The Effectiveness of Conveyor Layout affected Production Output using Arena Simulation Software

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Abstract

Manufacturing Industry cannot avoid problems involving of manufacturing process, including layout arrangement problems. Previous studies have reviewed the layout and improvements that have been made in order to make production going smooth. However, the previous studies did not explain about the importance of methods used in modeling or layout arrangement processes in details. There is no explanation about the importance of simulation methods used to improve the work process. Therefore, the main purpose of this study is to increase the production output based on simulation analysis by using ARENA simulation software. The qualitative method was used to conduct this study and data was collected at studied company to fulfill the result. The results shows that using simulation can improve the layout hence increase the production output. While the findings from experiments showed that the company's layout affected the production efficiency. This research used ARENA simulation software as method to analyze work process by creating an overview of the movement of a process with more accurate and precise simulation results.

Keyword: layout, ARENA simulation, production output.

1.0 Introduction

Nowadays, manufacturing industry always facing a problems involving processing systems. There are lots of problems cannot be solved by actual layout improvement. Simulation method can be used to solve the complicated problems happen in manufacturing industry. By using simulation methods, problems such as resource requirements and waiting time can be tracked, analyzed and solved. Hence, the root cause of the problems will be tracked and analyzed faster. As a result, solutions can be sought and be implemented to solve the problems such as increasing waiting time, inefficient layout, and other problems. Banks (1998) stated that the simulation method has proven to be the most effective method to improve the efficiency of a system. Therefore, this method of simulation is very effective and well-known in the handling and packaging of industrial materials. The use of the simulation makes easy to analyze the results and thus, create a new system or layout improvement to refigure of a conveyor system and increase the value of production.

The use of simulations is closely related to the layout of a plant. Layout play an important role to ensure that production runs smoothly. Layout plant is needed to ensure the data to be collected to create a model or simulation. The conveyor machine also provides the company with the advantages of facilitating the movement of objects or output. Ineffective and inefficient production layout is one of the major issues arising due to machines that are not well arrange and thus may effects in a reduction in productivity of the company. Productivity is the ratio of output to input; efficiency in production by measuring the ability to produce output from a given set of inputs (Syverson, 2011).

The design or layout of the machine will have a high impact on the manufacturing industry (Ahmad, 2007). Problems occurred when particular party such as engineer of production line facing difficulty to imagine or simulate how the movement of a conveyor machine works without using the simulation technique. They only can see a diagram and illustration without seeing from different views such as rear view, side or front view (Akbarudin, 2016). Therefore, the function of ARENA application is to create a simulation related to object movement. It will help the engineer or involved party to see how its work and how it will impact their productivity. Therefore, this study consists of three research objectives are (i) to reduce waste in production using lean concept, (ii) to improve conveyor layout of production to increase effectiveness and (iii) to increase the production output based on simulation using ARENA simulation software. The result of this study gave the company an opportunity to improve the conveyor-based processing system as well as to improve the layout that currently been used. This study used software ARENA v14.0 as a method for simulation modeling. This study consist of current output of the company to be compared with the output after process improvement has been taken.

2.0 Literature Review

The problem of arranging an industrial process has been in existence as far back as the Industrial Revolution. When Taylor first developed his concept of scientific management, industrialists had been wrestling with the problem of arranging facilities for years. Although plant layout evolved as a distinct industrial function relatively recently, it was a dominant factor of production throughout the development of the factory system (Moore, J.M.1962). The definition of "plant" in term of specified meaning in the dictionary is "a factory that makes car, machines, and equipment" based on Macmillan English Dictionary. Hence, the meaning of layout from the same source is "the way in which the different parts of something are arranged" or "the way in which something such as room, building, or city is arranged" Macmillan English Dictionary.

Plant layout is a sub-part of a wider subject called facility design (Meyers, F.E. 1993). This facility design is a minor element under the facilities planning activity which may be further subdivided by separating into three components of a facility; the structure, layout, and handling system (Tompkins, J.A. 1984). Plant layout is the organization of the company's physical facilities to promote the efficient use of equipment, material, people, and energy (Tompkins, J.A. 1984) it is the activity that deals with the design of an arrangement of the physical elements of an activity as stated by Apple (Apple, J. M. 1977) It should be a thoughtful, well-planned process to integrate equipment, materials, and manpower for processing a product in the most efficient manner (Sheth, V. S. 1995).

2.1 Simulation

Simulation is defined as a method used to create an illustration that implies the movement of an object or a process. The simulation can describe the real situation as well as identify the system's response to different state changes (Jeddi et al., 2012).

2.2 Conveyor

The use of conveyors in the industry is to deliver products to increase productivity and reduce mobility (Muhammad, 2009). According to Muhammad (2009) in his study, the conveyor can be divided into two types which are heavy duty conveyor or normal conveyor. In industry there are various conveyor machines such as belt conveyor, roller conveyor, wheel skate, chain conveyor, and in-floor towline conveyor.

2.3 Production/output

Production refers to any activity or activity of producing, creating or changing raw materials into finished goods and providing services that meet the needs and satisfaction of the users. Good manufacturing process are:

i. Ensure that the product is manufactured according to the specifications that have been specified.
ii. Ensuring that production costs are properly controlled, as not to affect the company's profits.
iii. Production is done efficiently, without waste of resources.
iv. Production is done wisely to ensure the value of production increased.
v. Ensure that the production process goes according to the set schedule.

2.4 ARENA Simulation Software

Arena Software allows user to model and simulate processes for business or enterprise use. It was designed to analyze the effects of small and compact changes involving redesigns related to supply chain, manufacturing, processes, logistics, distribution, warehousing and systems service (Michael & Cynthia, 1994).

3.0 Research Methodology

The methodology used in this study is the simulation method by ARENA software. ARENA software is a simulation technology that combines the power of modeling and flexibility of SIMAN / Cinema system with easy-to-use package focusing applications. ARENA offers a high degree of flexibility of modeling from a variety of key issues with easy to learn and use (Michael & Cynthia, 1994). The methodology explains the way a problem is investigated and the reason for a particular method and technique are used (Sarah, 2015). The purpose of the methodology is to help understand more broadly about the application of the method by making a description of the research process.

The framework of the research is divided into five main phases; initial assessment phase, the research phase, the simulation phase development model, the discussion phase and the decision analysis and the conclusion and suggestion phase. According to Khotari, (2004), the methodology of the study is a way of systematic solving problems in the investigation.

4.0 Data Analysis

Data that have been gathered was being analyzed in details. Each analysis played an important role in ensuring the objective of this study can be achieved successfully. Layout alternatives were developed and the layout must fulfill the lean manufacturing aspect and provide smooth flow, reduce travel distance and time, efficient use of space, and must be practical and feasible to implement.

4.1 The production flow chart

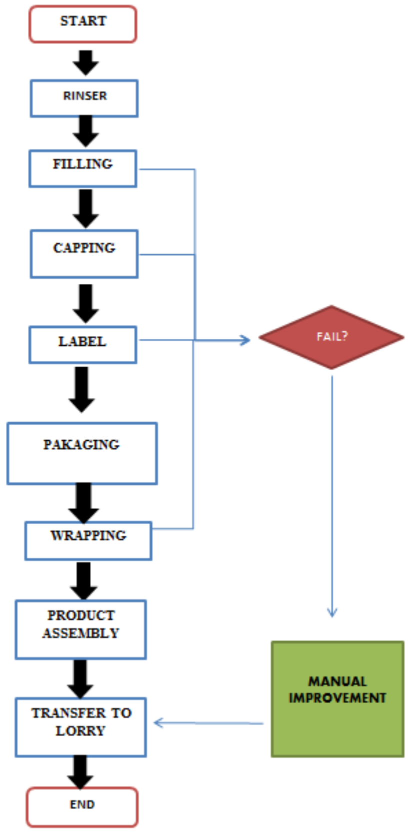

Figure 4.1: Flow chart

The model was built using Arena 14.0 software. Figure 4.1 provides an overview of the original simulation model developed to represent the entire operation at the production plant.

4.2 The actual model of production in one day.

Table 4.0 shows the operating time set for day-to-day work. The time has been set 6 hours as working time for studied company. All simulation analysis used 6 hours operation time as benchmarking operation time.

Table 4.0: Operating hours of worker per day.

Date		20 October 2017
	Total operator soy source department	9 operator
Total work hour	Total daily work	9 hour
Total non-operation time	Resting time / out	2 hour
	Time setup	30 min
	Machine/raw material problem	30 min
Total time	Total daily work	9 hour
	Total non-operation time	3 hour
	Total time operation	6 hour

Based on the table 4.1 employees were divided into their respective tasks according to the expertise of machine control. Their task is to keep the machine process running smoothly without any problems that may interfere with the production results.

Table 4.1: Distribution of workers by station

OPERATOR	STATION
1	Take and dry the bottle
2	Fill the soy sauce into the bottle
3	Seal the bottle cap
4	Melt the bottles wrapping
5	Take and divide the bottle to 24 unit (per carton)
6	Take and packing into the box
7	Send the bottle to the truck

Figure 4.2 below is the predetermined time for each machine per bottle production process. The machine's operating time affects the quantity of the product produced at the end of the process. The process of time study were taken 4 times and actual time used in ARENA simulation is the average time for all processes related.

MECHINE	1ST EXSPERIMENT (SECOND)	2ND EXSPERIMENT (SECOND)	3RD EXSPERIMENT (SECOND)	4TH EXSPERIMENT (SECOND)	TIME AVERANGE (SECOND)
Rinse	8.30	8.90	8.6	9.04	8.71
Filling	8.10	8.31	8.03	8.52	8.24
Capping	1.13	1.10	0.89	1.36	1.12
Labelling	1.00	1.21	1.11	1.16	1.12
Wrapping	6.45	6.50	6.51	6.62	6.52

Figure 4.2 Operating time of each machine

4.3 ARENA Simulation Model for actual production line

The simulation model consists of components such as system entities, input variables, performance measures, and functional relationships. Prior to the creation of the simulation model, this study has ensured that all problems are identified to differentiate existing systems or requirements that need to be set on the proposed system.

In this research, it uses processes, stations, routes, batches and disposals. Figure 4.3 shows the simulated arrangement of the drying process that has been encoded into the software. The creation module is an important characteristic in ARENA as it describes the beginning of anything that uses simulation such as transport, process, packing, flow, report, and navigating.

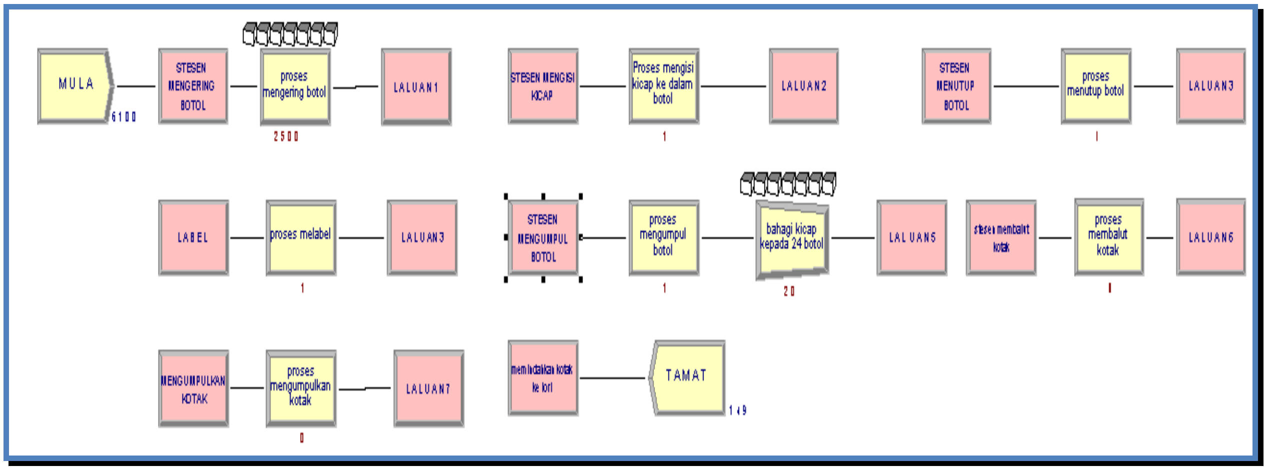

Figure 4.3: Arena simulation model overview

4.3.1 Actual Production Layout

Figure 4.2 show the conveyor layout of current production in the company. This company used 3 conveyor system in their production to produce output. This conveyor are divided in 3 separate units, so the continue flow of production from every conveyor related must be done by manually or operators. So this process involving manual task by operators to take and pick the bottles to put at the next conveyor. This consumed lots of time and waste of process, hence waste the energy of operators to take and move the bottles.

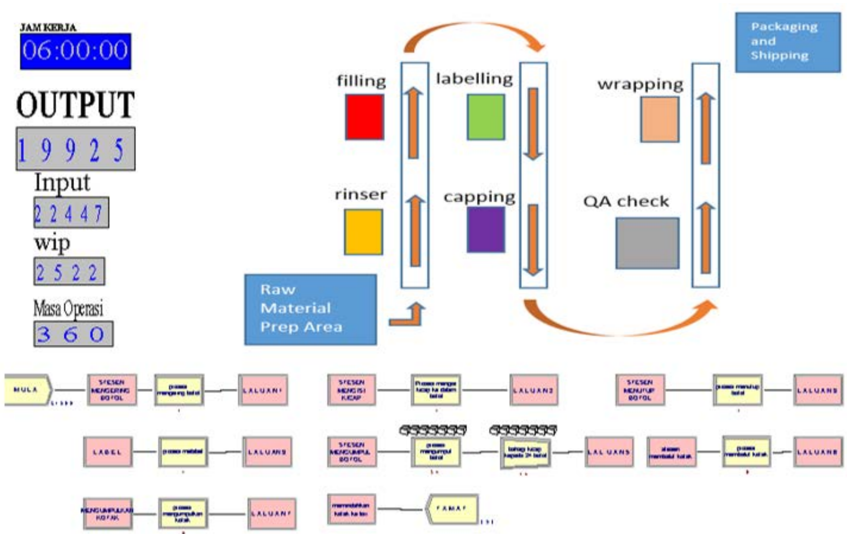

Figure 4.2

Basically, there are three major concepts of layouts, which are the product layout, the process layout, and fixed position layout. The company in this study is applying the product layout which means only one product, or one type of product, is produced in a respective area. However, due to the previous management decision and constraint, the machineries allocation for the current layout is not gathered within the area. Thus, the process flow and materials flow for certain products are not as smooth as desire. Observation process of improvement have been done to plan the improvement action to be taken at studied company. After identifying the problems that occured in the company, a flow analysis and activity analysis were conducted and discussed. This layout shows that there are three conveyors placed side by side to cover 5 processes in production which are rinse process, filling process, capping process, wrapping process and also product assembly consist of labelling process and sealing assembly. Other than that, there are five machines to complete to produce output. Their layout also have areas for putting raw material and inventory of production. During product assembly a testing or quality check is done to make sure their product whether have defects or problems. Figure 4.2 show production output per day for 6 hours of operation time for current (before improvement) layout. This company managed to produce 19,925 units per day.

4.4 Problems Identification for Actual Production Layout.

This project deals with process improvements in the company by using various Lean Manufacturing tools like Value Stream Mapping and Kaizen. The main reason of using these tools is to identify waste in value streams in order to find an appropriate way reducing waste. All waste are related to the layout problems such as improper layout location planning and ineffectiveness of conveyor location. Table 4.2 show the problems identified during observation and improvement suggested based on the current layout.

Table 4.2: Problem Identification

No	Waste	Observation	Proposed Improvement
1	**Complexity**	Production area full and crowded of unused item	Remove all unnecessary items from working area
		The current layout no effective to produce output	Rearrange items in production area
		Arrangement of material not in proper way.	Rearrange material in effective way.
2	**Labor**	Long distance covered by operators to take material for production use.	Reduce walking distance by placing the material near working area to be taken by operators
4	**Space**	Space of raw material not in proper arrangement	Rearrange all materials inside working area. Find proper space to place raw material and finished goods.
6	**Defect**	Finished goods produced need to recheck/rework to maintain packaging/labelling quality.	Relocate proper area for quality check in process of production
7	**Material**	Shortage of raw material to supply in production	Follow the JIT system
8	**Idle material**	Too many unused rack	Unnecessary items is removed from production area.
9	**Time**	late supply of raw material and bottle to use in production	Eliminate unnecessary movement and non value added process.

In Table 4.2, the proposed improvement have been implemented at studied company to improve the operation process. The implementation has reduced all unnecessary movement or non value added process in operation process. The process to produce finished goods become smooth, going with the flow and the working area become clean from unnecessary items or unused material. By implementing this improvement, operation of the company become more effective and efficiently, thus increased the number of output for finished goods. The new layout have made significant effect to the production area. Layout of conveyor before more stable, the process of output follow the concept of one piece flow. The arrangement of conveyor made operators or workers easily to handle production process, material and equipment in used.

4.5 New Improved Conveyor Layout.

After discussion among managers, engineers and production supervisors, decision to change layout have been made. Some ideas of layout have been discussed and proposed during brainstorming process. And final decision was made and new layout have been implemented to improve the working condition to increase the effectiveness of conveyor use in production area.

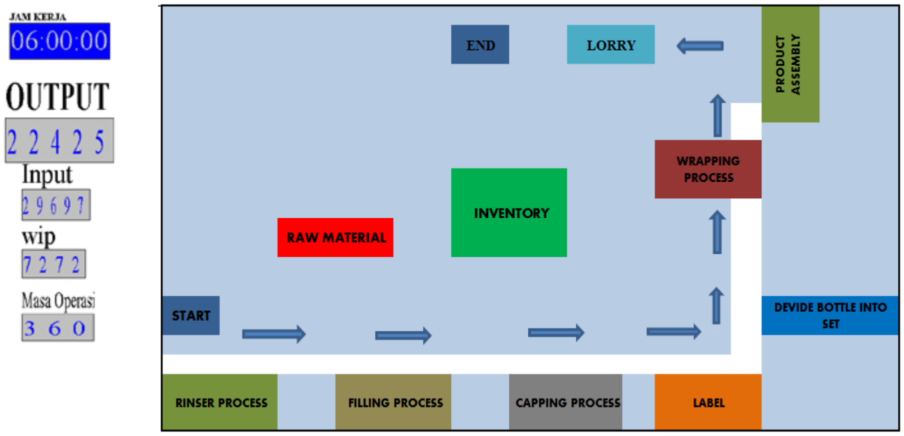

Figure 4.3: New implemented layout at studied company.

Figure 4.3 show the output per day have improved after new layout of conveyor been implemented. Company managed to produce 22,425 units per day. This made an immediate impact to the production and conveyor layout. Production become easier to handle, reducing material movement distance, reducing non value added process, thus increase production units of 2,500 units per day.

4.6 Analysis of simulation modeling results.

Comparing to the output per day produced by this company, new improved conveyor layout managed to produce 22,425 unit per day compare to 19,925 units from previous conveyor layout. The increment is 2,500 unit per day or 11.15%. This can prove that new conveyor layout made significant improvement comparing to the previous conveyor layout. Due to this new layout, operators do not need to transfer the WIP to be placed to next conveyor to continue the production process. Table 4.3 show the items improved from the previous layout.

Table 4.3: Difference in both layout

Item	Previous Layout	New Improved Layout	% difference
Output quantities	19, 925 units	22,425 units	11.15% increased
Operation Process	Complicated	One piece flow	-
Walking distance	18 meter	11 meter	38.89% reduced
Material movement	45 meter	36 meter	20% reduced

The results shown that, the production have much better from previous layout. However, some improvement have done need to be relooked for the better results, hence increased the production output. So its proven that this new layout was done by the researcher help much to improve the condition of the operation. Therefore increase productivity, hence giving more profits for the company. Figure 4.4 show the graph of difference units to be compared both layout.

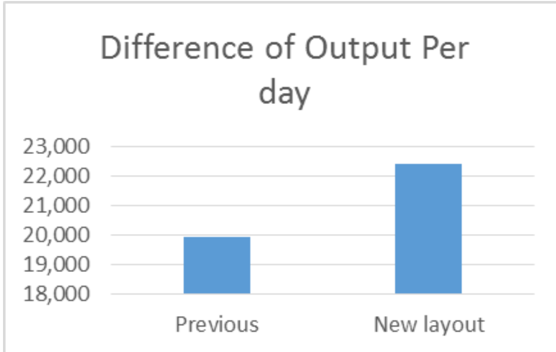

Figure 4.4: Difference of output per day

4.7 Conclusion

The main objectives of this project are to identify the actual layout and process flow of the company, to analyse and evaluate the existing layout based on the lean aspects and to propose the best and effective conveyor layout of the company based on the criteria related. In order to overcome the poor layout design problem, two methods have been applied to generate layout alternative for the studied company. The methods which are being utilized are by observation and location measured by using measuring tape. Those alternatives layout are then evaluated based on comparison distance process flow between each layout with existing layout. Finally the best layout alternative is chosen based on the result obtained. Discussions also be made thoroughly on the difference between actual operations and the results of the improved layouts. While doing this study, some problems regarded in the existing layout at the manufacturing company have been identified and have listed to be improved. Thus in order to facing those stated layout problems, some procedure has been taken to the step of the preparation in the layout alternative planning. To come up with the effective layout alternative, some layout criteria being considered in the planned alternatives.

Among the sketched layout alternatives, one of them was selected and defined as the effective layout in perform its consciously capability or function towards the whole production flow. The prepared improved layout has been evaluated by specific criteria in each of the layout alternative. From the evaluation, final improved layout is the most suitable layout and have been implemented. So this research assist the studied company to improve the operation value, thus increasing output and increased the effectiveness of conveyor.

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