Faculty of Manufacturing Engineering

A PROPOSAL OF OEE SIMULATION DECISION SUPPORT TOOLS FOR LEAN PRACTITIONERS

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DECLARATION

I declare that this thesis entitle "A Proposal of OEE Simulation Decision Support Tools for Lean Practitioners" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……..

Name : ……..

Date : ……..

APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Manufacturing Engineering (Industrial Engineering).

Signature : ……..
Supervisor Name : ……..
Date : ……..

DEDICATION

To my beloved mother and father

ABSTRAK

Pada masa kini, Lean Manufacturing (LM) adalah satu kaedah peggerak kepada syarikat-syarikat mencapai kejayaan dalam persaingan global. Tujuan utama inovasi pada LM adalah mengurangkan dan menghapuskan pembaziran. Selain itu, LM menyumbang kepada nilai-nilai yang baik kepada pelanggan dan sentiasa menambahbaik proses pembuatan secara beterusan. Walaubagaimanapun, kepakaran yang rendah terhadap Lean Principle (LP) dalam beberapa aspek negatif mempengaruhi kemampuan syarikat ke arah perlaksanaan LM seperti kekangan masa, sumber dan kos. Kehadiran pengamal LM adalah cara yang terbaik kepada syarikat untuk mencapai keseimbangan dan mengekalkan pergerakkan seluruh produksi. Akan tetapi, beberapa aspek akan sukar untuk pengamal LM menentu ukur kesan alatan LM ke tahap yang diingini selepas memutuskan dan melaksanakan LM sesuai. Tujuan pembelajaran ini adalah untuk mencadangkan satu rangka kerja secara simulasi LM untuk pegamal LM iaitu Keseluruhan Keberkesanan Peralatan (OEE) berasaskan alatan sokongan membuat keputusan secara simulasi (SDST). Seni bina OEE-SDST berdasarkan rangka kerja yang asal konsep OEE oleh Nakajima (1988). Mengintegrasikan kos purata dengan menghubungkan kecekapan OEE adalah salah satu daripada pengenalan baru dalam konsep OEE. Reka bentuk dan pembangunan akan dibina di Microsoft Visual Basic 2010. OEE-SDST akan beroperasi sebagai pengantaramuka grafik pengguna (GUI). Kajian kebolehgunaan kriteria keupayaan perisian berdasarkan ISO / IEC 25010: 2011 atau ISO / IEC 9126 yang terdiri daripada keboleh-fahaman, keboleh-belajar, kebolehan operasi, dan daya tarikan. Berdasarkan kaji selidik daripada 50 responden, kira-kira 78% mempersetujui keupayaan OEE-SDST. Kesimpulannya, OEE-SDST berkebolehan untuk membantu pengamal LM mebuat keputusan.

ABSTRACT

Nowadays, Lean Manufacturing (LM) is a driving method for companies in order to succeed in global competition. Reducing as well as eliminating waste in production line using equipment is the main use of LM innovations. Having an expert in LM is a good way for companies to balance and maintain in order to deliver a good value to the customers. Nevertheless, some aspects are hard for the LM practitioner to evaluate the impact of LM tools at certain desired level after deciding and implementing appropriate LM. Hence, may negatively affect the resources and time consumed as well as cost. The aim of this study is to suggest a simulation framework of LM tools for LM practitioners which are Overall Equipment Effectiveness (OEE) in simulation-based decision support tools (SDST). The architecture of OEE-SDST based on the original framework of OEE concepts by Nakajima (1988). Integrating the average cost by relating OEE efficiency is a one of the new introductions in OEE concepts. The design and development will be built on the Microsoft Visual Basic 2010. The OEE-SDST will operate as graphical user interface(GUI). The usability study of software capability criteria based on ISO/IEC 25010:2011 or ISO/IEC 9126 that consist of understandability, learnability, operability, and attractiveness. Based on the 50 respondents, about 78% are agreed with capabilities of the OEE-SDST. To conclude, OEE-SDST capable of assist the decision making for the LM practitioner.

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May Allah bless us all.

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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

ANP	-	Analytic Network Process
DES	-	Discrete Event Simulation
GUI	-	Graphical User Interface
JIT	-	Just in Time
LM	-	Lean Manufacturing
LP	-	Lean Principle
LT	-	Lean Thinking
OEE	-	Overall Effectiveness Equipment
SDST	-	Simulation Decision Support Tools
TQM	-	Total Quality Management
TPM	-	Total Production Maintenance
TPS	-	Total Production System

CHAPTER 1

INTRODUCTION

This chapter basically explains the introduction of the study that includes the motivation, scope, the problem statement and objectives of the study. The title of study is about a proposal of OEE simulation decision support tools for lean practitioners.

1.1 Motivation of the Study

Today, organizations search the approaches to enhance their production and management process in order to stay competitive in markets. A year ago, Global Manufacturing (2014) has published the top ten company achieved success in applying LM in their organization. Therefore, for the top ten organizations are from Nike, Kimberley-Clark Corporation, Caterpillar Inc., Intel, Illinois Tool Works, Textron, Parker Hannifin, John Deere, Ford and the first most successful LM practice is Toyota. The successful LM practice gave path for other organizations to achieve competitiveness and seeks strategy to access all the capability to reduce the cost especially tackling the waste issues. This related to the decision making for organization in order to determine good result. The good decision making will provide organization toward brilliant achievement. Previously, the main issue faced by organization is waste. In manufacturing non-value added activity described as waste which may contribute the increasing of cost (Yuniawan, 2014). Therefore, decision making by organization identify the concept to reduce non-value added process

for entire production as well as improving productivity. LM addresses by the organization in order to improve the organizations with an excellent starting point for companies to seek an improvement of their current manufacturing methods which depends greatly on flexibility and workplace organization (Bosch Rexroth Corporation,2009). Organization which desire to apply needs to conquer and understand the Lean principle (LP). LP is the heart inside the lean manufacturing. It derived from the Japanese manufacturing industry where it is a set of tools which contribute to the elimination of waste. The type of waste elimination in Japanese called as 'muda' described by Taichi Ohno. Ohno is an engineer in Toyota Motor since 1953 defined seven types of waste which are transportation, inventory, motion, waiting, over processing, overproduction, and defects. The seven types of waste are capable to reduce non-value added activity by eliminating waste and continuously improving the process (Keyte et al., 2004).

The total productive maintenance (TPM) is one of the tools in part of LM. In early 1951 TPM can trace preventive maintenance that was introduced in Japan. (Ali et al.,2010). TPM usually uses overall equipment effectiveness (OEE) index to measure the effectiveness of equipment. The Japan Institute of Plant Maintenance (1971), mentioned that OEE eliminate the six big losses that indicated by Nakajima (1988), such as down time that caused by equipment failure, set-up and adjustment. It also measures the speed losses such as owed by idling, minor stoppage, reduced speed and defects that caused by process defects (Yuniawan, 2014). OEE typically advances from a base measure for efficiency (Sohal et al., 2010). Thus, OEE is an initial purpose or a tool to improve effectiveness for analyzing data to support the objectives in TPM.

1.2 Problem statement

The existing literature lacks of systematic approach and analytical model in order to select an appropriate LM strategies. These strategies are for identifying manufacturing wastes within manufacturers resource constraints (Ttacks, 2009). The impact of LM tools implementation may be difficult and complex.

Besides that, implementations of LM, organization sometimes do not meet the positive results. Moreover, the organizations encountered difficulties to decide the appropriate LM tools and technique within their limited knowledge of lean thinking (LT) and lean principles (LP) (Aulakh et al., 2008).

Expert decision makers not always available for delivering the LM concepts is challenging for manufacturer (Wang et al., 2008). Thus, the decision making will be based on intuition and experience from others.

The gap between LM practitioners and simulation approaches who are expert in using simulation software may lead to development of a biased simulation model (West, 2000). Consequently, knowledge and expertise about the system may be limited to the people who do not develop a simulation

Hence, in order to synthesize precise decision making, an integrated of LM support system tools that can be use for LM practitioner even it lack of knowledge. Thus, the concerning of these issues will be solved by developing a SDST.

1.3 Objectives

In order to achieve the overall study, the following objectives have been set for the purpose study;

1. To propose a framework of OEE-SDST
2. To design and develop OEE-SDST
3. To conduct usability study on OEE-SDST

1.4 Scopes

The study focus on LM tools and techniques which is OEE. The original OEE framework by Nakajima (1988) is a driver for architechture of SDST framework study in order to assist the LM practitioner for easy decision making. This is to obtain utilization for reducing waste in manufacturing production. The design and development will be built using Microsoft Visual Basic 2010 in the form of Graphical User Interfaces (GUI). The set of OEE metric functions consist of availability, performance and quality. The cost metric functions also intergrate in SDST in order to know the cost per part produce depend on the OEE percentage. Thus, this OEE-SDST will be used by LM practitioner to measure the effectiveness and efficiency in their identification problem toward implementation of the LM practices.

1.5 Gant Chart

The Gannt Chart shows the operation schedule to complete the study includes Master Projet 1 and Master Project 2. This study was conducted in 27 weeks shown in Appendix A.

1.6 Summary of Report Structure

In the chapter one, focus will be on the introduction of the study. This chapter will explain the introduction of the study which consists of problem statement, scope and objectives. This chapter also introduces the framework development which was implemented in order to achieve the objectives.

The chapter two is about literature findings. It also considered as critical points of current knowledge including substantive findings, as well as theoretical and methodological contributions to a particular topic. This chapter will also describe the whole information reviewed by other researcher. There are also details regarding fundamental of LM including their principles, tools techniques and simulation for decision making.

In the chapter three, the study would proceed on the method implementation from literature reviews and objective. It will cover the design and development of OEE-SDST.

The chapter four explains the result and discussion of study in OEE-SDST which consist of coding architecture development of each GUI form, procedure to use, example of data collection test analysis, and survey result from OEE-SDST usability study.

Lastly, chapter five describes the conclusion of the whole study and project report including the future work.

CHAPTER 2

LITERATURE REVIEW

This section will describe about findings of LM backgrounds including principles, techniques, and simulations in order to implement the SDST. The idea to implement SDST shows up practically with findings and knowledge between the researcher and other researchers.

2.1 Industrial Waste

According to Environment Protection Authority (2009), significant of waste can be summarized as unused material or energy. Waste described can be categorized as solid wastes which were transported to the landfill. The global solid waste are growing rapidly every year and the global solid waste generated about 1.3 billion tons of solid waste per year (Hoornweg et al.,2012). This volume is expected to increase to 2.2 billion tons by 2025. Increasing of solid waste affects the environment, especially in public health. Improper management of solid waste is one of the primary causes for environmental pollution and degradation in towns and cities, of the third world especially. Most country do not enforced solid waste regulations and proper solutions for disposal of waste, including hazardous waste (Selin, 2013).

Nowadays, industry have main objective which is to fulfill customer's needs. In industrial perspective, waste is defined as material not in use generated in processing or production such as metal, chemical, paper, rubber and woods (Safe Drinking Water Foundation,2009). The biggest and well known industry is from manufacturing sector. In United States, the amount of hazardous waste caused by manufacturing industries has increased from an estimated 4.5 million tons annually after World War II to 57 million tons by 1975. This information from Safe Drinking Water Foundation (2009) claims that the total had fluctuate increasing to approximately 265 million tons by 1990. Manufacturing is a process of transforming a raw material to form the final part or product according to the needs from the customers. In order to fulfill customer's needs, most manufacturing sector produces some product without concern about the waste effects. In manufacturing industries, waste can be related to energy, material, product, and waste flow as well as their associated costs (Piazza, 1992). The main crucial element industry sector is cost. The poor concern of the firms regarding waste in production may contribute to additional cost. When costing issues rises, the firms will make a decision to reduce it without proper strategy. Thus, the improper decision by firms may change into worst effect. The effect may occur which the firms reduce the number of workers and force the current workers work in more pressured environments. In addition, the impact will bring low productivity and produce low quality product that increase the defect that contribute to waste. Moreover, the low concern about the machine maintenance as well as placing the cost into objective.

The issues become popular when almost all industry tried to reduce as well as eliminating the cost that came from waste effect. In 1953, the young engineer from Japan, Taiichi Ohno, become an engineer in Toyota Motor visited the USA to study Ford's production methods. His task is to find knowledge of increasing productivity by driving in the

concepts of Just-In-Time and Jidoka in Toyota Motors. Later on, Ohno introduced the Toyota Production System (TPS). By 1974, Japan economy had collapsed to zero state growth. At that time, Toyota has suffered. However, Toyota was able to sustain their profit from 1975 to 1977 due to TPS implementation. The driving of TPS aimed for waste elimination by improving quality, cost, performance, safety and motivation. In TPS philosopy measures the waste in all factor consists non – value added of the product or service, whether in parts, labor or production process (Art of Lean, 2013). According to Ng et al. (2013) TPS assist in reducing cost and product lead-time by challenging and analysing every single process step flow.

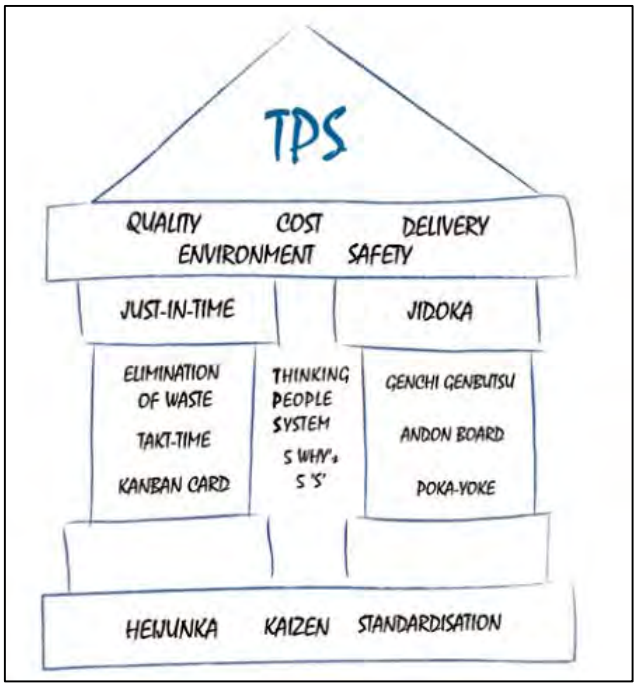

Figure 2.1: The House of TPS philosopy (Toyota, 2012)

TPS requires continuous effort in cost reductions to maintain the surplus of firms. Thus, TPS empowers team members to optimize quality by constantly improving processes and eliminating unnecessary waste in natural, human and corporate resources. It entrusts the

employees with responsibilities in each production step and encourage each team member to strive for overall improvement (Harris, 2007). Continuous improvement focuses on the elimination of seven major types of waste. The seven types of waste or can be known as 'Muda' by Ohno in Japanese language consists the waiting, overproduction, defects, motion, transportation, over processing, and inventory.

In recent years, many approaches to cut down waste in industry sector, especially in the manufacturing field. The approach effects in well organize management system towards the cost effectiveness and quality maintenance through the ware as good as eliminating waste due material throughput. After decades, the approach method to tackle the waste had widely been used in most of industry sector. The approaches consist of Six-Sigma, Total Quality Management (TQM) and Lean Manufacturing (LM). These three concepts were implemented in big companies successfully.

TQM, six sigma and LM have many similarities, especially concerning origin, methodologies, tools and effects, they differ in some regions. In particular, it concerns the main theory, approach and the main criticism. The LM concept is slightly different from TQM and six sigma. However, there is a lot to gain if organizations are able to combine these three concepts, as they are complementary (Andersson et al.,2006).