Faculty of Manufacturing Engineering

PROPOSAL OF EFFECTIVE MAINTENANCE PLAN FOR ENHANCING OVERALL EQUIPMENT EFFECTIVENESS AT PALM OIL MILL

Jamadeel Izwan Bin Ibrahim

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PROPOSAL OF EFFECTIVE MAINTENANCE PLAN FOR ENHANCING OVERALL EQUIPMENT EFFECTIVENESS AT PALM OIL MILL

JAMADEEL IZWAN BIN IBRAHIM

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Alamat Tetap:

MP 1101 Jalan Melaka Perdana 7,

Taman Melaka Perdana,

78000, Alor Gajah, Melaka

Cop Rasmi:

ASSOC. PROF. DR. MOHD RIZAL BIN SALLEH
Associate Professor
Faculty Of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka

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DECLARATION

I declare that this thesis entitled "Proposal of Effective Maintenance Plan for Enhancing Overall Equipment Effectiveness at Palm Oil Mill" 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 the candidature of any other degree.

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APPROVAL

I hereby declare that I have read this dissertation/report and in my opinion, this dissertation/report is sufficient in terms of scope and quality as partial fulfilment of Master of Manufacturing Engineering (Manufacturing System Engineering).

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Supervisor Name : ASSOC. PROF. DR. MOHD RIZAL BIN SALLEH
Associate Professor
Faculty Of Manufacturing Engineering
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DEDICATION

To my beloved mother, wife, and son.

ABSTRACT

Every company, be it manufacturing or service-oriented will be looking for its best ways to improve profits without increasing the business capital. The management team will work at their best to think and execute any alternatives that can increase productivity at the same time having the concept that can save cost, time and energy. It is undeniable that machines have contributed a lot to increasing productivity, but if it is not well-maintained, it will not serve the purpose. This study emphasizes reducing the downtime in *Kilang Sawit Kota Bahagia* (KSKB) Palm Oil Mill caused by the breakdown of the production. The downtime data for the year 2017 showed that downtime has increased from January until December especially during the months of July, August, October and November where the hours of downtime were 10, 15.5, 15 and 15 hours respectively . The objective of this study is to identify the potential causes of the downtime by using the Ishikawa Diagram and Pareto Chart. Additionally, the performance of the machines related was assessed using Overall Equipment Effectiveness (OEE) Analysis. The Total Productive Maintenance (TPM) method was proposed to overcome the downtime problem with the implementation of 5S, Planned Maintenance and Autonomous Maintenance for two months of the trial period. Finally, the proposed method was evaluated and the result indicated that there was an increment of machine's OEE for example; screw press machines from 6.4% to 30.5%.

ABSTRAK

Setiap syarikat yang berasaskan pembuataan mahupun menyediakan perkhidmatan akan mencari kaedah yang paling optimum untuk mengurangkan penggunaan modal di dalam pengurusan kewangan syarikat. Pihak pengurusan akan memikirkan kaedah terbaik yang dapat meningatkan produktiviti tetapi didalam masa yang sama meminimumkan penggunaan kos, masa dan tenaga. Tidak dapat dinafikan teknologi mesin pembuatan yang terbaru dapat meningkatkan produktiviti tetapi sekiranya tiada pengurusan penyelenggaran yang efisien hasil yang diharapkan tetap tidak dapat dicapai. Kajian ini memberikan tumpuan terhadap kaedah yang mampu mengurangkan masalah masa terhenti semasa proses pengeluaran yang dihadapi oleh Kilang Sawit Kota Bahagia yang disebabkan oleh kerosakan mesin-mesin. Berdasarkan data 'masa terhenti' yang dijana pada tahun 2017 menunjukkan peningkatan sepanjang bulan Januari sehingga Disember terutamanya pada bulan Julai dan Ogos, dimana masa terhenti bagi dua bulan ini adalah 10 dan 15.5 jam manakala bagi kedua-dua bulan Oktober dan November adalah 15.5 jam. Objektif kajian ini adalah untuk mengenalpasti punca-punca yang mungkin bagi masa terhenti tersebut dengan menggunakan Rajah Ishikawa dan Carta Pareto. Prestasi keupayaan mesin pula akan diukur menggunakan analisis *Overall Equipment Effectiveness (OEE)*. Cadangan menggunakan kaedah *Total Productive Maintenance (TPM)* telah diusulkan kepada kumpulan pengurusan kilang untuk digunapakai selama dua bulan untuk mengkaji perbandingan dan melihat perbezaan pengeluaran kilang. Kajian akan memberi fokus kepada tiga elemen iaitu 5S, Penyelenggaraan Terancang dan Penyelenggaraan Autonomi. Akhirnya, kaedah yang dicadangkan tersebut dinilai dan keputusan mendapati terdapat peningkatan pada OEE mesin. Sebagai contoh, *OEE* bagi mesin *Screw Press* meningkat daripada 6.4% kepada 30.5%.

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Finally, yet importantly, I would like to give a special and greatest thanks to my wife and family for their moral support, understanding, motivation, and patience, in which without their support and love we may not be able to complete this dissertation. May Allah s.w.t. reward you all for what the thing that you all had done.

Amin.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

CPO	Crude Palm Oil
EFB	Empty Fruit Bunch
EFQM	European Foundation for Quality Management
FFB	Fresh Fruit Bunch
ISO	The International Organization for Standardization
JIPM	Japan Institute of Plant Maintenance
KSKB	Kilang Sawit Kota Bahagia
MCCB	Moulded Case Circuit Breaker
OEE	Overall Equipment Effectiveness
QMS	Quality Management Systems
SFB	Sterilised Fruit Bunch
SMED	Single-Minute Exchange of Dies
THP	Tabung Haji Plantation
TPM	Total Productive Maintenance
WIP	Work in Progress

CHAPTER 1

INTRODUCTION

1.1 Background

This research is expected to be conducted as an industrial based project with *Tabung Haji Plantation – Kilang Sawit Kota Bahagia* (THP-KSKB) Palm Oil Mill. Basically, the research is about the analysis before and after the improvement of the mill's performance after Lean manufacturing philosophy adapted via Total Productive Maintenance and Visual Stream Mapping.

In the palm oil industry, there are several machines or equipments that are used for palm oil processing. For example, the screw press is the main equipment that is used to separate the oil and solid waste from the palm fruit and the process is called press cake. The process at the screw press will produce are a liquid which consists of crude palm oil and water and solid which consists of mesocarp fibre, nuts, broken kernel, and shell. One of the main issues faced by the mill is unnecessary unpredicted breakdown of those machines due to various reasons. Some of the reported cause of machines breakdown are broken drive shaft, wear and tear, leakage at joints, low hydraulic pressure, loose chains and broken coupling module. Usually, the machine breakdown occurs due to the unintentionally occurrence of external objects such as stone, iron bar, a wrench and gravel that cause by poor housekeeping and maintenance. Other than that, the causes of the breakdown are loose thread, worn disc plate, clogging due to overfeed and leakage of gearbox (Harun et.al, 2015).

However, current solution taken by the mill is to repair on the spot for the machines breakdown. The maintenance unit will only act if there is breakdown happened. There were no serious or solid solution planned and taken by the company. This matter has brought the attention of the researcher to suggest potential action plan that could improve the performance of the process. Therefore, the aim of this project is to identify the root cause of the breakdown and to propose possible solution in order to solve the issue.

1.2 Problem Statement

The palm oil mill is where the processes of producing crude palm oil took place by using processing machineries which contains involved series of processes starting from loading fresh fruit bunches (FFB) from the plantations and ending with crude palm oil and kernel storage. The current production capacity of *Kilang Sawit Kota Bahagia* (KSKB) Palm Oil Mill is 30 matrix tones per hour and the working hours is 16 hours per day with two shifts of operations. The mill operates six days per week. In ideal case, the mill should manage to finish processing crude palm oil by the available working hour. However, the ideal case would not happen as problems occur almost every day due to the production breakdown or planned downtime. This breakdown are caused by equipment and mechanical failure.

Planned downtime may refer to any schedule downtime controlled by the management while the unplanned downtime refers to unplanned shutdown or stoppage happened to the operation due to the equipment or mechanical problems (Fazeeda et al., 2015). The downtime may create disruption to the planned production schedule and ultimately will increase the unnecessary operation cost such as overtime payment, electricity and etc. The occurrence of failure, whether serious or not, results in uncertain losses in terms of money, time and life. Maintenance is thus necessary to reduce losses (Ding et. al, 2014).

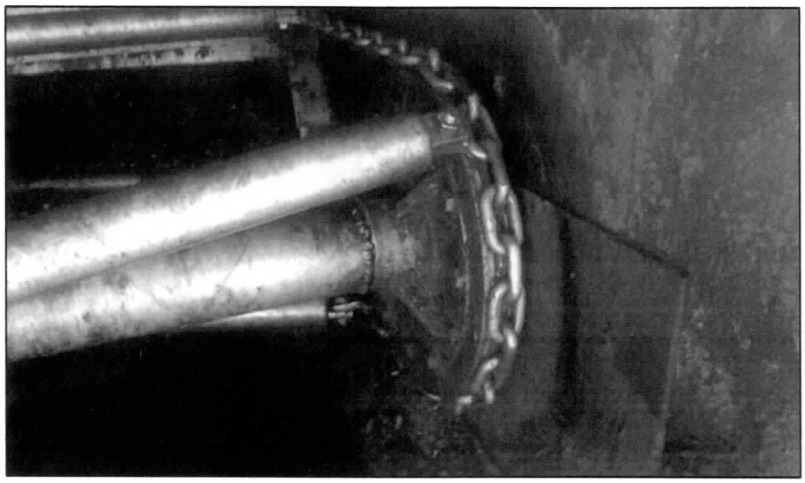

Figure 1.1: Loosed conveyor belt due to poor maintenance

In KSKB Palm Oil Mill, there are no scheduled maintenance are performed and the failure or damage of the machine will only be detected and repaired during breakdown. Sometimes the downtime dragged too long in order to find the root cause of the breakdown or machine failure. Figure 1.1 shows an example of damage happened in of the conveyor in KSKB Palm Oil Mill.

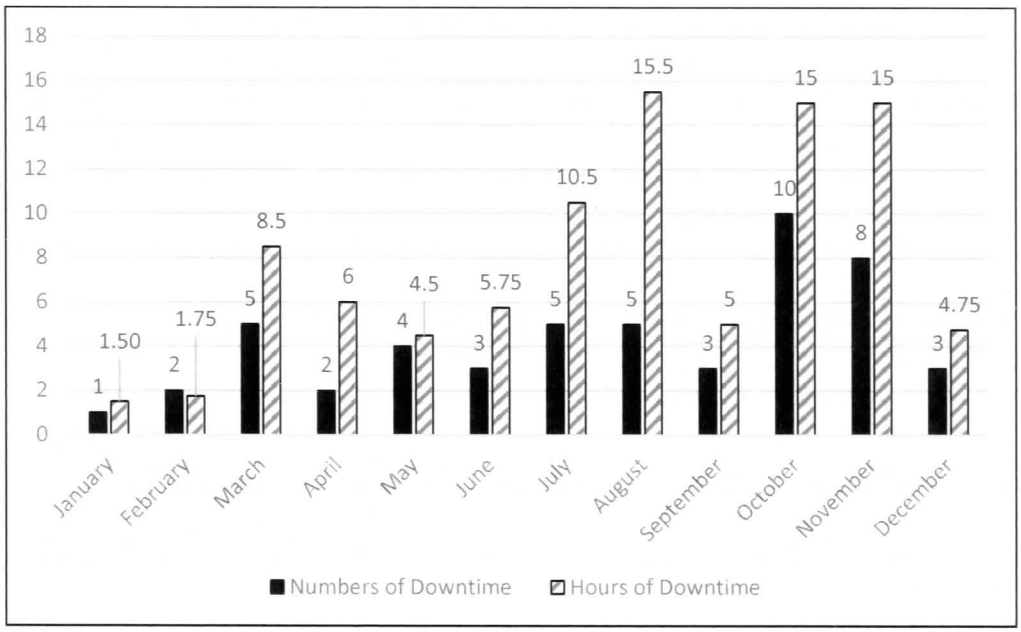

Figure 1.2: KSKB Palm Oil Mill's Downtime Data 2017

Figure 1.2 shows the number of downtime occurred in KSKB Palm Oil Mill in the year of 2017. From the graph, it can be comprehended that the numbers of downtime occurred during 2017 are increasing from January until December. The hours of downtime in January and February were just 1.5 and 1.75 hours respectively but during March the hours of downtime was significantly increased to 8.5 hours. The following months April and May, the hours of downtime recorded a slight decrement which was 6 hours and 4.5 hours respectively. Then, it increased again in June and July which was 5.75 hours and 10.5 hours one-to-one. August, October and November recorded the highest hours of downtime within the year which was 15.5, 15 and 15 hours respectively. Meanwhile, in September and December it was reported for 5 and 4.75 hours of downtime correspondingly. From this data, it can be understood that the increasing numbers and hours of downtime created problems to the KSKB Palm Oil Mill.

The downtime caused by machine breakdown is risky to any manufacturing companies. 'Downtime' recognized as any unplanned occasion that halts production for certain period. Operator's fault, poor maintenance, hardware or software error and 'perceived downtime' were among causes of unplanned downtime, which includes poor performance or slow changeover. In spite of everything, the old saying that compares time to money is correct. According to Elliot (2014), downtime costs the world's top companies billions in revenue every year. Then products are not being made unless the people or machines are not in idle condition, which surely affects the business's outcome.

When downtime happens, it can cause delays to the production. Due to these delays, work activities are finished than the time scheduled. The delays in workstations affect the whole production system and lead to deviations from target throughput (Ozkok, 2013). This downtime also will contribute to the risk that faced not only to the organization, but by its customers as well.

The organizations and their customers should aware that they have enough stages to cover. Customers could find themselves insufficient funds when dealing with the repairs and business disruption significances of the breakdown should the worst happen and these crucial systems fail. Furthermore, a machine's breakdown that cause downtime exact cost is occasionally hard to measure. Recently, in a general survey conducted by Chola MS Risk Services, it shows that the cost for a machine breakdown is more expensive than the cost of maintenance labour and materials to make the repair. A recent survey showed the actual cost for a breakdown between four to fifteen times the maintenance costs (Oliveira et.al, 2016). When the breakdown causes production to stop, the costs to repair are very high because output produced and thus compromise the income of the company.

In order to overcome downtime and breakdown during operation, Total Productive Maintenance (TPM); one type of Lean Manufacturing tools is something that can be considered as the possible solution. TPM has been acknowledged as one of the important operation strategy to recover the production losses due to equipment inefficiency (Seng et. al, 2005). A lot of organizations have applied TPM to improve their equipment efficiency and to acquire the viable benefit in the global market in terms of cost and quality. In the highly competitive environment, organizations must possess both efficient maintenance and effective manufacturing strategies to be successful and to achieve world-class-manufacturing (Ahuja & Khamba, 2008).

1.3 Objectives

This study embarks on the following objectives:

i. To investigate the potential causes of downtime at KSKB Palm Oil Mill.

ii. To measure the equipment effectiveness of KSKB Palm Oil Mill.

iii. To suggest the maintenance plan based on Total Productive Maintenance method.

1.4 Scope of Study

The research proposed is an industrial based project and will be conducted at Tabung Haji Plantation (THP) – *Kilang Sawit Kota Bahagia* (KSKB) Palm Oil Mill only. The Lean Manufacturing tools that will be used in solving this problem are Total Productive Maintenance (TPM). The solution will be proposed based on the previous case study. The delimitation in this study would be the continuous manufacturing process in Palm Oil processing. The study need to relate and adjust with the ordinary manufacturing process such as discrete or batches manufacturing.

1.5 Significance of Study

This topic was chosen because researcher has undergone an Industrial Attachment at one of Palm Oil Mill for about six weeks duration. During that time, researcher had preliminarily observed several situations in the production which consist numerous wastes that affected the palm oil production efficiencies. Then, some ideas arose to improve the said situation by implementing Lean Manufacturing at the mill and utilise appropriate Lean Tools.

After some thoughtful discussions with KSKB Palm Oil Mill management team, they were more than agreed and willing to cooperate if the research can improve current situation at their mill. Furthermore, there were only few studies that relate to palm oil mill and lean production. Indirectly, this research also will contribute to the Malaysia's palm oil industry since Malaysia is the second largest producer of crude palm oil.

The type of research that researcher would plan to do on this topic is applied research. Certain process or department will be selected as subject matter to implement the TPM. Current process data will be recorded first prior to TPM implementation. Then, new data (after TPM implemented) will be compared to the old data (before the TPM implementation) and the changes will be recorded.

1.6 Research Planning

The planning of the research is described later on in the flow chart in Chapter 3 and Gantt chart in Appendix A. This is just an overview plan of the project since a detail plan will be explained once the project is executed.

CHAPTER 2

LITERATURE REVIEW

2.1 Palm Oil Mill

The occasion of large-scale fully mechanised palm oil processing came from the founding of plantations, which delivered the evolution of a sequence of processing steps. The machineries were designed to extract, from a harvested palm oil fresh fruit bunch into a high yield of a product of acceptable quality which is called crude palm oil. The process, generally implicates the reception of fresh fruit bunches (FFB) from the plantations, sterilizing and threshing of the bunches and pressing out the crude palm oil. The crude palm oil is then treated to purify and dry it for storage and trade.

Palm oil mill began its development at the early nineteenth century when the potential of palm oil were realized, alike in Europe and America. Nowadays, Malaysian engineers are able to provide process systems designs in Palm oil mill to reach lower production cost, train and organize a stable work force, which will maintain the efficiencies of the oil palm mill and produce the best quality product at maximum yield extraction within the minimum cost. Whilst Palm Oil Mill operation face many challenges nowadays especially, both management and the operation of the oil palm estates and palm oil mills need effective team work, fruitful synergy effect on each other, cross- functional responsibility and accountability, inter personnel co-operation and relationship, reduced bureaucracy and resources utilization (Baluch et. al, 2010). Hence, it is a commitment for a manufacturing or production company to have a decent, systematic and steady maintenance program to control breakdown in order to stay competitive in the market.