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Procedia Engineering 41 (2012) 1702 – 1707

Engineering Procedia

www.elsevier.com/locate/procedia

International Symposium on Robotics and Intelligent Sensors 2012 (IRIS 2012)

Simulation of Integrated Total Quality Management (TQM) with Lean Manufacturing (LM) Practices in Forming Process Using Delmia Quest

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Abstract

Study on TQM in Malaysia is first reported in 1997 while LM in 2010. Since then, voluminous studies reported that TQM and LM can bring more benefits to a company but there is still lack of case study on company that has implemented both initiatives. Preliminary status of Integrating TQM and LM has been established from survey conducted on the highly practices LM in Malaysian automotive companies in 2011. The findings from the survey are used in order to evaluate the Integrated TQM and LM in a Malaysian Automotive Company. An Integrated Total Quality Management (TQM) with Lean Manufacturing (LM) is a system comprises TQM and LM principles. This system focuses in achieving total customer satisfaction by removing eight wastes available in any process in an organization. This paper presents the Integrated TQM and LM practices by a forming company. The integrated practices are an adaptation combination of four models award, ISO/TS16949 and lean manufacturing principles from Toyota Production System, SAEJ4000 and MAJAICO Lean Production System. A case study of the forming company in Selangor has been conducted and simulation of the process is done by Delmia Quest Software. It was found out that the company has been practicing TQM and LM separately. Other type of software can also be used to measure the level of TQM and LM implementation and can determine whether the model is adaptable for other industry and for all type of manufacturing process. This is the initial case study that combined 4 awards practices, ISO/TS16949, Toyota Production System, SAEJ4000 and MAJAICO Lean Production System (LPS).
Lean Total Quality (GLTQ).

Keywords: Total Quality Management, Lean Manufacturing, Automotive Industry, Operational Engineering Management and Manufacturing Simulation Software.

Nomenclature

LM	Lean Manufacturing
TQM	Total Quality Management
EMS	Environmental Management System

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1877-7058 © 2012 Published by Elsevier Ltd.
doi:10.1016/j.proeng.2012.07.371

MAJAICO	Malaysia Japan Automotive Industries Cooperation
LPS	Lean Production System

1. Introduction

Automotive industry in Malaysia started in 1983 with the establishment of PROTON Berhad. The industry has started much earlier. TQM and LM coined in 1985 by different entity. TQM is coined by U.S Naval Air System while LM by Krafcik in International Motor Vehicle Program in Massachusetts Institute of Technology. However, TQM is first discovered in 1997 [1] for Malaysian Automotive Industry but the implementation of LM is only found in published paper in 2010 [2] a nd [3]. However, the LM implementation can be said to start in 2006 with the establishment of Malaysia Japan Automotive Industries Cooperation (MAJAICO) program under SME Corporation Malaysia which is one of the agencies under Ministry of International Trade and Industry (MITI). This program is a collaborative effort between the Malaysian government and the Japanese Government towards inculcation Lean Production System in this country from 2006 to 2011. However, due to the high demand of MAJAICO LM system in automotive companies, the program is extended in 2012 with different organization which is Malaysia Automotive Institute (MAI). MAI which is incorporated on 16 April 2010 is a non-profit organization under the custodian of MITI that functioned as a focal point and coordination centre for the development of local automotive industry in all matters related to Malaysian automotive industry [4].

Previous studies are available on manufacturing simulation such as NX-IDEAS, Star-CD, Micro Saint Sharp and ProModel and the advantages of these softwares vary based on the application type and the needs of the company [5]. Besides that, simulation models like Delmia Quest when combined with Catia and Product Data Management (PDM) have helped to improve communication between different units and departments. Simulation models have helped to generate more constructive proposals and ideas before the actual implementation. However, simulation works requires high software cost and high design engineers cost which not only need knowledge and skills on the software but also in the manufacturing processes [6]. A simulation model based on object oriented discrete system software eM-Plant on main shaft production line has been able to come out with the production line throughput, utilization and bottleneck operations and verifies that modelling and simulation technology could be successfully used in manufacturing industry [7].

This paper presents a case study on LM implementation for Integrated TQM with LM practices in a forming automotive company. The paper starts with the methodology and followed with the findings from TQM and LM practices in the forming process company, line improvement activity via simulation and ended with conclusion.

2. Methodology

The case study is based on the adaptation of MAJAICO Lean Production System method, Toyota Production System, SAEJ4001: Implementation of Lean Operation User Manual which has been issued in November 1999 by The Engineering Society for Advancing Mobility Land, Sea, Air and Space and four awards which are Malaysia Quality Award, Deming Prize Award, Malcolm Baldridge National Quality Award, European Award and ISO/TS16949. The case study is focused on the verification of operation control practices in the Integrated TQM and LM Systems [8].

The company were visited in order to judge the current production condition before improvement and to collect data. All the data and information gathered during the visit are then used for the Delmia Quest Simulation. Some actual data that are needed from the company will be current process flow, cycle time and number of labours employed. The simulation is conducted despite of actual improvement at production line so that company production will not be disrupted.

Delmia Quest Software is powerful tools that can create a virtual manufacturing environment that allow the simulation of actual processes. With this, the company understudy will know the effect of the integrated TQM and LM from the simulation first before actual improvement of the processes and will give initial expected outcome of the improvement.

3. Results and Discussion

3.1. TQM and LM Practices in Forming Process Company

Company A which was established in 1999 and located in Rawang, Selangor is a privately 100% Malaysian owned and has annual turnover of sales of RM74 million in 2009 with total employees of 350. According to Malaysia SME Corporation definition of an enterprise [9], Company A is considered as a large enterprise based on the annual sales turnover and number of employees. Company A is specializing in car interior parts and NVH products to its customers namely PROTON Berhad, Perodua, Honda and Toyota. Some of the products are headlining, floor carpet, pad dash panel, door trims, package tray and REM products. Currently, Company A has not exported any products. This company has Research and Development capability but no product is designed in-house. All of the products manufactured in this

company are based on the products designed by the customers. From year 2009 to 2010, Company A still has no design collaboration with customers.

In order to compete in the challenging automotive and manufacturing industry, several initiatives are implemented starting in 2003 with certification of ISO9000 followed by ISO/TS16949. The latest initiative implemented in this company is Lean Manufacturing Practices under consultation of MAJAICO from SME Corporation Malaysia.

Being a MAJAICO company, Company A belief in the importance of having lean policy and lean objectives in order to promote the lean manufacturing activities throughout the company and to show that Top Management is highly supportive and committed with the system. To ensure smooth implementation, LPS Kaizen Unit is established comprises of one team leader with two employees. The functions of the LPS Kaizen Unit are to ensure that the lean objectives can be accomplished especially in promoting Lean Production System throughout the company and established kaizen environment in the company. In order to do that, LPS Kaizen Unit has LPS Improvement Plan that includes LPS training to all departments so as to have LPS Master Trainer, LPS Trainer for each department and LPS Executive. This is to make certain that knowledge of LPS can be spread widely. Besides that, employee suggestion scheme is introduced in order to encourage all employees doing continuous improvement around their work area and provide ideas that can improve the company overall performance and productivity. From the suggestions, Small Working Groups are established to implement the idea. Small token is given to the employee and 15% out of the cost saving achieved from the improvement activity will be given to the Small Working Groups. These benefits hopefully will encourage more improvement activities that will not only benefit the employees but the company as well.

3.2 Line Improvement Activity via Simulation

The objectives of the line improvement activity are to obtain cost saving and cash flow improvement by increasing the productivity and reduction in work-in-progress. The project is led by the LPS Kaizen Unit Leader. In order to select which line to improve, material and information flow chart or sometime called Value Stream Mapping is done. Overall the manufacturing process of producing packing tray from monthly plan forecast to the shipping of the products takes 17.5 days. After discussion and brainstorming with all the improvement team and based on the severity and highly impact factors to the company, they decided to improve Packing Tray Line due to the problems of low productivity, uncomfortable working environment and too many work-in-progress.

After identifying the main problem, the next action is to find the current layout of the packing tray line, conduct cycle time study and prepare Yamazumi chart on the current layout. The time study involves some calculation to find time availability, takt time and necessary manpower. Time availability is the time available to work specifically on the process of producing the product while takt time is the time availability that a process has based on customer demand. Takt time is the foundation of pull system. Mass production requires only cycle time but lean production requires takt time. Necessary manpower is the manpower required for a required process. It is total cycle time for a product line based on total takt time.

From the time study, analysis of the current productivity and time study is conducted and improved time study is proposed based on 90% takt time and 90% utilization of labor. Company A targeted for 90% which is higher than world class practice and Toyota Production System set the target at 85%.

From the time study, the necessary manpower is 2.71 or 3 people. However, in actual improvement, Company A decided to cut from the current labor of seven to four since they could not find the ideal work combinations. Through this study, Yamazumi chart is rearranged and Company A is able to have three manpower based on Delmia Quest simulation. The next step is to simulate the current layout process with the improved layout by using Delmia Quest Simulation Software. This software is able to simulate the manufacturing processes. Thus, it can portray the result before the actual relayout and is able to produce the output result of the finished goods, machine and labor utilization. However, this software usage and benefits is still unknown to PROTON Berhad staff, vendors and MAJAICO consultant. They are more familiar with design software such as CATIA and AUTOCAD. In the western, this software is used especially in the aerospace industry whereby any line modification can be used effectively with least cost.

Figure 1 displays the current layout of the forming and assembly process for packing tray. There are seven labors for the processes. From the observation, labors capability has not been utilized effectively. This is because the process is designed without considering the lean manufacturing system which uses some of the tools in order to optimize a production line like value stream mapping, problem identification and takt time consideration.

Figure 2 displays the improved layout with only three man powers and the layout is designed to be in a U-shaped as practiced by most lean production system. The simulation is modelled for eight working hours which is a day work. Table 1 listed down the comparison between the current layout and the improved layout.

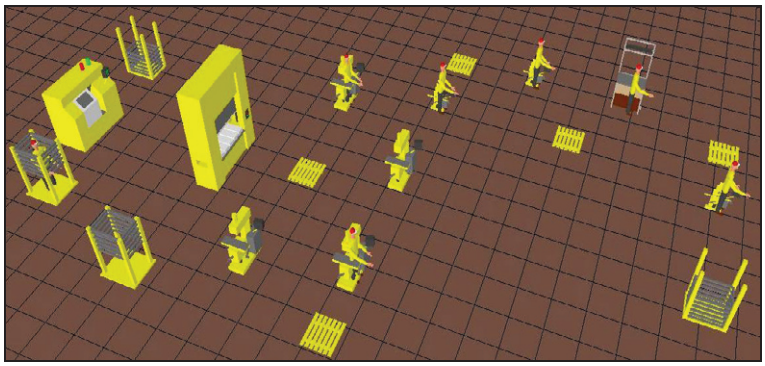

Fig. 1. Delmia Quest Simulation Model for Current Layout

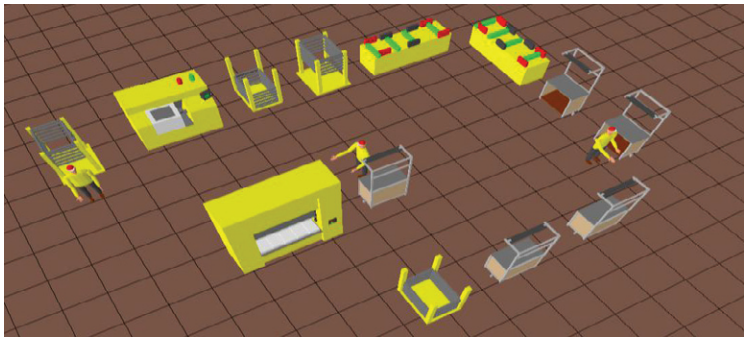

Fig. 2. Delmia Quest Simulation Model for Improved Layout

Delmia Quest is used for model validation as previous studies had indicated that a valid model will be able to produce a reasonable prediction of the system's performance. This can be done by comparing its performance with some past data available from the actual system [10]. In this study, the type of distributions used for key input parameters are as in Table 1 which is similar to Quest Tutorial Manual [11]. These distributions are chosen due to the closest simulation result produced compared to the actual production finished product. The actual production cycle times were used in order to produce 10.3% finished parts difference between actual production and simulation of current production for 1 day shift as displayed in Table 2. The simulation of current production data has produced 10.3% less finished parts compared to actual production data. Thus, it is believed that this gives good input to the manufacturers as the actual outcome will be more compared to simulation data. Delmia Quest Simulation is able to validate by implementing value stream mapping, levelling the production by customer demand, using pull system, calculating takt time instead of using cycle time and conducting time study. Some benefits have been accomplished as described in Table 1 from Delmia Quest Simulation. The finished parts produce from the simulation is slightly higher than current layout with more than half reduction of labors from seven to only three. Eventhough the labors are reduced more than half however according to Delmia Quest Simulation Result, the utilization percentage is still below 50% as displayed in Figure 3. Less work in progress parts will cause low inventory. Thus, this helps the company to have more cash flow rather than having to keep stocks as more work in progress parts will affect the total revenue of the company for the year. More space is available as the production line is arranged in ways that avoid wastes of time, inventory, motion, overproduce and over processed. Besides that, machine utilization is slightly better for the improved layout as illustrated in Figure 4. However, process and cycle time are slightly increased in improved layout as there is reduction of one machine. Despite of this, production rate is still slightly better in improved layout.

Table 1. Key Input Parameters for the Simulation Model and Their Distribution

Variables	Distributions
Source	Constant
Sink	Constant
Machine Cycle Time	Constant

Table 2. Comparison between Current Layout and Improved Layout

Items	Actual Production Data	Delmia Quest Simulation	
		Current Layout	Improved Layout
1. Finished parts.	263	236	240
2. Manpower	7	7	3
3. Space saving	-	-	More 40m2
4.Productivity (pieces/man-hour)	4.7	4.7	9 (91% Increase)
5. Work-In-Progress	342 pieces/day	342 pieces/day	10 pieces (<97%)
6. Average Manpower Utilization Percentage	Not available	27.9%	33.4%
7. Average Machine Utilization	Not available	33.7%	36.3%
8. Average Process Time (second)	Not available	2.1	2.3
9. Average Cycle Time (second)	Not available	0.87	0.93
10. Average Production Rate	Not available	0.50	0.51

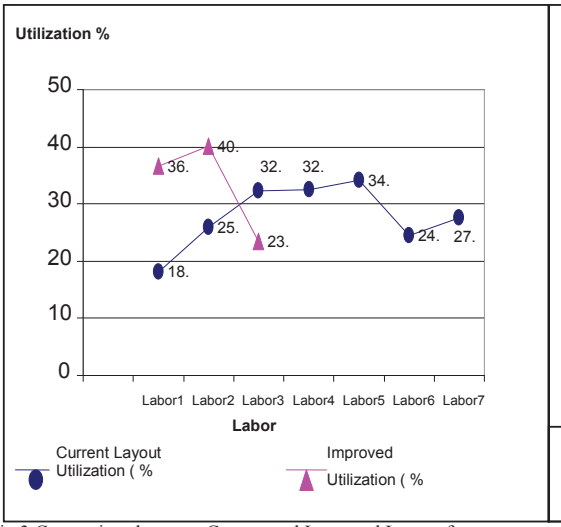

Fig.3.Comparison between Current and Improved Layout for Labor Utilization

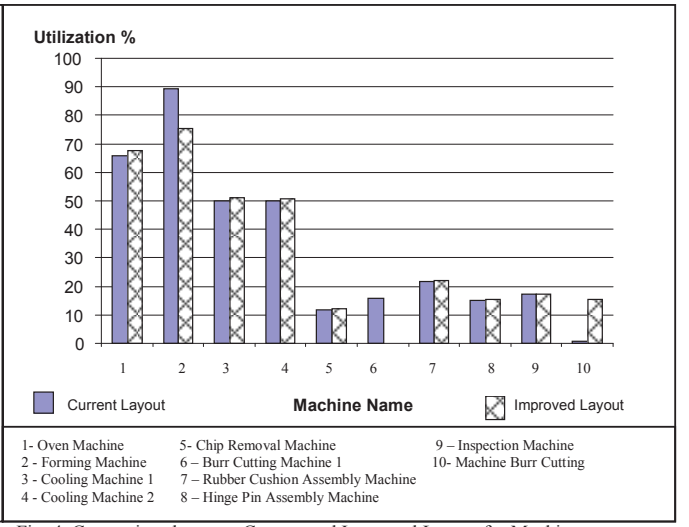

Fig. 4. Comparison between Current and Improved Layout for Machine Utilization

4. Conclusion

Delmia Quest Simulation has proven to be able to simulate the manufacturing process. More improvement activities can be done to measure the consistency between the simulation and the actual result for other type of process and other industry. The usage of Delmia Quest Simulation is not available for the company due to the high cost of purchasing the software. Besides the software provider, it is recommended that there is another centre that can provide services to the local automotive companies to simulate the process improvement as the university is only granted for academic license.

It was also found out that in Lean Manufacturing System, takt time and yamazumi chart are very powerful tools that can be used together with cycle time in mass production. All companies are recommended to use takt time and yamazumi chart especially in relayout their production line from push production to pull production. It is recommended, based on this finding, that takt time calculation and yamazumi chart are thought to engineering students to prepare them for latest jobs requirements as production engineer, process engineer, planning executive and quality engineer.

Acknowledgment

This contribution was developed from PhD Research Study funded by UiTM Excellent Fund (600-RMI/ST/ DANA 5/3/Dst 206/2009) and FRGS Fund (600-RMI/ST/FRGS 5/3/Fst (126/2010). Special thanks to CEO of MAI En.Mohamad Madani Sahari and MAI LPS team – En. Norjamalullail Tamri, En.Shahasif Mohd.Nasir and others, PROTON Holdings Berhad Y.Bhg.Dato'Syed Zainal Abidin Syed Mohamed Tahir, Vendor Management Group lead by Encik Mohd.Taufik Kamarudin, Encik Amir Shah Mohd.Ariff, Cik Ernie Fadzlina, all participated vendors especially Encik Ahmad Shukri Saad and Dean of Faculty of Mechanical Enginnering UiTM Shah Alam for their full support.

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