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Modelling and Analysis of Manufacturing Process Layout

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Abstract. Manufacturing layout is an arrangement of more than two elements in a manufacturing plant. Process layout shows the layout of elements which running certain process cycle at a certain sequence. Through simulation software, process layout can be simulated and predicted the outcome of the certain model layout before it is implemented. An activity that is conducted in this study such as time study, line balancing and production line re-layout. Furthermore, lean manufacturing tools such as takt time calculation and Yamazumi chart is utilized in order to improve the mechanism in this study. Commercial software is used in order to simulate a model of manufacturing layout and increase the efficiency in the model. These simulated results were compared with the current process layout. The proposed new production plant layout showed promise in its application. However, approaches and layout models need to be evaluated in application to ensure usability so that it is effective and efficient in its performance. The layout of the proposal has increased overall line efficiency which shows an increase of 19%.

1. Introduction

Model is a corporeal, scientific, or rational representation of a system, phenomenon, or process while replication is a model that is applied from time to time. Simulation makes the model and illustrates how certain objects or phenomena will occur. This is advantageous for testing, study and exercise where real-world systems or ideas can be expressed in the form of a model. Modelling and simulation provide virtual repetition of goods and procedures and represent the product or process in an operationally existing and legal environment [1]. Practise of models and use of recreations can reduce costs and risks of life cycle activities.

Modelling simulations are often used in various engineering fields. In various conditions that occur and various systems, various models are cast-off applied. In grouping simulations, there are some differences significance between the types of models that are being and will be simulated, and between the types of database structures used to run the software doing the simulation [2]. System simulation is the application of models and systems. Models can be re-designed and tested with; usually, not optimal, high costs or not having aesthetic value to do in the system that will be run. The application of the model can be identified, and therefore, the specification that are interrelated with the actual behavior of the system or subsystem can be concluded by an analysis. In its broadest understanding, simulation is a software to analyze the optimization of a system, which is currently and proposed for improvement, over a period of time. Simulations are carried out before the existing system is implemented or when a innovative system is built in order to improve the old system, this is done to



reduce the possibility of failure to meet specification requirements, to reduce unexpected obstacles, to prevent under-utilization of excessive or excessive resources and to optimize current system performance.

Delmia Quest Simulation is a software, which this software offers a series and integrated manufacturing solutions that have differences to build a factory digitization process, little by little [3]. Through implementing digital technology in manufacturing in an organization, organizations are expected to have the development technology and develop continuously to interact with all processes in the plant at the beginning of the process and design at the time before the actual production commitment. 3D visualization that can be run at this time through technology to make changes and developments, identify and reduce errors that can lead to cost overruns and design failures, improve higher quality and create new innovations. Delmia Quest Simulation has benefits that have been widely felt by previous researchers from the implementation of the entire manufacturing process as digital Product Lifecycle Management (PLM) pipe [3]. Implementation of complete digitalization of all environments and applications in manufacturing, from the process planning stage to the implementation of shop floors, this enables researchers in manufacturing to provide the latest product design data benefits and to anticipate and optimize production processes and requirements under certain conditions.

The field of marketing is an important role, this states the design of manufacturing systems that have faster time and a shorter ramp-up process. Production simulations and virtual manufacturing tools are highly desirable in shortening the design steps, for example. Virtual manufacturing systems also accelerate the rate of increase in production [4], because operators undergo and have experience in running processes so that operators know better the planned system, and can provide input for the development of parameters and adding new system features at the time before the process is executed. Simulation results on manufacturing production process lines will provide useful data for daily base planning and improvements for development. This situation is included in handling raw materials used and operating procedures in the production process. Simulation results generated from computerized generated will be used for the process of evaluating and analyzing path competence and as long as useful information for planners and developers to identify waste on the floor during planning. Modeling using an integrated computer is the best tool to be applied for forthcoming researchers in instigating lean manufacturing and sustainability.

The persistence of this study is to advance efficiency on the production process path through evaluating and analyzing and re-modeling the process path layout currently in the industry. Manufacture simulations and computer-generated manufacturing apparatuses are very useful in the stages of evaluation and analysis and can predict the desired design of a model and give manufacturers better understanding and decision-making on certain issues.

2. Methodology

The purpose of this study is to examine the role of simulation in production process layout. The research was conducted based on SME Malaysian manufacturer which located at Selangor, Malaysia. Selected production line and inspection. This line consists of eight work stations with standard operating procedures that have differences in each and five actions of workers as production operators on the production floor. Production floor space such as the size and capacity of demand in production is determined at the time of data collection through the stages of interviews with production management. The time study methodology is used to recapitulate certain jobs performed by work elements such as humans or machines which cover a certain period under certain conditions and processes.

The selected production line then modelled in computer simulation and analyze using Delmia Quest D5R19 Simulation software.

In the education, the distress area was determined, and the origin reason of the trouble was identified. Data were extracted from the daily production layout by conducting time study and required demand. Observation method used in terms of data collection research. The time to be

recorded for the specified work cycle and work elements are restrained using an electronic chronometer and the consequences obtained are recorded along with the predicted time for each element during the process. After completing the process in determining the time, the results of the study are assessed; the measured time is set, and the measured time is multiplied by the rank to get the "base period". "Representative period" is determined based on the base period and "standard time" is calculated. During the time study, data were taken three times and averaging method was used. Data then was analyzed by executing line balancing. Determination of workers who will be carried out time study measurements is based on one-on-one interviews with factory executives and related managers. Managers and executives were asked to describe a suggestion for improvement of outstanding workers who worked at a balanced pace and on average and workers to participate together in the time study were chosen accordingly. The result from simulation then referred to identify the best solution for improving efficiency and the process repeated until a satisfying result. Delmia Quest was used to simulate the current study. Through this software, evaluation of data such as the effectiveness of the manufacturing layout process, line optimization at the factory and handling of raw materials used can be simulated. To determine the line efficiency that occurs, the Yamazumi graph is used as a tool to compare the current layout with the proposed new layout. Rearrange the layout of the production plan and then do it based on existing data. Data is then generated and generated by the software and the results obtained through the software will be compared to the current process layout.

3. Result

3.1 Existing Layout Configuration

Based on this investigation, the current production time applied is 8 hours daily from Monday to Friday with the production demand of 550 pieces daily. It shows the takt time is 1.14 minute per piece. If the daily products demand is not achieved overtime work were applied.

Figure 1 explains that the existing layout process has three sources, (SOURCE 1, SOURCE 2, SOURCE 3) of the many components complete to the assemblage line. The three components of this component at the initial stage are checked for quality (damage) at the time before and after each process that occurs to sustain quality and guarantee and reduce wasted time. This is in line with the normal state of lean manufacturing. The three component sources from the store are fully facilitated and the transfer to each buffer is known as the Standard in Process Stock (SIPS) at SIPS 1, SIPS 2 and SIPS 3. Then, the components of SIPS 1 are selected by operator 1 (OPR1) from SIPS 1 to workstation 1 (WS 1). The process is then continued on workstation 2 (WS 2) which is also directed and carried out by OPR 1. In WS 2, the parts are then assembled to get a part that is half-assembled. Operator 2 (OPR 2) then continues the process on workstation 3 (WS 3) and continues to workstation 5 (WS 5), before being transferred to SIPS 4. The process is then continued on workstation 6 (WS 6) by operator 3 (OPR 3). OPR 3 then takes half-assembled parts and assembles them with components from SIPS 3. Workstation 6 (WS 6) produces finished parts which are then transferred to workstation 7 (WS 7), carried out by 4 operator quality checks (OPR 4). After checking in terms of quality, OPR 4 sends to the finished part of the product packaging area for packaging with bubble wrap and attaching the label to the box. The complete product is formerly allocated at SIPS 4 earlier transferring to the warehouse zone, SINK 1. Details of process flow can be view in Figure 1.

According to the current layout and collected data, the Yamazumi chart was developed as shown in Figure 2. It was found that operator 2 has exceeded the takt time limit which results in a product shortage. Production that is currently occurring is a blockage when operator 2 uses extra period than the existing takt time has been set. This congestion has caused a shortage of production now. This a line with simulated production line results shows a shortage of 60 pieces.

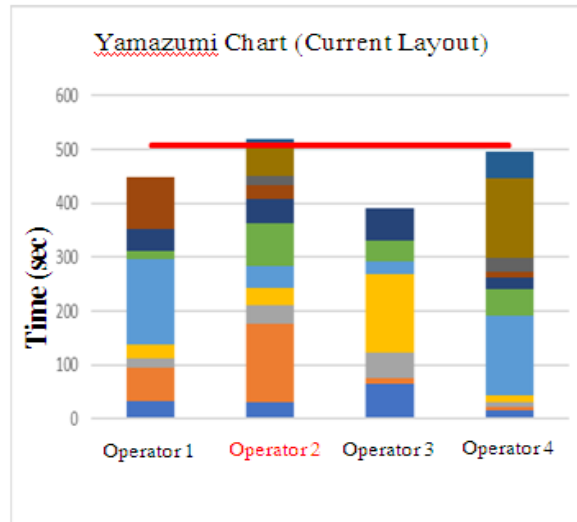
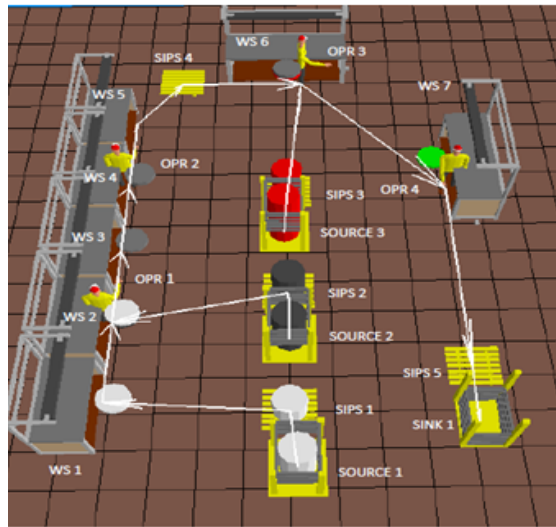


Figure 1. Current layout configuration. **Figure 2.** Yamazumi chart for current plant layout

3.2 Proposed New Production Plant Layout Analysis

Based on data analysis of current layout plant, the re-layout of the production plan as shown in Figure 3, was performed by substituting existing manufacture layout data with original data that goes through the line balance process. Re-layout remains the actual process (referred to SOP) and no process is simplified or altered. New production plant layout was being simulated with all other parameters keep in constant as the current layout. This simulated result was likened with the current process layout. Thus, Yamazumi chart was developed according to the proposed new production plant layout. The result as in Figure 4, shows bottleneck was removed in the process line and daily order prerequisite was achieved. The productivity of the line in the manufacture line has increased from 79% to 98%, increasing by 19%. The overall layout of the proposed performance is associated to the recent layout shown in Table 1.

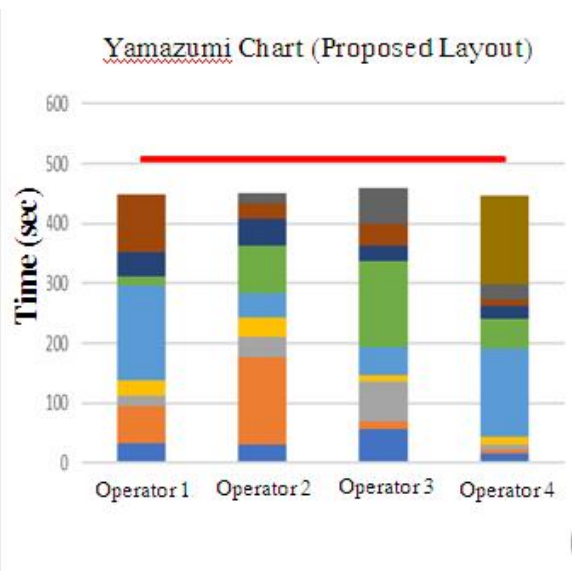
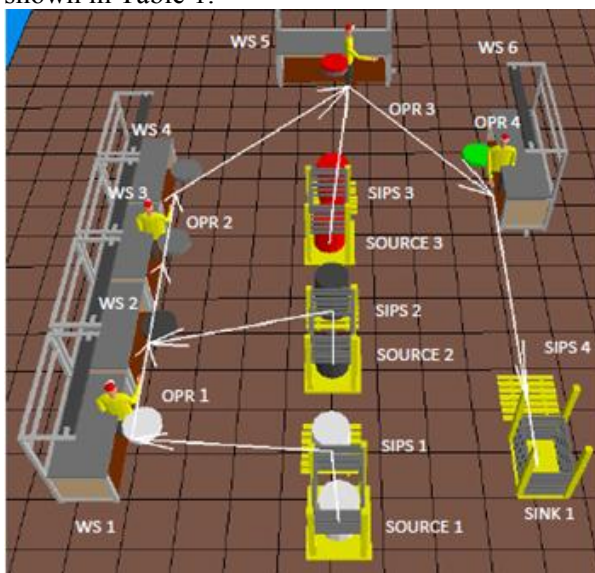


Figure 3. Proposed layout configuration. **Figure 4.** Yamazumi diagram for the future plant layout

Table 1. Comparison of presentation among existing and future layout

KPI (Key Performance Index)	Existing Layout	Proposed Layout
Uppermost process cycle time	540	460
Line efficiency	79%	98%
Daily productivity/ Daily demand requirement	490/550	560/550

4. Conclusion

The aim of this education is to optimize the efficiency of the production line with evaluation and re-modelling the present process line layout in automotive vendor manufacturing. Production process simulations and computer-generated manufacturing apparatuses are very useful in recognizing and forecasting the results of existing design layout models and giving manufacturers an understanding and can make better decisions in certain circumstances. Simulation software is capable of simulated and predicted the outcome of certain model layout before it is implemented. The produce a more optimal layout than before where an increase of 19%. It shows by computer simulation as a tool can be effective in reducing costs and time. With simulation, not only can cut costs but another element such as shortening time-to-market, quality goods with standards will be raised.

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