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IMPROVING PRODUCTIVITY BY SIMULATE FACILITY LAYOUT: A CASE STUDY IN A CAR COMPONENT MANUFACTURER

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ABSTRACT

Facility layout is an important component of a manufacturer's operations especially in terms of maximizing the effectiveness of the production process. The key of good facility layout is the integration of the needs of people, materials and machinery in such a way that it does create a single well-functioning system. An effective layout can help an organization achieve a strategy that supports differentiation, low cost or response while wrong layout planning will lead to lack of space in key areas, poor placement of key activities, excessive material handling, and increased operating costs. In this case study, ARENA software has been used to simulate the production time requires in completing the assembly process. Several options from re-layout activities have been tested in order to find the best outcomes that can optimize the output since the existing layout creates lots of wastes. The result shows the productivity increase from 68.2% to 81.5% and production efficiency also rises by 20%. Simulators are able to provide the

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organization with practical feedback and determine the correctness of a design before any improvement activities are actually taken place.

Keywords: facility layout, process improvement, simulation

INTRODUCTION

Selecting a layout is a complicated decision because it represents a risk and a long term commitment. In securing the success of manufacturing industry, the manufacturing company needs to pick out a desirable layout for the assembly line. A poorly designed layout will result in poor productivity (Wang et al, 2011). The suitable layout will make the workplace more efficient and effective. There are a few types of layout that are suitable in the manufacturing line. It can be classified into four types, which are, product layout, fixed position layout, process layout and combination layout that is also known as a cellular layout.

There are a lot of research which state that the use of cellular manufacturing layout is very famous layout used in the manufacturing industry. According to Heizer and Render (2011), about half of US plant with fewer than 100 employees use some sort of cellular system, whereas 75% larger plant have adopted the cell production method. Mungwattana (2000) also shared Choi (1992) research that the estimated number of manufacturing cell operating in the US has increased from 525 to over 8000 and the trend will continue to grow.

According to Mungwattana (2000), traditional manufacturing systems such as job shop and flow lines are not capable of satisfying the requirement. She also stated the research conducted by Asking et al (1993) which said job shoppers spend 95% of their time in non-productive activity and the time was spent on waiting in the queue and the remaining 5% is split between lot setup and processing time. So, this means that it leads to a longer production time, high level in process inventory, high production cost, and low production rate.

In contrast, the cellular layout is one of layout application which is emerging as an alternative system for manufacturing. Using this cellular layout will lead to a reduction in setup time and quick response to changing condition. In Mungwattana (2000) research, she shared the survey undertaken by Wemmerlov and Johnson (1992) that cellular layout appears along the dimension of time which is manufacturing lead time and customer response time. This survey states that this is the greatest benefit in cellular manufacturing suitable to be adopted.

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METHOD

This study aims to identify the line balancing efficiency of current layout focusing on process cycle time and to compare the productivity effectiveness between traditional layout and cellular layout. The methods used to archive this objective are observation and time study. Observation method allows the documentation process of the methodology in the production layout and workflow process in order to determine the time and observe the line balancing of the current layout.

The observation was also used in order to develop a time study analysis of the production process that is designed to improve efficiency by identifying areas of production where time is a waste and at the same time increase its productivity. Then, Discrete-even Simulation (DES) model using ARENA simulation software is used to validate the model of the layout in the production line. Interview with personnel that is involved in the production line of the company was also carried out to understand the flow process and the problem that occurs in the actual layout.

The company stated that the demand for the seat is 240 cars set per month or 12 sets per day. Meanwhile, the production operation was eight hours per day and need to meet the demand within 20 days of working days. The current layout should be rearranged to increase the efficiency by increasing the value adapt (VA) and decrease non-necessary value adapt (NNVA) due to increasing demand to 15 set per day next year. The time study was used to measure the parameter of cycle time at each workstation process, then, calculated to verify its efficiency.

RESULTS

The DES using ARENA simulation software is used in order to formulate and develop a model of the current layout. Then, to improve this current layout, what if analysis was used to convert the layout into some alternative based on the cellular layout. From the analysis, the best 3 trial layout were chosen and suggested to the company.

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Current Layout

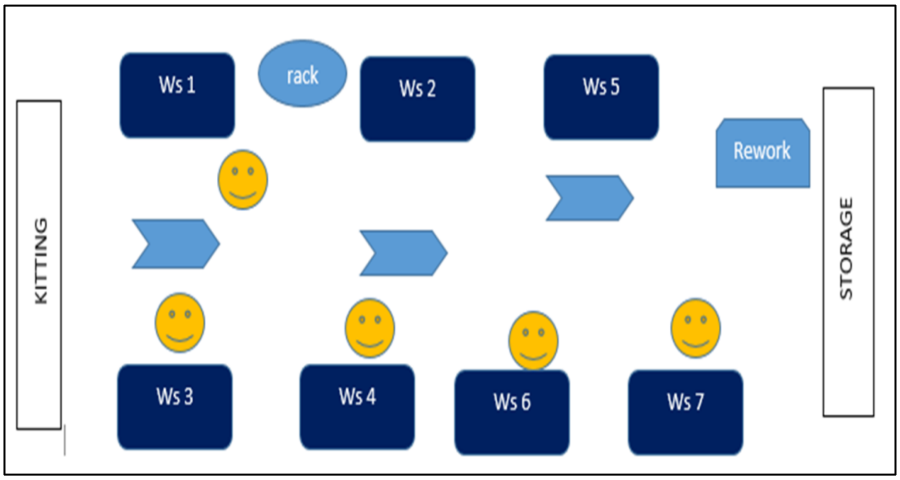

Figure 1: Actual Layout of Production Line

From Figure 1, there are many tasks that worker 1 needs to handle which are at workstation 1, workstation 2 and workstation 5. The workstation 5 will do the functional tester for finish marriage product. If the marriage product had failed in the functional test, it will be repaired at rework station and this will consume more time. Meanwhile, the worker from workstation 1 and workstation 2 is an expert worker that can complete tasks in sufficient time. Thus, the line will be unbalanced because there will be high workload for worker 1. Figure 2 below shows the line balancing from actual layout.

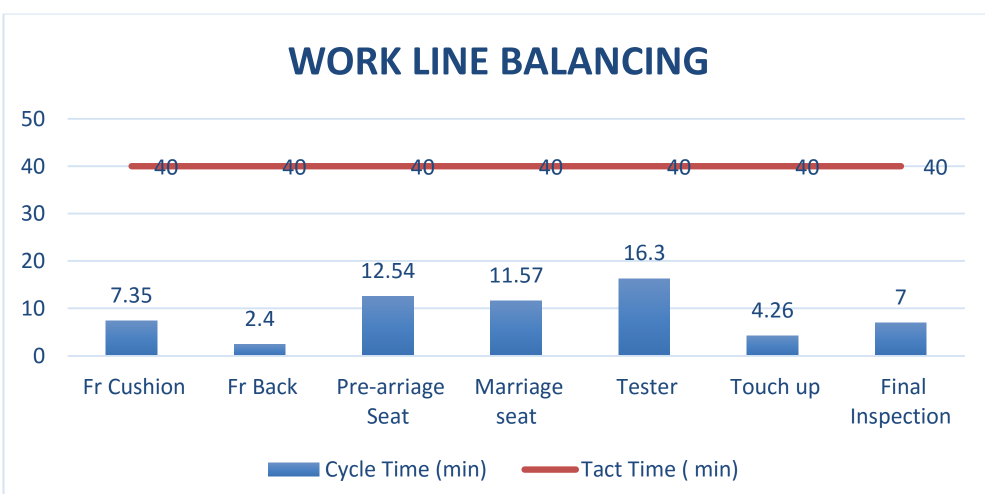

Figure 2: Actual Layout Line Balancing

Table 1: Capacity Study of Actual Layout

	Capacity Study				
Item	**Model : W212 Fr seat**				
	Product : Seat Mercedes-Benz Car				
Company X	**Type**		**Total**	**Unit**	**Remark**
	Customer requirement		12	Set/day	20 day
	Working time		8	Hour/day	Working time 480 min/shift
	Workstation		7	Station	
	Worker		5	Worker	Running for 1 shift
	Task time	$\sum time\ for\ task = 455 + 160 + 774 + 717 + 990 + 265 + 420$	3780	Seconds	63 minutes
	Cycle time	$\frac{production\ time\ per\ day}{unit\ required\ per\ day} = \frac{(63x12)}{12}$	63	Minutes	
	Tact time	$\frac{total\ work\ time\ availabe}{unit\ produce\ per\ day} = \frac{480}{12}$	40	Minutes/unit	
	Productivity	$\frac{output}{worker+production\ time\ per\ day} = \frac{12}{5+(12.6hr)}$	68.2	%	
	Efficiency	$\frac{\sum task\ time}{num.workstation\ x\ largest\ cycle\ time} = \frac{63}{7x16.5}$	54.5	%	

From Table 1, the overall cycle time for this production line is 63.00 minutes for one set of seat. Unfortunately, this cycle time did not include the rework and testing time for rejecting seat. The total rework and testing estimation time for one day is 15.00 minutes. Meanwhile, the tact time for this production line is 40.00 minutes for one-day operation that run 8 hours per day with only one shift. The efficiency of this current layout is 54.5% in daily operation and the productivity for daily operation is 68.2%.

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Cellular Layout

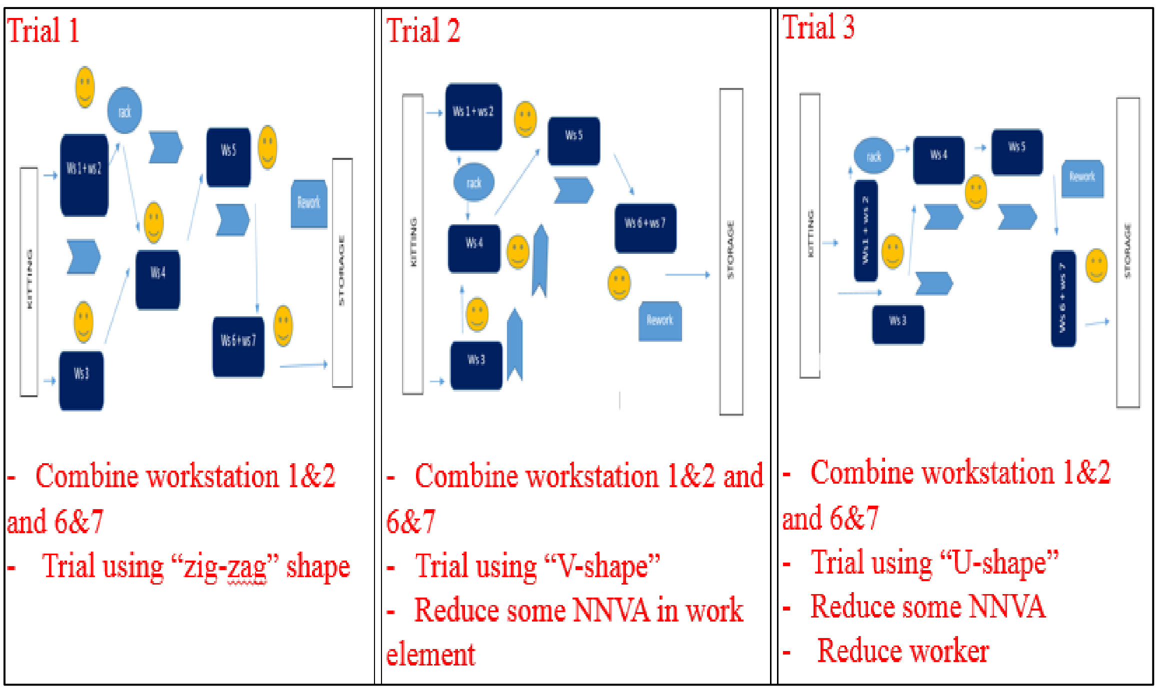

Figure 3: Trial's using Cellular Layout

Figure 3 shows the trial's using a cellular layout that has been chosen. The first trial is employed to simulate the effect if the workstation is combined together and the 'zig-zag' type is used as the layout to reduce the cycle time. Workstation 1 and workstation 2 and workstation 6 and workstation 7 are chosen as combined workstation because their work element is almost the same.

The second trial was made by using the same combination layout from Trial 1 and the layout type was changed to V-shape. The model was run according to this layout and reduced some non-necessary value adapt (NNVA) at each combination layout from the resources in the simulation model. These resources are work element for workers at each workstation who need to use in order to complete their task.

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The third trial was also made by using the same combination layout from Trial 1 and the layout type was changed to U-shape. The model was run according to this layout and reduced some non-necessary value adapt (NNVA) at each combination layout from the resources in the simulation model as in Trial 2. Besides, some resources at WS3 and workers were reduced. In this trial, only expert worker was chosen to manage the task in the production line.

Comparison of current layout with cellular layout design.

Table 2: Result Comparison Existing Layout with Cellular Layout

Type	**Existing layout**	**Trial 1**	**Trial 2**	**Trial 3**
Num. of workstation	7	5	5	5
Num. of worker	5	5	4	3
Cycle time	63 minutes	59.29 minutes	59.05 minutes	58.63 minutes
Efficiency	54.5%	72.3%	71.6%	73.3%
Productivity	68.2%	60.85%	75.9%	81.5%

From the table above, the comparison between the trial and existing layout do not have much difference. In terms of cycle time, there are a reduction in the number of times from each trial, which are from 59.29 minutes for Trial 1, 59.05 minutes for Trial 2 and 8.63 minutes for Trial 3. Unfortunately, not all of the trial can increase productivity if the cycle time is reduced. In Trial 1 the productivity rate is smaller than the current layout and other trials, that is only 60.85%, but, apart from that, it has good efficiency compare to Trial 2 and current layout which is 72.3%.

The efficiency of the production line is closely linked with the worker and line balancing. The worker satisfaction and capability to their task at each workstation will affect the efficiency and the fairness of work distribution to the worker will make the production line more balance. Figure 4 shows the comparison of work line balancing obtained from this study. The result shows that the line is more balance in the cellular layout trials compare to the traditional layout. This line balancing involves continuous improvement and still can be improved from time to time.

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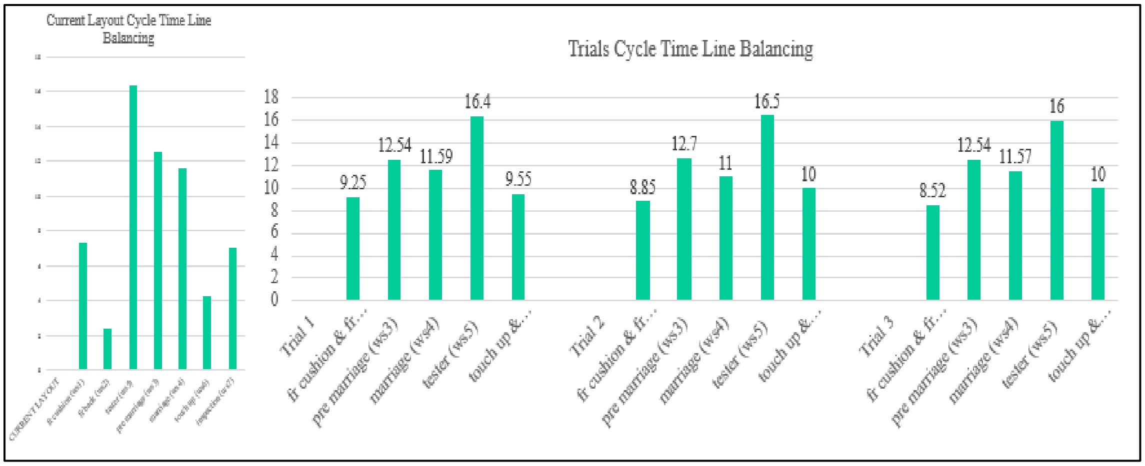

Figure 4: Line Balancing Comparison

DISCUSSION AND CONCLUSION

The result from ARENA simulation does not completely satisfy all, but, it clearly shows that the simulation process provides the improvement by reducing cycle time, unbalance line, and increase its productivity than using traditional layout. Trial 3 is the best layout that can achieve both objectives of the study as compared to the other trials. This trial gives high improvement by reducing the workers and some non-necessary value adapt (NNVA) such as lifting the seat frame from the dolly, walking to the dolly and movement involved in taking the components to assemble the part to the seat frame.

The result shows that cellular layout can improve productivity about 13.3% and efficiency of 18.8% by using Trial 3 layout. Besides, other manufacturing industries can develop this layout in their production line as one of the strategies to grow their company. Companies will be able to provide higher productivity, improve company efficiency and effectiveness, and then meet organization and customer demand requirements by using cellular layout. Moreover, by using this layout, the task is easier to conduct, avoid chaotic workplace condition and accident. In addition, this layout can make unbalanced line become balanced and more efficient to use.

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