OVERALL EQUIPMENT EFFECTIVENESS DECISION SUPPORT TOOL FOR LEAN PRACTITIONERS

This report is submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Hons.)

by

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I hereby, declared this report entitled “Overall Equipment Effectiveness Decision Support Tool for Lean Practitioners” is the result of my own research except as cited in references.

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Author’s Name : KUA ANN NEE

Date : 26 June 2019

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for the Bachelor Degree of Manufacturing Engineering (Hons.). The member of the supervisory committee is as follow:

…….....

(Associate Professor Ts. Dr. Effendi Bin Mohamad)

ABSTRAK

Pada masa kini, Pembuatan Kejat adalah satu kaedah pemanduan bagi syarikat-syarikat untuk mencapai kejayaan dalam persaingan global. Pembaharuan dalam Pembuatan Kejat adalah untuk mengurangkan dan menghapuskan pembaziran dalam barisan pengeluaran dan meningkatkan produktiviti pengeluaran. Satu cara yang baik untuk mencapai keseimbangan dan mengekalkan syarikat adalah dengan mempunyai pakar dalam bidang Pembuatan Kejat untuk memberikan nilai-nilai yang baik kepada pelanggan. Walau bagaimanapun, kebanyakan syarikat mengumpul data secara manual dan mempunyai prosedur pengukuran yang rumit. Oleh itu, peningkatan produktiviti dan masa yang digunakan akan dijejaskan. Tujuan kajian ini adalah untuk membangunkan satu model sokongan membuat keputusan yang baru bagi alatan Pembuatan Kejat untuk pengamal Pembuatan Kejat iaitu Keseluruhan Keberkesanan Peralatan berasaskan alatan sokongan membuat keputusan (OEE-DST). Model OEE-DST adalah alat yang boleh dipercayai untuk membantu pengamal Pembuatan Kejat untuk memudahkan dan mempercepatkan proses dalam membuat keputusan untuk meningkatkan produktiviti. Rangka kerja model OEE-DST adalah berdasarkan falsafah Pembuatan Kejat. Reka bentuk dan pembangunan model OEE-DST telah dibina dengan menggunakan NetBeans dalam bentuk Antara Muka Grafik Pengguna (GUI). Penentusahan model OEE-DST telah dilakukan dengan menguji fungsi antara muka, sedangkan pengesahan telah dilakukan dengan menggunakan data yang dikumpul dari industri. Kajian kebolehgunaan model OEE-DST telah dijalankan dengan membina soal selidik. Penilaian perisian adalah berdasarkan ISO / IEC 25010: 2011 yang terdiri daripada kesesuaian yang dapat dikenali, keboleh-belajar, kebolehan operasi, perlindungan kesilapan pengguna, estetika antara muka pengguna dan kebolehcapaian. Berdasarkan keputusan soal selidik, majoriti responden bersetuju dengan keupayaan model OEE-DST. Secara ringkasnya, model OEE-DST adalah alat yang boleh membantu pengamal Pembuatan Kejat membuat keputusan.

ABSTRACT

Nowadays, Lean Manufacturing (LM) is a driving method for companies in order to succeed in global competition. The innovations of LM is to reduce and eliminate waste in the production line and improve manufacturing productivity. 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. However, most of the companies use manually recorder data and have complicated measurement procedures. Therefore, this may negatively affect the productivity improvement and time consumed. The aim of this study is to develop a new decision support model of LM tool for LM practitioners which are Overall Equipment Effectiveness Decision Support Tool (OEE-DST). OEE-DST model is a reliable tool to assist the LM practitioner for easy and speed up in decision making to improve the productivity. The framework of OEE-DST model is based on the LM philosophy. The design and development of OEE-DST model was built by using NetBeans in the form of Graphical User Interfaces (GUI). The verification of the OEE-DST model was done by testing the functionality of the interfaces, whereas the validation was performed by using data collected from the industries. The usability study of the OEE-DST model was conducted by constructing questionnaire. The evaluation of the software is based on ISO/IEC 25010:2011 that consist of appropriateness recognizability, learnability, operability, user error protection, user interface aesthetics and accessibility. Based on the results of the questionnaire, majority of the respondents are agreed with the capabilities of the OEE-DST model. In a nutshell, OEE-DST model is a tool which can assist the LM practitioners for decision making.

DEDICATION

The thesis is dedicated to:

My dearest family,

My Parents,

My Supervisor,

My Lectures,

And all my friends

Millions of thanks for their encouragement and support

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LIST OF ABBREVIATIONS

DST	-	Decision Support Tool
GUI	-	Graphical User Interface
IT	-	Information Technology
LM	-	Lean Manufacturing
OEE	-	Overall Equipment Effectiveness
TPM	-	Total Productive Maintenance
PDF	-	Portable Document Format
PNG	-	Portable Network Graphics
SVG	-	Scalable Vector Graphics
IoT	-	Internet of things
SQL	-	Structured Query Language
OS	-	Operating system

LIST OF SYMBOLS

min.	-	minutes
%	-	Percentage

CHAPTER 1
INTRODUCTION

This chapter is about the introduction of the study which includes problem statement, objectives and scope of the project. The title of this study is about the proposal of OEE decision support tool for lean practitioners.

1.1 Background of Study

Nowadays, Lean Manufacturing 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 practitioners to evaluate the impact of LM tool at certain desired level after deciding and implementing appropriate LM. Hence, this may negatively affect the resources and time consumed. The aim of this study is to develop a new decision support model of LM tool for LM practitioners which are Overall Equipment Effectiveness Decision Support Tool.

OEE is a term which was first described in the book 'TPM tenkai' by Seiichi Nakajima in the 1960s to evaluate how effectively a manufacturing operation is utilized. The meaning of OEE incorporates downtime and other losses in production which decrease efficiency (Ljungberg, 1998). The downtime and other losses in production are consider as waste, which do not add value to the products and reduce the effectiveness of machines. OEE is the standard for measuring productivity improvement for a given manufacturing operation. The productivity improvement depends on three categories of loss which are availability, performance, and quality.

OEE is a key measurement in the improvement approach called Total Productive Maintenance (TPM). In Japan, the idea of TPM was defined by JIPM throughout the 1970s from real world experience in several Japanese companies. TPM which is an idea for corporate change, likewise, incorporates a method for characterizing OEE.

1.2 Problem Statement

Although there are numerous researches carried out on LM, but there are only a few researches have been discovered focusing on the implementation of LM tool and methods (Nudurupati *et al.*, 2005). These reviews provide overall view of the choice and implementation of LM tool and methods in numerous industries and the elements that influence the determination process. The reviews also showed that there is not enough study on the choice of LM tool and methods by using rational decision-making process. Hence, further study is required on the choice of suitable LM tool and methods in view of a few essential decision measure (Yahya *et al*., 2016).

Besides that, improvement in the current LM tool is needed. The LM tool which is focused in this study is OEE. Most companies are starting with the OEE measurement manually which is difficult, and time is wasted in calculating the OEE score and thus delayed the decision-making process. In order to minimize the time wasted, a software can be used to calculate OEE automatically by inputting the data. However, implementation of LM tool are unsuccessful in many plants due to shortage of Information Technology (IT) support. The most significant obstacle for the implementation of the LM tool is the insufficient of IT platforms and the way people deal with the information. Therefore, IT has a high influence in the implementation of LM tool (Nudurupati *et al.*, 2005).

Furthermore, the software interface available in the market is difficult to learn or understand by the user especially those who are not expert in using the software since not everyone is expert in practicing the software. They are mostly the people who are seldom or never use computer. The interface can be modified and improved to become more user-friendly and easier-to-use so that people who are not expert in using the software can learn, understand and use the software more easily (Heilala *et al.*, 2010).

Nowadays, fast and efficient production networks are necessary in order to compete with other companies of the same field. The relationship between manufacturing organization and processes are become more complex and thus increases the quantity of the data used for making decision (Heilala *et al.*, 2010). To solve these problems of changes to the manufacturing organization and production, the appropriate solution is to develop a DST of a manufacturing basis to help in decision-making.

1.3 Objectives

The objectives of this study are:

1. To design and develop OEE-DST model.

2. To verify and validate OEE-DST model.

3. To conduct usability study on OEE-DST model.

1.4 Scopes

The LM tool and methods which is focused in this study is OEE. OEE is a performance metric that indicates the productivity of an activity or production line by depending on three dimensions of performance, which consist of availability, performance and quality. The framework of OEE-DST model is based on the LM philosophy. The design and development of OEE-DST model was built by using NetBeans in the form of Graphical User Interface (GUI). The verification of the OEE-DST model was done by testing the functionality of the interfaces. The data used to validate the OEE-DST model is collected from the industries. The usability study of the OEE-DST model was conducted by constructing questionnaire survey. The expected respondents to be participate in the questionnaire survey are the LM practitioners from the industries who will use the OEE-DST model. After the OEE-DST model is developed, LM practitioners can measure the effectiveness of the machines by implementing the OEE-DST. This study is focused on the

measurement of productivity losses within the manufacturing process in order to assist the LM practitioner for easy decision making to improve the productivity.

CHAPTER 2
LITERATURE REVIEW

This chapter will describe about the findings of OEE and DST and the combination of them can further improve the manufacturing productivity within the production line in the fourth industrial revolution.

2.1 The Fourth Industrial Revolution

The word “revolution” denotes sudden and radical change. Revolution have occurred throughout history when new technologies have become an awareness of the world and cause great changes in economic systems and social structures. The first industrial revolution marked the transition of muscle power to mechanical power which was triggered by the construction of railroads and the invention of the steam engine. The second industrial revolution which was triggered by the development of electricity and assembly line, made mass production possible. While for the third industrial revolution, which is also called the computer or digital revolution, was triggered by the development of semiconductors, mainframe computing, personal computing and the internet.

Now is the beginning of the fourth industrial revolution, which is characterized by so-called “Cyber-Physical Systems” (CPS) or information age. It is characterized by artificial intelligence, machine learning, the Internet of Things, autonomous vehicles, 3-D printing, nanotechnology and so on. A world in which virtual and physical production system collaborate with each other internationally has been created in the fourth industrial revolution and this allows absolute product customization and the development of new operating models.

As consumers, the efficiency of human lives has been improved with zero cost as new products and services has been created in this fourth industrial revolution. The social network, mobile platforms and apps, advanced analytics and Big Data, are making our life easier and more productive.

Back to the late 1970s and early 1980s, the revolution of performance measurement had been started due to lack of satisfaction with the old systems. The process of developing in the design of performance measurement had been carried on since then. In recent years, the implementation and utilize of the performance measurement has been getting more well-known and awareness (Nudurupati *et al.*, 2005).

2.1.1 Data collection

Data is the raw material of the information age. In 1996, digital storage became cheaper than paper storage. After 4 years later, only 25% of data was stored electronically. In 2007, the percentage of data stored had increased to 94% and continue to rise since

Most of the companies collect the data of machinery waste with their administrative maintenance system. The data recorded by the system is often the repair time of the machine, not the stoppage time of the machine. In addition, the data of major stoppages is recorded by operators in logbooks. However, these data collection do not provide any proper or relevant picture of the losses and their reasons. Furthermore, the data collection is of high quality in some factories as they refuse to accept the data collection from the operators and supervisors. A shorter time interval and an accurate method of collecting data are essential in order to achieve the desired data collection. Besides, different department of employees have different views of pattern of losses, especially operators. Sometimes operators may think that some losses might affect greatly on the equipment's efficiency, but they are proven wrong after the measurements of the data collection is carried out.

There are different ways of collecting data for the analysis of machine, which are automatic data collection or manual data collection. Wiendahl and Winkelhake (1988) stated that the utilization of machine can be expanded by using the automatic data

collection continuously. But due to the highly-priced and highly complexity of the automatic data collection, manual data collection is preferable in most industries as the data collected can be very detailed and the losses can be inspected thoroughly (Ljungberg, 1998).

2.2 TPM

TPM had been established by Nakajima (1988) to the United States as a method of improving equipment efficiency. The correct data of machine performance is important to the accomplishment of TPM activities for a longer period. The implementation of TPM cannot be utilize in the best way to solve problems that occur by the machines if the machine losses and their reasons are not identified or understood (Dal *et al.*, 2000).

TPM is a company-wide approach to deal with equipment maintenance that endeavors to accomplish impeccable production, which includes no breakdowns, small stops or slow running, defects and accidents. TPM increases the equipment efficiency by underline proactive and preventive maintenance. TPM is very effective in improving productivity and capability of the machines which includes increasing uptime, reducing cycle times, and eliminating defects. Significant outcomes had shown in the Japanese industries by the implementation of TPM. Nakajima (1988) stated that the overall utilization of machine has been increased from 60% to 90% which represents a great increase in production. The three important concepts of TPM are:

1. Maximizing the effectiveness of the equipment

2. Autonomous maintenance by operators

3. Small group activities

The concept of TPM was created by JIPM from the practical experiences of knowledges and skills gained in the Japanese industries. The implementation of TPM is a difficult change for most companies. The activities that make changes in most companies do not give the planned outcomes as expected. “Total quality” or “continuous improvement”

which is implementing in most of the companies has also failed to achieve the objectives (Ljungberg, 1998).

The conventional way to deal with TPM was produced during the 1960s and comprises of 5'S foundation and eight supporting activities which is often referred to as pillars. The activities planned in the TPM framework is a suitable foundation obtained from the machinery losses data (Ljungberg, 1998).

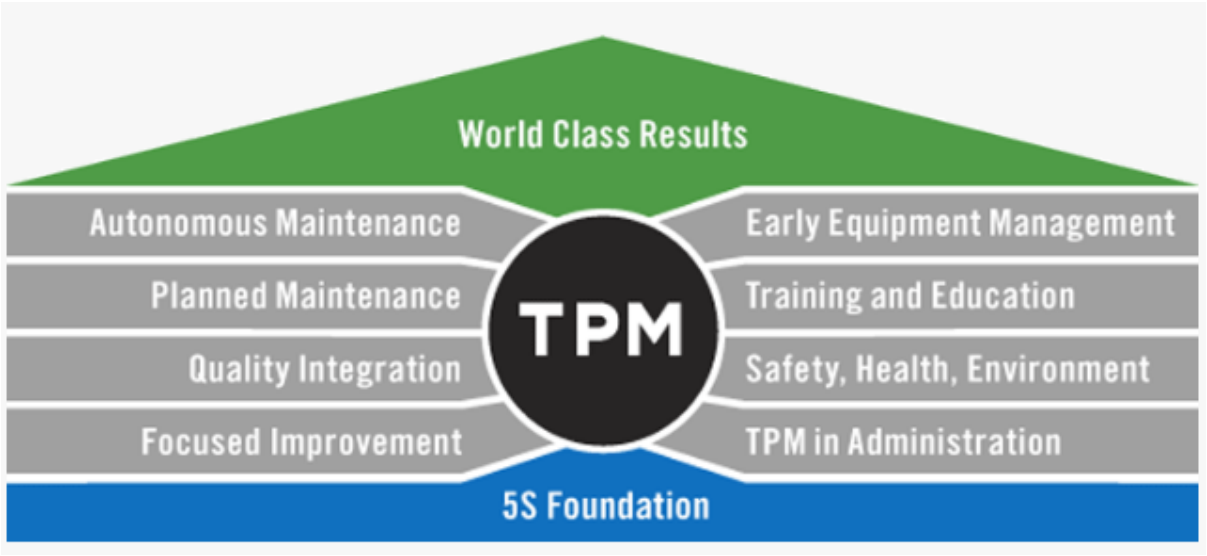

Figure 2.1: The eight basic pillars of TPM (https://www.leanproduction.com/)

2.2.1 The 5'S foundation

The objective of 5'S is to create a clean and well-organized workplace. 5'S is used to organize the workplace by applying the five elements which consists of Sort, Set in Order, Shine, Standardize and Sustain which is shown in Figure 2.2 below.