302 Simulation-based decision support for lean practitioners

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Implementing lean manufacturing (LM) enables companies to produce any product range in any order or quantity. To succeed in LM implementation, personnel need to have the expertise in deciding which LM tool to implement at the right time and on the right place. However, this expertise is not always available. In previous study, a simulation-based decision support system (SDSS) is proposed to address the gap between lean practitioners and simulation-based approaches in terms of expertise in utilising simulation software tools and supporting real-time decision making by providing four functions through interactive use of process simulation. The functions are layout, zoom-in/zoom-out, task status and Key Performance Indicators (KPI) status. This study reveals the feasibility of the proposed decision support system. SDSS is able to address the complex interdependent input parameters in manufacturing line and provides lean practitioners with time to react to emerging problems, evaluate potential solutions and decide on LM implementation.

Key Words: Decision Support, Lean Manufacturing, Simulation.

1. Introduction

In previous study [1, 2], a simulation-based decision support system (SDSS) is proposed to address the gap between lean practitioners and simulation-based approaches in terms of expertise in utilising simulation software tools. SDSS is a system capable of supporting real-time decision making by providing four functions through interactive use of process simulation to assist lean practitioners (who are not experts in simulation) in their decision to implement LM tools.

The functions of SDSS are layout, zoom-in/zoom-out, task status and Key Performance Indicators (KPI) status. Following simulation runs, results (SDSS output) will be saved in an independent database. The results can be retrieved during or at the end of simulation runs in the form of total production output, total production time, changeover time, bar chart, Work in Progress (WIP) and Inbound/Outbound buffer values. From the results, lean practitioners can detect problems in the simulated production line and select the most suitable LM tool to be applied to solve the problems. For example, if the result shows high changeover time, lean practitioners could choose Single Minute Exchange of Die (SMED), implement it into the simulation model and conduct simulation run again to observe the improvement brought by the chosen LM tool.

The process could be repeated countless until the desired results are achieved. By using this process simulation approach, lean practitioners are able to forecast the output of manufacturing processes and the effectiveness of LM tools based on the input values. This provides the lean practitioners time to react to emerging problems, evaluate potential solutions and decide on LM implementation. This paper focuses on the feasibility study of SDSS that was conducted using a manufacturing process model of a Coolant Hose Manufacturing (CHM) factory. The development of CHM factory simulation model was elaborated in [1, 2].

2. Feasibility study of SDSS

A lean practitioner with experience in the traditional method of implementing LM tools is chosen. For the purpose of this feasibility study the lean practitioner selects S4 of CHM factory simulation model. By using zoom in/zoom out function and task status function (Fig. 1 and Fig. 2) of SDSS, the lean practitioner observed bottleneck in S4W1 and prolonged idle status of operators in WS4, WS5 and WS6.

The reason for this bottleneck situation is acquired from the KPI status function which showed high changeover time (51 minutes) (Fig. 3). The high CO time causes a low total production output (100 units/day) and high total production time (553.33 minutes).

![Fig. 1 Zoom-in/zoom-out function of S4](image1)

![Fig. 2 Task status function of S4](image2)

![Fig. 3 Snapshot of KPI status function for S4](image3)

Table 1: SMED implementation at S4 for WS1 and WS6

<table>
<thead>
<tr>
<th>Changeover (CO) Task Time</th>
<th>WS1</th>
<th>WS6</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Task 1 (Minutes)</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>b. Task 2 (Minutes)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>c. Task 3 (Minutes)</td>
<td>3</td>
<td>1.5</td>
</tr>
<tr>
<td>d. Task 4 (Minutes)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>e. Task 5 (Minutes)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>f. Task 6 (Minutes)</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>g. Task 7 (Minutes)</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>h. Task 8 (Minutes)</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>i. Total CO Task Time</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

To react to these problems, the lean practitioner conducted what-if analysis as follows:

i. What-if of SMED is implemented at S4?

Table 1 show the values of changeover task time which is
incorporated into the simulation model to observe the improvement by SMED implementation. Fig. 4 shows snapshot of S4 with SMED implementation. Following SMED implementation, the lean practitioner observes an increment of 9% in the total production output and decrease of 4% in the total production time from the KPI table of S4 (Fig. 5).

ii. What-if Cellular Manufacturing (CM) is implemented at S4?

By observing the task status function continuously during simulation runs, another problem detected in S4 is prolonged idle status of operators in WS4, WS5 and WS6. By implementing CM, the total production output is increased by 5% while the total production time is reduced by 1.74% as seen in Fig. 6 and Fig. 7. Despite the minor improvements, the number of operator has been reduced by 33.33% (from six to four people).

iii. What-if SMED is implemented together with CM at S4?

By implementing SMED and CM concurrently (Fig. 8), the total production output is increased by 10% while total production time is reduced by 5.06 % (Fig. 9). The number of operator is also reduced by 33.33% (from six to four people).

By utilising the specific functions of SDSS and comparing the difference in results before and after LM tool implementation, the effectiveness of LM tool implementation (in this case, SMED and CM) is quantified by the lean practitioner. This feasibility study showed that SDSS is a suitable decision support system for lean practitioners because it increases the literacy in simulation among lean practitioners by providing a structured approach of using simulation software tool. Moreover, the idea of user understanding support, which was implemented in the model as several functions, also assists users in visualising the production processes and simulation outputs.

3. Conclusions

The development of SDSS is motivated by the need to address the gap between lean practitioners and simulation-based approaches, in terms of expertise in utilising simulation software tools and to develop a system capable of supporting real-time decision making in LM implementation. By deploying a process simulation model and providing four functions, SDSS enables lean practitioners to assess current and future state of manufacturing process, perform what-if analysis and measure impact of improvement after LM tool implementation. Therefore, lean practitioners could choose a suitable LM tool to implement at the right time and on the right place. This study reveals the feasibility of the proposed decision support system. SDSS is able to address the complex interdependent input parameters in manufacturing line and provides lean practitioners with time to react to emerging problems, evaluate potential solutions and decide on LM implementation. SDSS could also be used not only to improve lean system but also to support decision-making in replacing an existing manufacturing process with a lean system.

4. Acknowledgement

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5. References