow ,(Heilala, J., 1999). Material handling also affects positively on workers more than any other area of work design and ergonomics besides gaining the flexibility in efficiency of production. Figure 2.1 shows the relationship between manufacturing system. By having the effective schedule of material transportation system, the right kind of parts can be delivered in the right quantity, at the right place, at the right time and in the right manner.

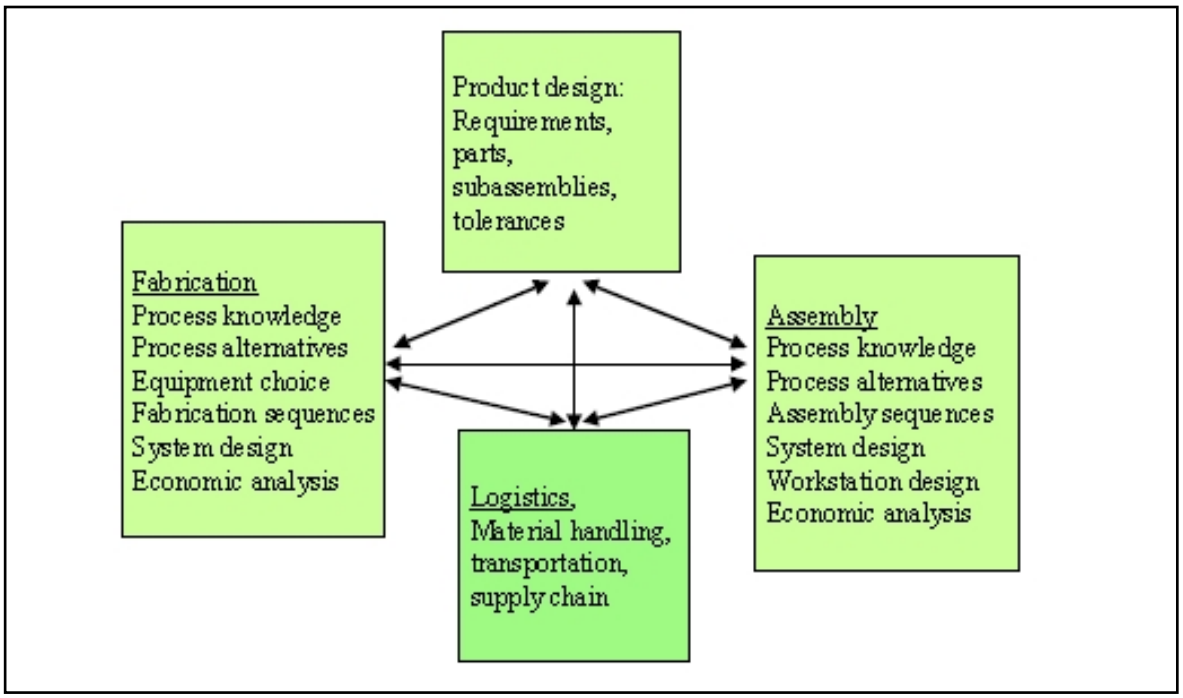

Figure 2.1: Connection between product design, fabrication, assembly and logistic system. (Heilala, J. 1999)

AGV or it is known as a driverless system which able to select its own path or route to

reach destination. There are two basic categories of AGV control system; static and dynamic (Steve et.al, 1985). The static control system gives the same route for AGV to run continuously and stops at each pickup or delivery station until the job is loaded or unloaded. It is considered as the conventional material handling system such as conveyor or tow lines, but it will provides an ease in developing the different routes in the future. The dynamic system is the most applicable to a job shop environment where the vehicle can be routed to different stations using different paths.

2.2 AGVs Optimization

In automated warehouse system, AGV as an important part to enhance the efficiency of the system. Due to the high efficiency of a system, the scheduling planning should be more optimize and to avoid deadlock and lower efficiency. Usually one way traveling path always leads to deadlock even though it quit simple. According to Sai-nan, L. (2013), on consideration of bidirectional AGV traveling path, an alternative path policy is proposed to avoid deadlock. The bipartite graph and a task allocation are used to construct transportation task of AGV based on maximum weight matching in bipartite graph.

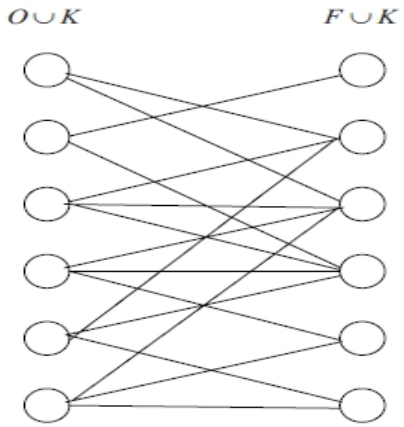

Figure 2.2:A bipartite graph is construct based on AGV task (Liu, S.,2012)

In the semiconductor fabrication bays, AGV are used as transportation systems for dust-less operation. In capacity of production growth, the number of vehicle also increased and this situation required to the generate a collision-free route planning within a few seconds. In Nishi, T., & Maeno, R. (2010) paper's. it treats an operational issue to derive a collision-free route planning for AGVs to minimize the total transportation time for efficient operations in recent semiconductor fabrication bays. Petri Net (PN) is commonly used to analyze or design AGV systems to avoid deadlock among AGVs. The causes of deadlock is because of conflict and interactions between the sources which is used by AGVs. At the scheduling and routing planning level, the routing selection is executed from a number of alternative routes to maximize the total system performance. To solve the routing problem for multiple AGVs, dispatching rules, meta-heuristic and knowledge-based processing system were used. the entire PN model for AGVs route planning problems into subnet for each AGV system is decomposed to get the final evaluation.

Besides that, in maintaining the reliability of material transportation system in manufacturing activity, monitoring the entire system to get the optimum maintenance is needed (Pang & Lodewijks, 2012). Pang & Lodewijks (2012) using the agent technology collecting and integrating the data to optimize the large scale continuous material transport.

Job shop dispatching by AGVs is studied by Liu, S. (2012). The genetic algorithm is used for the optimization problem of AGV in automated warehouse system. Through the simulation approach based on coding and selection of mutation, the method resulted a good practical way for optimization problem in automated warehouse system.

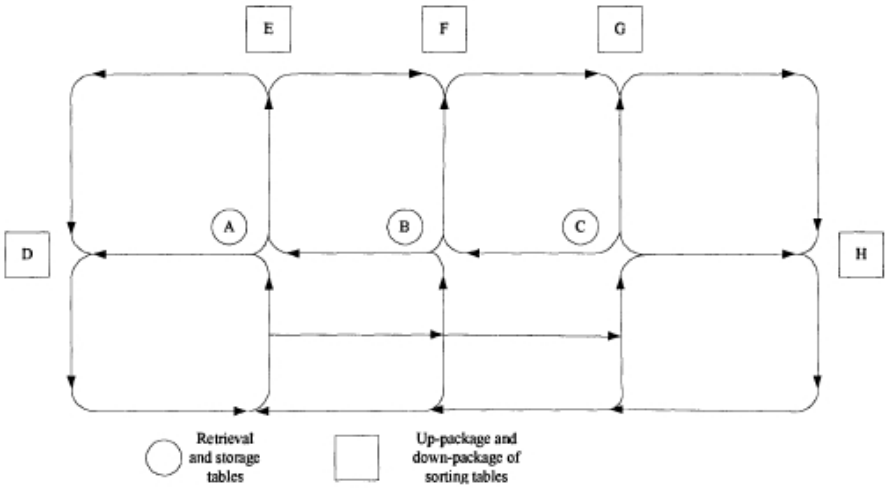

Figure 2.3: Direct graph of AGV walking route between retrieval, storage, and sorting.

2.3 Method used in AGVs

Efficient AGV system can be achieved through the best method which is has been developed by and proposed by researcher. The study regarding all the method used in AGVs is made to clarify what is the method necessary for efficient AGVs. The first method which is dispatching rules is explain further in 2.3.1. Other method used is simulation method in 2.3.2.

2.3.1 Dispatching Rule Method

In determining the process order of job and equipment, project scheduling is an important thing which is as a core content and key technology of production management. (Chen et al. 2012). In their study, they state that, there are four categories which has been classified for optimal dispatching rule which is:

i. Dispatching rule for batch processor.