ANALYSIS OF THE TRAVELLING FORKLIFT IN MATERIAL TRANSPORT ACTIVITIES IN A MANUFACTURING PLANT

Awang, N., Bani Hashim, A.Y. and Jamaludin, Z.

Department of Robotics & Automation,
Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka,
Durian Tunggal, 76100 Melaka, Malaysia

Email: nurfadzylah@gmail.com

ABSTRACT: Analysis of forklifts movement within actual manufacturing plant environment was performed. It was intended to study current efficiency in parts delivery using Arena simulation software. The work proposed improvements for the current manufacturing arrangement to achieve a greater efficiency. The results show that there was an improved efficiency at a distance of 100 meters based on the proposed layout. This improvement was indicated by the reduction in the non-added value from 3.0 seconds to 2.4 seconds. This analysis concludes that the proposed changes to the current material transport activities could improve the material transport efficiency at the manufacturing plant.

KEYWORDS: *Arena, Material transport, Manufacturing plant, Forklift.*

1.0 INTRODUCTION

Manufacturing sector in Malaysia is one of the major sectors that generate opportunities for the employment. However, activities that had been conducted in the plant of manufacturing sometimes did not really efficient especially in material transport. Material transport system is a medium to take materials from one location to other location. Material transport system that usually used is forklift, AGV, rail-guided vehicle, crane and conveyor. If the problem persists, it will cause a bad impression and quality of the product that produce. Conveyor system is one of the effective material transport systems in transporting continuous operation [1]. While, AGV is used widely in many applications such as automotive industry, warehouses and steel industry as a material transport and the function of AGV is to transfer material pallet from AGV to the load stand and back and AGV is driverless. AGV have been found to increase routing flexibility, improve space, ensure safety and also reduce operational cost [2].

Another type of material transport is rail guided vehicle that operate asynchronously and are driven by an on-board electric motor, with power being supplied by an electrified rail.

Forklift trucks are a basic element in material handling and transport [3]. It is also can be describe as a motorized vehicle used for lifting heavy objects at variety of places such as factories and warehouses [4]. Cranes are used for horizontal movement of materials in a facility, while hoists are used for vertical lifting. In order to solve the problem, optimization of path by using some method that already done by some researcher are been done. By doing simulation, it can show effectiveness. Besides that, genetic algorithm (GA) can be used to solve the tedious problem that occur [5]. Furthermore, optimization strategy is mainly aimed at optimizing the discovery in the process capacity bottleneck. It can be divided into two kinds which are change the capacity of various aspects of operations, thereby reduce the processing time to wait for the goods and adjusting the businesses processes or work system [6]. By doing witness simulation and Petri Net also can increase efficiency in a job floor production [7].

Simulation is a powerful analysis tool that helps engineers and planners make intelligent and timely decisions in the design and operation of a system. Simulation does not solve the problems but it does clearly identify problems and evaluate alternative solutions [8]. There are some simulation software available to analyze manufacturing systems such as the Flexsim, the Witness, and the Arena.

II. METHODOLOGY

In order to conduct this analysis, the following sequences of activities were designed: identification routes of material transport; designing the simulation program structure; and testing the simulation.

A. Routes of Material Transport

Routes of material transport system is the main thing in identify the distance between each of assembly or manufacturing station that involve. In order to identify the routes, the plant layout of the company or organization must be referred. Furthermore, in the plant layout, manufacturing station that involved with the material transport should be identified. Besides that, the process at each station also should be considered because it will affect the cycle time of the process. The material transport also need to know which station need the raw material first and where is another situation or which work they need to do it. When the station and process is identified, the routes for the movement of material transport also can be determined. Even though the distance was estimated using plant layout, the recitation of distance in a real area in the plant is quite same. The flowchart of the process is shown in Figure 1.

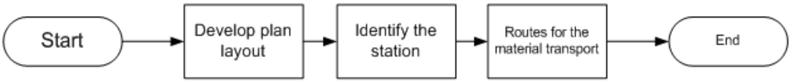


Fig. 1. Identification routes of material transport.

B. Simulation Software

The simulation software used for this analysis is Arena software simulation. In Arena software, data of cycle time for each process and distance between one station to another station must be fill in the block diagram that already provide. Both of the information needed to fill up because the movement or simulation of material transport is depend on that information. If the information is incorrect, and filled in wrong block diagram, the simulation did not run or run incorrectly. Interface of the software provided many types of the block diagram with the different shapes and information need to fill up.

C. Testing the Simulation

The simulation of the material transport is carried out for several times in order to get a correct flow chart and the data that written also correct. If the data did not correct, the simulation will face a problem. Besides, the simulation also cannot give a correct result. In this process, the data about distance and cycle time that filled in plays an important role to make sure the simulation movement is correct. Figure 2 shows the process that involve in movement of material transport.

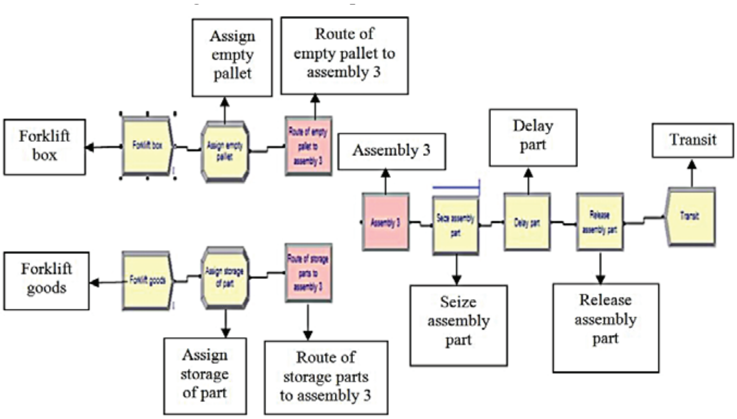


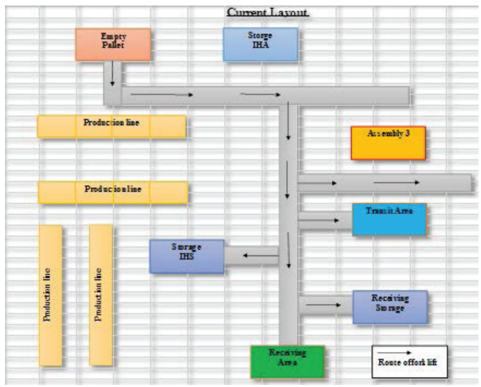
Fig. 2. The flowchart that dictates the movement of materials while under transportation simulated in Arena.

III. RESULTS AND DISCUSSION

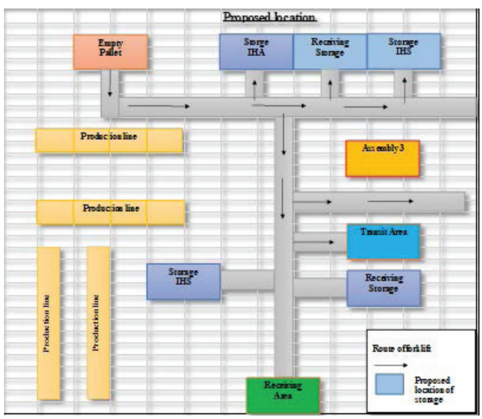
The results obtained from the simulation conformed to the current and to the proposed location. The locations of the current and the proposed layout had produced different results. The results of the proposed layout was better compare to the current layout because in proposed layout where the distances were reduced in the proposed layout. Thus, the results in proposed layout had decreased when compared with the current layout. This was due to the reducing of distances between stations. Figure 4 shows the current layout and proposed layout. While Table 1 and Table 2 show the results obtained from each situation that have slightly changed because of the changes in distance. Based on the current layout, there was a non-value added time in the entity process. Non-value added is not good in the production company because it will cost loss to the company. The waiting time was also reduced in the proposed layout. In fact, the improved results were due to the significant reduction of distances between stations for material transport.

The current layout has a flow of material transport such that the forklift began at the Empty Pallet station, followed the route that ended at three different stations: the Transit Area, the Storage IHS, and the Receiving Storage. The proposed layout, however, has a different arrangement. There were additional stations adjacent to the Storage IHA. The stations were the Receiving Storage and the Storage IHS. The flow of material transport was made simpler by having a shorter distance for the travelling forklift. The forklift began at the Empty Pallet station, followed the route where it transited at the Storage IHA, the Receiving

Storage, the Storage IHS, and ended at the Transit Area. The results showed that the proposed adjustment to the current layout have had reduced the value added to 2.4 seconds. For a manufacturing company, a value added refers to an increase in performance of production. Besides that, the waiting time and transfer time also increased when compared to the current layout. For the waiting time, the value was reduced from 1.56 seconds to 1.32 seconds while the transfer time was reduced from 4.80 seconds to 3.00 seconds. The number of forklifts in and out was increased from 154 units to 158 units. The work in process was reduced from 13.80 seconds to 10.2 seconds. Furthermore, the total number seized was increased from 924 units to 948 units, which indicated a higher productivity.



(a)



(b)

Fig. 4. (a) The current layout. (b) The proposed layout.

Table 1. Result of the simulation for the current layout.

Entity	**Time**			
VA time	**Average**	**Half Width**	**Minimum Value**	**Maximum Value**
ent forklift	0.00	(Insufficient)	0.00	0.00
NVA time				
ent forklift	0.05968962	(Insufficient)	0.03348814	0.08304274
Wait time				
ent forklift	0.02638065	(Insufficient)	0.00	0.1700
Transfer time				
ent forklift	0.08378334	(Insufficient)	0.3347500	0.1331
Other time				
ent forklift	0.00	(Insufficient)	0.00	0.00
Total time				
ent forklift	0.1699	(Insufficient)	0.05821356	0.3573
Entity	**Other**			
Number In	**Value**	**Half Width**	**Minimum Value**	**Maximum Value**
ent forklift	154.0			
Number Out				
ent forklift	154.0			
WIP	**Average**			
ent forklift	0.2303	(Insufficient)	0.00	6.0000
Queue	**Time**			
Waiting time	**Average**	**Half Width**	**Minimum Value**	**Maximum Value**
Seize assembly part queue	0.02638065	(Insufficient)	0.00	0.1700
Number waiting				
Seize assembly part queue	0.03577610	(Insufficient)	0.00	3.0000
Resource	**Usage**			
Instantaneous Utilization	**Average**	**Half Width**	**Minimum Value**	**Maximum Value**
p process part	0.08094805	(Insufficient)	0.00	1.0000
Number busy				
p process part	0.4857	(Insufficient)	0.00	6.0000
Number scheduled				
p process part	6.0000	(Insufficient)	6.0000	6.0000
Scheduled utilization	**Value**			
p process part	0.08094805			
Total number seized				
p process part	924.00			

Table 2. Result of the simulation for the proposed layout.

Entity	**Time**			
VA time	**Average**	**Half Width**	**Minimum Value**	**Maximum Value**
ent forklift	0.04206127	(Insufficient)	0.03338494	0.04997755
NVA time				
ent forklift	0.00	(Insufficient)	0.00	0.00
Wait time				
ent forklift	0.02206401	(Insufficient)	0.00	0.1427
Transfer time				
ent forklift	0.05908737	(Insufficient)	0.03350763	0.08282391
Other time				
ent forklift	0.00	(Insufficient)	0.00	0.00
Total time				
ent forklift	0.1232	(Insufficient)	0.06732819	0.2386
Entity	**Other**			
Number In	**Value**	**Half Width**	**Minimum Value**	**Maximum Value**
ent forklift	158.00			
Number Out				
ent forklift	158.00			
WIP	**Average**			
ent forklift	0.1738	(Insufficient)	0.00	6.0000
Queue	**Time**			
Waiting time	**Average**	**Half Width**	**Minimum Value**	**Maximum Value**
Seize assembly part queue	0.02206481	(Insufficient)	0.00	0.1427
Number waiting				
Seize assembly part queue	0.03112714	(Insufficient)	0.00	4.0000
Resource	**Usage**			
Instantaneous Utilization	**Average**	**Half Width**	**Minimum Value**	**Maximum Value**
p process part	0.05933643	(Insufficient)	0.00	1.0000
Number busy				
p process part	0.3560	(Insufficient)	0.00	6.0000
Number scheduled				
p process part	6.0000	(Insufficient)	6.0000	6.0000
Scheduled utilization	**Value**			
p process part	0.05933643			
Total number seized				
p process part	948.00			

IV. CONCLUSIONS AND FUTURE WORK

The results showed that the proposed adjustment to the current layout had reduced the value added to 4 seconds. This indicated an increase in performance of production. Besides that, the waiting time and transfer time also increase compared to current layout. For waiting time, the value reduces from 26 seconds to 22 seconds while transfer time reduces from 8 seconds to 5 seconds. The number of forklifts that move in and out increased from 154 units to 158 units. The work in process reduces from 23.00 seconds to 17.00 seconds. Furthermore, the total number seized is also increase from 924 units to 948 units, indicating higher productivity. This study concludes that the proposed changes to the current material transport activities have resulted in improved efficiency at the manufacturing plant about 98%. For future work, the complexity of the simulation process may be increased by adding more stations and forklifts. If there are more stations, simulating the movement of the material transport activities in a manufacturing plant will be more attractive. The results obtained from the simulation will produce more items such as the entity, the queue, the resource, the transfer, and the processes.

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