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AN EARLY PHASE CASE OF VSM AND DISCRETE EVENT SIMULATIONS

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ABSTRACT

This paper use a case study to investigate the process analysis methods using value stream mapping and discrete event simulation in early phases change decision making. The case study discuss the practical situation for the modeler. The output of each tool and the combination is evaluated with the modelling effort in mind. The result shows that it may be preferable to analyze issues like static bottlenecks and average capacity with value stream mapping while for dynamic issues discrete event simulation may be necessary. For industrial application purposes it is proposed to build the models simultaneously and to take time to do the proper static analysis before doing the dynamic analysis in order to understand the dynamic results.

1 INTRODUCTION

This case study describes and discuss the process analysis method used in a larger early phase study including material and technology change of a manufacturing line published in Kurdve et al. (2016).

In early phases of considering investment of new production technology, discrete event simulations (DES) and/or Value Stream Mapping (VSM) are commonly used to validate if the new concept will meet requirements. The VSM rely on a structured methodology (Rother and Shook 2003) used to visualize the processes, operations, with lead times, buffers and information flows and give details of value adding and non-value adding process components and needs for improvements e.g. bottlenecks or opportunities for better planning (D'al Forno et al. 2014). The VSM is often a, lean specialist driven analysis, the time spent on detailed mapping and data collection versus how to reach management consensus is discussed in Kurdve and Salonen (2016). VSM can be extended as environmental-VSM (EVSM) e.g. to include material efficiency (Kurdve et al. 2011) and may be part of elaborate sustainability mapping (Paju et al. 2010). One of the most important outputs of a VSM is the design of a future state for the studied system.

In advanced VSM versions, lean experts can use VSM instead of simulation (Berndt et al. 2016). Lean tools need to be simple and quick to use why DES may be seen as too complex (Solding and Gullander 2009). When data availability, and structure for collection of data, may be an issue a joint data collection for VSM and DES is proposed (Bärring et al. 2017).

2 MATERIALS AND METHOD

The study was executed at a linear product line at in a plastic automotive component manufacturing plant. The aim was to find a solution with smaller buffers (to reach shorter leadtime) and new materials for the product and introduce automation technology in the line. VSM, E-VSM and DES were used together with company expert evaluation to analyse proposed changes. The process mapping was performed during line-walk and measurements on two occasions in 2014 to draw the current state VSM and E-VSM. Distribution data for the DES were estimated from the collected data. Two alternative future states, Kaizen and Kaikaku were formulated, drawn in visio and analysed by VSM. Then a DES model of the current state and future state was built in Process Simulator (add-on to Visio). First the current state was verified with production data and bottlenecks were evaluated. The two scenarios for the future were evaluated by VSM and DES.

3 RESULTS, DISCUSSION AND CONCLUSION

The VSM was first modelled, then afterwards, to get the picture of the dynamics a DES was modelled using the same observational data. The results of the current state VSM and bottleneck analysis showed the bottleneck operation, and that both scenarios would improve average capacity and shorten lead time significantly. The Kaikaku alternative looked best. However when the scenarios were analysed with DES it showed that both future state were more unstable than the current state, and the Kaikaku scenario was proven to be out of scope due to the instability. It was difficult to understand the reasons for the unstable behavior from DESs and whether these were due to modelling issues or in fact lack of process stability. Several runs were done trying different distributions and start-times and modelling discussion between the authors (of which one is a VSM-expert and the other is a DES expert). However when going back to the initial process model and the VSM it could be confirmed that the instability was connected to static setup-time and buffer settings which could be manually calculated giving an unstable process in scenario Kaikaku.

In this case, a linear production line, suitable for VSM, and all major decisions could be determined based on VSM and manual calculations. However the instabilities may have gone undetected unless the DES's would have been performed and clearly visualised them. In more complex production the manual calculations become more difficult and DES will be more necessary. A remaining issue however is that it was difficult to find the root cause of the unstable process behaviour with DES analysis (being less structured and software dependent). Regarding practical use it was deemed that the joint process mapping and analysis modelling method was time efficient with parallel VSM and DES modelling. Lean tools need to be simple and quick to use. Drawing process in a program (Visio) that could be connected to both VSM and Process Simulator was seen as an advantage.

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