SIMULATION-BASED APPROACH TO LEAN MANUFACTURING

Monograph Series

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Universiti Teknikal Malaysia Melaka

ISBN: 978-967-0257-59-4

Perpustakaan Negara Malaysia Cataloguing-in-Publication Data

Effendi Mohamad
SIMULATION-BASED APPROACH TO LEAN MANUFACTURING/
Effendi Mohamad, Mohd Amri Sulaiman.
Includes Index
Bibliography: page 81
ISBN 978-967-0257-59-4
1. Lean manufacturing. I. Mohd Amri Sulaiman.
II. Title.
658.5

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Published and Printed in Malaysia
Penerbit Universiti
Universiti Teknikal Malaysia Melaka
Kampus Bandar
Aras 1, Blok B, Jalan hang Tuah,
75300 Melaka
Tel: 06-283 3344 Faks: 06-283 3019

DEDICATION

Bismillahirahmanirahim

To our parents, families, and friends for their continuous support.

Effendi Mohamad and Mohd Amri Sulaiman
January 2016

PREFACE

Lean Manufacturing (LM) has been applied to various manufacturing sectors, and has gained particular acceptance and momentum over the past few decades. However, the implementation of LM is not always successful due to a number of reasons. Firstly, there is a general lack of understanding of lean concepts as well as a lapse of proficiency in the selection of appropriate LM tools, inappropriate employee attitude on the shop floor, a lack of LM experts within companies, difficultly in implementing concepts due to a lack of support, and an inability of LM tools to address various independent processes in the production line. There is also a lack of tools to quantify effectiveness of LM implementation and a lack of self-learning education software for LM tools. Another main cause of poor implementation is the deficiency in the current user training programme (UTP) for LM tools.

The current UTP lacks the ability to demonstrate and convince the users of the impact of implementing LM tools on the production floor prior to their use. Therefore, users must conduct pilot studies and other experiments on the production floor post-training in order to study the impact of applying LM tools to their manufacturing process. In other words, there is gap between the attendance of UTP training and the confident application of LM on a real-time production floor.

To overcome these challenges, simulation-based approaches have been proposed as effective methods of supporting and evaluating LM tools, as well as assessing the current and future state of manufacturing processes, performing "what-if" analysis, and measuring the impact of improvement after LM implementation. However, the simulation software tools are generally more suitable for simulation engineers, who know how to design, build or analyse a simulation model, and how to integrate the simulation model to LM tool software. The approaches are not as suitable for other domain experts in the lean project, such as process engineers, mechanical engineers, quality engineers, production engineers, materials engineers, marketing executives and finance executives. These team members are generally not familiar with simulation software or LM tool software. Differences in the level of understanding between simulation engineers and other domain experts may lead to the development of a biased simulation model and impaired decision-making in LM implementation. Therefore, appropriate niche techniques to bridge the gap between domain experts and simulation-based approaches are required in order to support LM implementation.

Motivated by the need to fill in the gaps in the current UTP for LM tools and simulation-based decision support in LM implementation, this research proposes two solutions. Firstly, a solution that provides a training framework that integrates Lean Manufacturing Tools Training System (LMTTS) with the current UTP for LM tools. LMTTS is a training system that consists of an e-learning module and an S-module (simulation module). In this study, LMTTS covers Single Minute Exchange of Die (SMED) training. By providing a learner-centric orientation of learning, the comprehension and confidence levels of users towards LM tools is increased and the overall training results of the LM tools is enhanced with the use of LMTTS. Most importantly, LMTTS creates a dynamic and flexible learning environment for users to study LM tools. Users are able to experiment with simulation models using real input parameters from their production floor, which allows them to immediately see the effects of the changes. This will reduce the amount of time spent developing solutions to problems in real-time operations.

The second proposed solution is a simulation-based decision support system (SDSS), which can assist in the decision making of LM tool implementation. SDSS provides four functions through an interactive use of process simulation: layout, zoom-in/zoom-out, task status, and Key Performance Indicator (KPI) status. In this study, these functions are incorporated into a process model of a coolant hose manufacturing (CHM) factory. A feasibility study revealed that SDSS was able to address complex interdependent input parameters in the manufacturing line. It provided lean practitioners with time to react to emerging problems, the ability to evaluate potential solutions and make proper decisions regarding LM implementation. SDSS can also be used in supporting decision-making processes to replace the existing manufacturing processes with a lean system. This research has provided important insight into a simulation and modelling approach to lean manufacturing, as well as highlight associated issues.

ACKNOWLEDGEMENTS

Bismillahirahmanirahim

The authors acknowledge the Ministry of Education Malaysia and Universiti Teknikal Malaysia Melaka (UTeM) for funding this research via Short Term Grant(PJP/2014/FKP/ (9C)/S013262).

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