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論　文　内　容　要　旨

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学位論文題目	Simulation Modeling and Analysis for Productivity Improvement in the Production Line (製造ラインにおける生産性向上のためのシミュレーションモデルと分析)		

内容要旨

Lean manufacturing addresses the growing need for all types of organizations that drive process change and performance improvements in their organization environment and supports the evolution toward demand-driven supply networks. Lean principles are derived from the Japanese manufacturing industry. It is the set of "tools" that give contribution in the identification and steady elimination of waste (muda). As waste is eliminated, quality improves while production time and cost are reduced. The key to lean manufacturing is to compress time by eliminating waste and this continually improving the process. Ohno (1988) defines waste as all elements of production that only increase cost without adding value that customer is willing to produce.

The total productive maintenance (TPM) is mostly regarded as an integral part of Lean. TPM originated in Japan in 1971 as a method for improved machine availability through better utilization of maintenance and production resources. TPM uses an overall equipment effectiveness (OEE) index to indicate equipment and plant effectiveness. The technique works to eliminate the six big losses indicated by Nakajima, as down time (caused by equipment failure, set-up and adjustment), speed losses (owed by idling, minor stoppage and reduced speed) and defects (caused by process defects and reduced yield). The Japan Institute of Plant Maintenance promoted TPM which includes the OEE in 1971. In 1988, Nakajima introduced the TPM to the U.S. OEE has since gained a lot of attention as the ultimate performance measure of a piece of equipment.

Sohal et al., (2010), from survey results, found that OEE typically advances from a base measure for efficiency (as its initial purpose), to being a tool to improve effectiveness for analysing data to support continuous improvement objectives through the identification and elimination of six big losses, namely (i) breakdowns, (ii) setups and changeovers, (iii) running at reduced speeds, (iv) minor stops and idling, (v) quality defects, scraps, yields, reworks, and (vi) start-up losses. The first two affect Availability rate (A), the second two affect Performance efficiency (P), and the last two affect Quality rate (Q). These three OEE elements, since being introduced by Nakajima until this research was conducted, already experienced several improvements involving a weight calculation method for OEE elements. This study proposes a procedure to obtain weight settings of each OEE element and OEE estimation for productivity improvement in the production line.

The first research proposal is sought to offer a procedure to cover the drawbacks of weighting OEE elements. The research motivation was initiated by several researches of OEE improvement, which met difficulty when determining the proper weight for each OEE element. The calculation results of OWEE and PEE by STP also showed better results than the original OEE for the simulation model case study. From the result analysis, it can be concluded that the

outcome of this research experiment can be implemented in OEE with a weighted method, among others; for example, in PEE (Production Equipment Effectiveness) as well as OWEE (Overall Weight Equipment Effectiveness). A simulation model was chosen because it is able to mimic a real production line and therefore act as a suitable experiment tool. This study provide a lean overview followed by a description of how simulation is being used to enhance lean performance. This study offering simulation as the lean way to implement and accelerate the TPM. The STP (Simulation Taguchi method Procedure) provided characteristic mapping of OEE elements through a response table. Naturally, even though STP seems to be difficult to implement, the outcome is worthwhile. Moreover, the company will have obvious data to consider when making decisions for the improvement of priorities in their production line.

The second research proposal offers OEE enhancement scheme, which provides a company with the appropriate information for decision-making on priority improvement in the production line. By using the Taguchi method and simulation as an experimental tool, this scheme can measure and estimate the contribution for each OEE element to an OEE score. This procedure can be implemented in a specific WS or in a production line if the factory is made up of more than one manufacturing line. They provide measurements for each OEE element in order to observe the extent of the influence the simulation experiment has on the OEE elements and scores.

All of those research proposals are to improve the OEE as a KPI in the factory. In order to meet the objective of the TPM itself, increasing the sustainability of the company by continuous improvements.

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論文審査の結果の要旨

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学位論文題目

Simulation Modeling and Analysis for Productivity Improvement in the Production Line

製造ラインにおける生産性向上のためのシミュレーションモデルと分析

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。生産性を向上させるための手法はそれ以外にも提案されているが、その効果を客観的に評価するための方法は確立されていない。

本論文では、生産設備の稼動効率に関する階層化された指標として用いられるOEE（総合設備効率）に着目し、シミュレーションモデルとその分析手法を用いることで、OEEを用いた生産性評価手法の提案を行っている。一般に、OEEでは稼働率(Availability)、性能(Performance)、品質(Quality)という3つの測定可能指標を利用するが、その重み係数については考慮していない。OEEに重み係数を導入する手法は報告されているが、重み係数の計算方法については確立されていない。本論文では、重み係数をタグチメソッドによるS/N比から算出し、生産性評価として用いる手法を提案している。さらに、OEEによる付加価値・非不可価値率に関する計算結果から、生産性向上に結び付く対応策への判断情報を提案している。さらに、プロセスシミュレーションモデルで構築した生産工場モデルを用いたシミュレーション評価により、こうした提案手法の検証を行っている。

本研究は、生産ラインにおける生産性向上のための評価手法が提案されており、提案手法の有効性についてシミュレーション実験により検証した結果に基づく内容となっている。以上から、本論文は博士（工学）の学位授与に値するものと判定する。