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論 文 内 容 要 旨

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学位論文題目	A Simulation and Modeling approach to Lean Manufacturing リーン生産方式に対するシミュレーションとモデリングによる接近		

内容要旨

Lean Manufacturing (LM) has been applied to various manufacturing sectors and has gained great acceptance and momentum over the last few decades. However, LM implementation does not always succeed due lack of understanding of lean concepts, lack of proficiency in selection of appropriate LM tool, shop floor employees' attitude, unavailability of LM experts in a company, difficulty to implement some LM tools without support, inability of LM tools to address various interdependent processes in the production line, lack of tools to quantify effectiveness of LM implementation and lack of self-learning educational software for LM tools. The deficiency in the current user training program (UTP) for LM tools is also among the main culprit leading to failure of LM implementation.

The current UTP for LM tools still lacks the ability to demonstrate and convince the users on the impact of implementing LM tool on a production floor before they actually apply the tools. Thus, users will have to conduct pilot studies and other experiments in the production floor post training to observe the impact of applying those LM tools to their manufacturing process. In other words, there is a gap between attending UTP and confidently applying LM tool in real production floor.

To overcome these obstacles, simulation-based approaches are proposed as an effective method of supporting and evaluating LM tools, assessing current and future state of manufacturing process, performing "what-if" analysis and measuring impact of improvement after LM implementation. However, the simulation software tools are generally more suitable for simulation engineers who know how to design/build/analyse a simulation model, and how to integrate it to LM tool software. These approaches are not suitable for other domain experts in the lean project (process engineer, mechanical engineer, quality engineer, production engineer, materials engineer, marketing executive and finance executive) who are familiar with neither simulation software, nor LM tool software. Misunderstanding between simulation engineers and other domain experts may lead to development of a biased simulation model. Therefore, some appropriate niche techniques to bridge the gap between domain experts (less-computer-literate users) and simulation-based approaches are expected 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 three solutions. The first solution is a proposal of a training framework that integrates Lean Manufacturing Tools Training System (LMTTS) with the current UTP for LM tools. LMTTS is a training system consisting of e-learning module and S-module (simulation module). LMTTS in this study covers Single Minute Exchange of Die (SMED) training. By providing a learner-centric orientation of learning, user' s comprehension and confidence levels towards LM tools are increased and the overall training results of the LM tools is enhanced by LMTTS. Most importantly, LMTTS provides a dynamic and flexible learning environment for users to study the LM tools. Users could experiment with the simulation models using input parameters from their production floor and immediately see the effects of the changes. This way, the time spent garnering possible solutions to problems within their production floor would be reduced.

The second solution is proposal of a simulation-based decision support system (SDSS) to assist the decision making in LM tool implementation. SDSS provides four functions through an interactive use of process simulation namely layout, zoom-in/zoom-out, task status and Key Performance Indicators (KPI) status. These functions are incorporated into a process model of a coolant hose manufacturing (CHM) factory which was developed in this study. Feasibility study showed that SDSS is able to address 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.

Lastly, an intelligent agent named Muda Indicator (MI) agent is proposed in this research to provide decision support functionality to lean practitioners in pursuing LM implementation. MI agent acts as an expert assistant to lean practitioners in using LM tool software and support their decision making by quantifying waste in manufacturing simulation. MI agent continuously monitors the status of Muda (waste) during simulation runs and provides Muda level indication by means of RAG status. Feasibility study showed that MI agent handled the dynamic nature of manufacturing processes autonomously and pro-actively translates the results of waste quantification by means of RAG status during simulation which is easily understood by the user. This research has provided important insights into a simulation and modeling approach to lean manufacturing and highlighted some associated issues.

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論文審査の結果の要旨

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学位論文題目

A Simulation and Modeling Approach to Lean Manufacturing

リーン生産方式に対するシミュレーションとモデリングによる接近

審査結果の要旨

トヨタ生産方式から生み出されたリーン生産方式は製造工程におけるムダを排除し，製品および製造工程の全体にわたってコスト削減を狙った方式として着目されている。リーン生産方式の導入による効果をあげている企業がいる一方で，導入に失敗する例も数多く報告されている。一般に，導入教育や，専用ソフトウエアなどの利用による対応がなされているが，各企業に応じた仕組みとはなっていないところに原因があると考えられる。本論文は，リーン生産方式を効果的に導入するための試みとして，Eラーニングシステム，意思決定支援システム，そしてエージェントシステムという３つのアプローチをそれぞれ提案している。Eラーニングシステムでは，既存システムとの統合例を試作し評価を行っている。意思決定支援システムでは，リーン生産のための手法選択を例として，試作評価を行っている。また，エージェントシステムでは，シミュレーションモデルの中に実装することで，利用者の支援に対する有効性を評価している。さらに，こうしたアプローチを統合することで，リーン生産方式導入の問題に対する新しい解決案を提案し，その適応に関する評価を行っている。

以上本論文は，リーン生産方式を効果的に導入するための支援システムに関する提案としてまとめられており，提案手法や本手法を組み込んだプロトタイプシステムの事例を通じてその有効性を検証したものであり，本論文は博士（工学）の学位授与に値するものと判定する。