UNIVERSITI TEKNIKAL MALAYSIA MELAKA

A CASE STUDY OF CAUSES OF MANUFACTURING LOSSES IN PALM OIL MILL

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

by

ATHIRAH BINTI MOHD GHAZALI
B051110023
921127-10-6088

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APPROVAL

This report submitted to the Faculty of Manufacturing Engineering of UTeM and has been accepted as fulfillment of the requirements for the Degree of Bachelor of Manufacturing Engineering (Manufacturing Management) with Honours. The member of the supervisory committee is as follow:

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ABSTRAK

Kerugian pembuatan boleh ditakrifkan sebagai apa-apa masalah yang tidak dijangka atau lebih dikenali sebagai aktiviti bukan nilai tambah yang wujud semasa rutin proses pengeluaran. Ia boleh disebabkan oleh kerosakan jentera, kekurangan bekalan, kesilapan manusia, cuaca dan isu-isu lain yang syarikat sendiri mempunyai kebolehan yang berbeza-beza untuk mengawalnya. Untuk mewujudkan satu persekitaran yang mapan, syarikat-syarikat didesak untuk menguruskan proses pengeluaran dengan input yang berbeza, termasuklah tenaga, manusia, peralatan dan mesin. Kajian ini disediakan untuk mengenal pasti pelbagai punca kerugian pembuatan yang berasaskan tiga elemen penting dalam mengira satu Keberkesanan Peralatan Keseluruhan (OEE) yang memberi kesan kepada produktiviti syarikat terutama di kilang minyak sawit. Kaedah yang digunakan untuk kajian ini memberi tumpuan kepada tiga jenis pengumpulan data iaitu soal selidik, lawatan tapak dan pemerhatian, dan temu bual separa berstruktur yang kemudian dianalisis dengan melakukan analisis statistik. Seramai 28 responden telah terlibat dalam kajian yang telah dijalankan di beberapa buah kilang minyak sawit di Malaysia. Dua buah kilang minyak sawit telah dipilih untuk menjadi tempat untuk menjalankan kajian kes. Kemudian, pengesahan terhadap 10 sebab-sebab penting kerugian pembuatan wujud di kilang minyak sawit secara menyeluruh telah dibincangkan. Hasil kajian menunjukkan bahawa terdapat dua parameter OEE, iaitu faktor kerugian ketersediaan dan faktor kerugian kualiti yang boleh dianggap sebagai formula baru untuk mengira OEE. Akhirnya, keputusan juga menekankan ke arah permulaan yang perlu diambil oleh kilang minyak sawit untuk menghapuskan kerugian dan bagaimana kerugian boleh ditetapkan sebagai parameter untuk mengira OEE untuk tujuan penyelidikan lanjutan.

ABSTRACT

Manufacturing losses can be defined as any unexpected problems or so called a non-value added activities exists during the production process routine. It can be due to machinery malfunctions, supply shortages, human error, weather and other issues that companies have varying abilities to control. To be able to create such sustainable environment, companies are urging to manage production processes with sustainable inputs which include energy, people, equipment and machines. This study is prepared to identify the various causes of manufacturing losses which are based on three important factors in computing an Overall Equipment Effectiveness (OEE) that affect the company's productivity especially in palm oil mill. The methodology used for this study is focuses on three types of data collection which are questionnaire, site visit and observation, and semi-structured interview which are later is analysed by performing a statistical analysis. A total of 28 respondents have been involved in the survey of this study that has been conducted in several palm oil mills in Malaysia. There are two palm oil mills been selected to be the venue for conducting the case studies. Later, the verification of top 10 critical causes of manufacturing losses exists in palm oil mill is comprehensively been discussed. The results show that there are two parameters of OEE which are availability and quality losses factors that can be considered as new formula to compute OEE. Finally, the results is also stressing towards the initiation that should be taken by the palm oil mill in order to eliminate those losses and how do the losses can be set as a parameter to compute OEE for further research purposes.

DEDICATION

Special thanks for my supervisors and treasured friends.
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LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

°C	-	Degree Celcius
Lb/in² gauge	-	Pounds per Square Inch Gauge
MJ/kg	-	Mega Joule per Kilogram
mg.L¬	-	Milligram per Litre
CO_2	-	Carbon Dioxide
COL		Causes of Losses
CPKO	-	Crude Palm Kernel Oil
CPO	-	Crude Palm Oil
EFB	-	Empty Fruit Bunch
FFA	-	Free Fatty Acids
FFB	-	Fresh Fruit Bunch
FGD	-	Focus Group Discussion
GHG	-	Green House Gases
HOD	-	Head of Department
IBM	-	International Business Machines
KKS		Kilang Kelapa Sawit
LCA	-	Life Cycle Assessment
LCIA	-	Life Cycle Impact Assessment
OEE	-	Overall Equipment Effectiveness
OFE	-	Overall Factory Effectiveness
PKO	-	Palm Kernel Oil
PME	-	Palm Oil Methyl Ester
POM		Palm Oil Mill
POME	-	Palm Oil Mill Effluent
PSM	-	Projek Sarjana Muda
RPO	-	Refined Palm Oil
SPSS	-	Statistical Package for the Social Sciences
TPM	-	Total Productive Maintenance

CHAPTER 1

INTRODUCTION

This chapter provides the background, objectives, scope and importance of the study. Besides, it is basically giving brief information about overall efficiency and sustainability in a palm oil mill industry.

1.1 Background

Modern manufacturing is under increasing pressure have to be adaptable not only to the needs of the market, but also the growing requirements for the overall efficiency of enterprises, products and processes in achieving growth in economically, environmentally and socially viable (Westkämper, 2008). Interdependence of economy, social, and environment is referred to as the three pillars of sustainability. Economic sustainability promotes profitability through minimizes resources consumption, such as materials, energy, water, and land, while environmental sustainability eliminates toxic substances and produces zero waste that in effect reduces greenhouse gases, for example, carbon intensity, across the entire life cycle of products and services. Social sustainability responds to the needs of employees, communities, and consumers.

In particular, to achieve sustainability, manufacturing organization needs to design and adopt specific policies and procedures to guide the internal practice. One important aspect the organization needs to contemplate is the performance of the portfolio assets which in fact has a significant impact in this context (Zhu, 2011).

Instead of maximizing over time, add up shifts for workers, or buy new equipment as their solution for capacity problems, the manufacturing companies nowadays should focus on optimizing the performance of their existing machines to increase equipment reliability, lower the time of the changeover, improve operator performance, and minimize overall downtime. Due to this, the manufacturing plant can spend its fruitful time and money in the manufacturing process and thus lead to an increment in dividend payments.

1.2 Problem Statement

Production of palm oil is expanding rapidly to fulfill worldwide needs not only for cooking oil and food ingredients, but also for biofuels, soap and other chemicals. There is growing awareness that the greater production of palm oil can increase the risk of destruction to environment, causing adverse impacts on biodiversity and climate change. For this reason, pressure for sustainable environment of Palm Oil Mill (POM) are getting serious primarily driven from stakeholder engagement, market competition, changing needs of sustainable palm oil (Oosterveer, 2014). Sustainable environment in the manufacturing are focused on managing the production processes with sustainable input such as energy, people, equipment and machines, coupled with the objective of reducing waste, rework, inventory and delays as well as reducing the environmental footprint (Gunasekaran and Spalanzani, 2012).

Overall Equipment Effectiveness (OEE) as key performance indicator is widely used in manufacturing because it monitors the actual performance of an equipment relative to its performance capabilities under optimal manufacturing conditions through three fundamental measures, which are availability, performance and quality to eliminate the six big losses (Raguram, 2014). It has been observed that the application of OEE is gaining increasing interest and considerable relevance for sustainability in manufacturing. This is because the changing needs of environment sustainable manufacturing recently have been putting great pressures on the organization to adapt proactive strategies for meeting the global requirements. OEE have no direct impact on power consumption and other utilities or the amount of generated waste resulting from the applied manufacturing technologies.

It is nevertheless, implemented to a system for analysing production data to identify potential areas of improvement and contribute to the reduction of environmental aspects identified in the organisation (Jasiulewicz-Kaczmarek and Drożyner, 2013). Thus, characteristically, OEE advances from a base measure for efficiency as the initial purpose, to being a tool to improve effectiveness to support environmental sustainability via the identification and elimination of losses and wastes. The combination of system availability rate, equipment performance rate, and production quality rate are the three essential factors for OEE measurement and each of these factors can be translated in all three perspectives of sustainable manufacturing. However, OEE measurement may differ amongst applications as data may not be available or feasible to collect in the form required for each formula (Zuashkiani *et al*. 2011).

Palm oil mills in Malaysia process the fresh fruit bunches (FFB) received from the oil palm plantations into crude palm oil (CPO) and other by-products. Two products are produced in a palm oil mill. There are CPO and palm kernel. Palm kernels are processed at palm kernel crushing plants into palm kernel oil. A few palm oil mills in Malaysia have also included in their operations the palm kernel crushing facilities. The process of extraction of CPO begins with the collection of ripe FFB that are harvested from the oil palm plantations and transported as soon as possible to the palm oil mills for immediate processing. The processes involve five major operations; fruit separation, sterilization, digestion, oil extraction and oil purification.

However, Fazeeda (2011) found that the actual production capacity is higher than the planned production capacity in the mill. Several factors detected which include lack of materials or input supplied which is mainly the FFB due to replanting, climate factors and shortage of labors at that particular time and it may also due to the breakdown of machines that led to downtime loss. The downtime loss either it is planned or unplanned may create disturbance to production, loss in productivity and increase expenses (Babbs and Gaskin, 2008). In the mill, there are more than 50% unutilized machines which breakdown as the main factor and the maintenance will be conducted only when these machines failed (Owolarafe, 2011). Baluch (2012) in his research study had used OEE as the maintenance measurement tool to evaluate performance in Malaysian palm oil mills particularly on how it helps in identifying the factors contributing to poor performance and validates how to advance the productivity, benefits and sustainability of the company.

Zandieh (2012) stated that the equipment which arranged in a continuous line of particular processes can produce valuable products which need some key tool as performance measurement and found that OEE is the most accepted metrics in the field. Thus, for this study, it is crucial to determine the causes of manufacturing losses present during operation to produce the primary product of palm oil which is CPO. Therefore, it totally deserves serious research attention to meet the best manufacturing practices, examine losses in operation besed on the computation of OEE towards the maintenance management and sustainability environment practices and thus provides greater insights from the Malaysia context.

1.3 Research Question

The research questions can be specified: What are the current statuses (state of the art) of palm oil manufacturing practices in a Malaysia, especially issues of environmental sustainability problems and barriers faced by Malaysian palm oil industries. In particular, what is the need and existence of any possible gap for palm oil products to sustain the highest environmental improvement?

How the improved manufacturing process information model will be used to examine the impact of environmental factors relation to palm oil industries. Different countries create different style of quality improvement practices, which mainly based on different cultures, infrastructure, and government policies. As a developing country, Malaysia is much lagging behind other industrial countries in practicing manufacturing quality tools, techniques and approaches.

Several questions can be used in order to obtain data for later analysis. These include:

i. What is the average of main products output, by-products, and raw materials for the past three years?
ii. What is the production performance of the organization for the past three years?
iii. What are the causes of losses in manufacturing system for the organization?

1.4 Objectives

i. To classify the causes of manufacturing losses exists in palm oil mill operation into three factors in computing OEE.What is the production performance of the organization for the past three years?
ii. To determine the correlation between causes of manufacturing losses in the oil palm process flow.
iii. To verify the tangible causes of manufacturing losses in the palm oil mill operations.

1.5 Scope

This study is conducted in Palm Oil Mill factory. It focuses more on the study of causes of losses in palm oil mill operation, determination of correlation between those losses exists and the verification of tangible causes of losses on the palm oil mill operation. For data collection, several methods like questionnaire, observation, and semi-structured interview from company will be used. The duration of this study is almost one year, which started on September 2014 and ended on June 2015. The result can be used as a reference for a further study and research. The result may not apply for other industries which have different business operation and measure indicator.

1.6 Significance of Study

The importance of this study is as follows:

i. As a reference tool for palm oil mill industries related to manufacturing losses.
ii. As a reference on how of the causes of manufacturing losses are correlated between each other in palm oil mill factory.
iii. For readers who want to understand how manufacturing losses can be translated and verified into the palm oil mill operations.

CHAPTER 2

LITERATURE REVIEW

In this chapter, it discusses the overall equipment effectiveness definition, concept, philosophy and causes of losses in manufacturing. It also covers some information about palm oil mill manufacturing in Malaysia. Besides that, it explains about the translation of overall efficiency in palm oil mills.

2.1 Definition of Overall Equipment Effectiveness

Overall Equipment Effectiveness (OEE), introduced by Seiichi Nakajima (Nakajima, 1988), the "father" of Total Productive Maintenance (TPM) in 1989 and 1990, and had developed several publications, books, conference presentations, and seminars related to TPM through the 1990s. OEE is the traditional evaluation measure of the Total Productive Maintenance (TPM) that has to be increased and it estimates the operating level with the ideal potential of the plant performance. OEE is defined as a measurement of total (*complete, inclusive, whole*) equipment performance and can be applied to manufacturing, petrochemical processes, and environmental equipment (air pumps, chillers, sewage plant, etc). OEE is simply can be said as a measurement and evaluation of performance, which indicates the current status of production by performing some calculations (Relkar and Nandurkar, 2012).

Three factors that define OEE are system availability, equipment performance and production quality, focused upon addressing the six major losses (breakdowns, setup and adjustments, small stops, reduced speed, start-up rejects and production rejects) associated with the manufacturing operation. According to Dal *et al*. (2000), these losses affecting the efficiency of the machine, energy consumption, material usage, quality of products, labor efficiency and the timely utilization of the overall process. The effective equipment or asset management is essential in streamlining manufacturing and garnering sustained profits in economic, environmental and social dimensions as stated by Sahoo and Parida (2010).

According to Vorne Industries (2008), the generally accepted World-Class of OEE is considered to be 85%, but the worldwide studies shows that the OEE rate for manufacturing palnts is 60%. The world class rate for each factor are shown in Table 2.1.

Table 2.1: World class OEE (Vorne Industries , 2008)

OEE Factor	World Class
Availability	90.0%
Performance	95.0%
Quality	99.9%
OEE	85.0%

2.1.1 System Availability

Availability in manufacturing system refers to the operating time (runtime) of equipment for the scheduled production. System availability is heavily affected by equipment downtime. Downtime losses happen when a breakdown arises, and an unplanned maintenance task must be done in addition to the set-up and adjustment time occurs. These activities reduce equipment availability and hence, affect the OEE of the firms.