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CONTENTS

Machine Maintenance Policies in Local Sugar Manufacturing: A Case Study of Madukismo, Indonesia

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Abstract. This study aimed to analyze the factors that cause un-optimal on a maintenance of machinery in P.G Madukismo. An engine maintenance which was carried out by P.G Madukismo for 6 months, had not been able to suppress an engine stop time. In 2016 the planned engine stop time in P.G Madukismo was on 88.8 hours, but in reality the P.G Madukismo engine stopped clock reached on 179.44 hours during a milling season.

By exploring a case study approach, data collection was examined by interviews, observation and documentation. The data collected was analyzed using the reduction, data presentation and concluding withdrawal stages. The results of this study indicated that the main factors that caused engine maintenance had not been optimal because the useful life of the machine had been exhausted and preventive maintenance that was carried out cannot replaced all engine components that were damaged or worn. In addition, P.G Madukismo also did not have a SOP related to machine maintenance. Efforts that had been made to optimize machine maintenance were preventive maintenance, which was carried out not only outside the milling season but also during the milling season and provided training to employees to improve employee capabilities.

Keywords: machine maintenance, stop time.

1. BACKGROUND

A decrease amount of sugar production in Indonesia was pushed by an imported sugar policy. Some common influencing factors on the domestic sugar production are weather conditions, a decreasing amount of sugar cane land and a decreasing production capacity of sugar mills in Indonesia. The production capacity can be improved by revitalizing machines and, then, by maintaining a production number toward optimal one [1].

Madukismo Sugar Factory (P.G Madukismo) is a sugar mill owned by PT Madubaru as one of state owned corporation. The production of Madukismo in 2016 was only reached at 32,326 tons from the production target of 37,233 tons (krjogja.com 2016). One of the factors that affect the productivity of Madukismo was that it related to the decrease in yield. Alternative improvements were first, a preventing the decline in yield and second, an increasing the effectiveness of machine maintenance [2].

The maintenance system applied by Madukismo is consisted of a preventive maintenance and a maintenance after breakdown. A preventive maintenance is a maintenance activity carried out to prevent an unexpected breakdown. A maintenance breakdown is an activity of maintenance that is carried out after some facilities' breakdown.

The maintenance of machines that were carried out from November to April had not been able to press the engine stop clock. The planned engine stop clock was 88.8 hours, but, in fact, the 2016's engine stop time reached 179.44 hours. An increase of some engine stop hours had increased of an engine maintenance cost around 6%. A

budgeted maintenance cost up to December 2016 was Rp. 11,009,094,003, but its' realization of maintenance cost reached Rp. 11,658,424,879.

Based on the problems mentioned above, some purposes of this study can be defined as: first, to identify un-optimal maintenance activity in P.G Madukismo. Second, to analyze a solution on optimizing a machine maintenance of P.G. Madukismo.

2. TERMINOLOGY

2.1 Maintenance

A maintenance is all related activities to maintain all equipment to keep working properly. According to [3], a purpose of asset maintenance is to extend an useful life of assets, to ensure an equipment availability and operational readiness of equipment and equipment installed for production activities, to reduce maintenance costs as low as possible by carrying out maintenance activities effectively and efficiently, meeting product needs and production plans timely, and, to improve employee safety and health.

2.2. Value Stream

Value streams are describing all activities carried out to create value for customers. Value streams are created into an image called value stream mapping (VSM).

Value stream mapping is an instrument for analysing some financial benefits obtained from a lean manufacturing. The benefits of lean manufacturing can be made into a box score. The box score is a framework for evaluating some operational and some financial impacts of Lean. In the box score, there are three categories as follows.

1) Operational

The components in operational are related to the performance measurement of the value stream. The performance measurement of the value stream aims to continuously improve some activities in the value stream. The performance measurement component of the value stream is as follows.

a) Dock to dock days is the time needed from received raw materials until the goods are delivered to the customer.
b) First time through is the units percentage that are processed perfectly and in accordance with quality standards during the first process without any improvement, rework, retesting, or re-adjustment.
c) On time shipment is the percentage of orders that sent to customers on time.
d) Sales per person is sales that is done by one person then it measured through created values from value stream productivity. Measurement of sales per person must be known by the number of sales and the people involved.
e) Average Cost Per Unit is the total cost of activities in the value stream in a period and divided by the amount of production.

2) Resources Capacity

A capacity is a level of ability to produce optimally from a facility which is usually expressed in the amount of output. The capacity that referred in the box score is the capacity of the number of people, machines and time available in a period. The capacity used is divided into three categories as follows.

a) Productive is the time of labor or machinery that spent to produce products.

b) Non productive is all the time used, including non-value added activities, the time spent reworking.
c) Available is the remaining machine or labor after calculating productive and non-productive time.

3) Finance Information

Financial information contained in the box score are items that become the attention of both accounting and finance in the company. These items are income, inventory, raw material costs, costs incurred in the value stream process, and profit from the value stream.

2.3. Factors that Cause Maintenance

The factors that cause machine maintenance problems will be analyzed using the 7M principle. According to [4], the source of the quality problems found is based on 7M principles:

1) Manpower (labor), related to lack of knowledge, lack of basic skills related to mental and physical, fatigue, stress and ignorance.
2) Machine and equipment, related to no preventive maintenance system for production machinery, including other facilities and other equipment that are not in accordance with the specifications of the task, not calibrated, too complicated.
3) Methods (work methods), related to the absence of proper work procedures and methods, the absence of an explanation regarding the work method, the existing work method does not match to the system being applied.
4) Material (raw materials and auxiliary materials), related to the absence of quality specifications of raw materials and auxiliary materials used.
5) Media, relating to work place and time that does not pay attention to aspects of cleanliness, occupational health and safety and a conducive work environment.
6) Motivation, related to the absence of a correct and professional work attitude caused by reward that is unfair to the labor.
7) Money (finance), related to the lack of support to improve the quality.

3. PREVIOUS CASES

The results of [5, 6] showed that in the last 5 years PT PLN Ranting Pekanbaru has faced problems, namely the high gas engine damage and engine maintenance costs which are increasing every year. The causes of these problems are (1) lack of planning, implementation and supervision by the company; (2) the policy has not been implemented in evaluating maintenance costs; (3) the price of spare parts is increasing; and (4) lack of expertise owned by maintenance personnel.

While [7] stated that the company has not made many new investments or replacements in a number of equipment whose useful life has expired. The company has not made replacements for equipment but has only carried out preventive maintenance on a number of equioments supporting facilities that they have so far. The results of this study indicate that the application of internal control components applied by PT Sawokembar Galeria was inadequate. However, overall it is not in accordance with COSO because there were still risks that have not been minimized by the company.

For example, a record error was made by the warehouse administration officer in recording spare parts, limited administrative officer who was only one person so that the task carried out could not be completed properly and on time and the absence of a company data security system including equipment data outside the company.

Based on previous case studies, a case approach was selected. An interview, an observation and a critical review of documents are examined in collecting relevant data. A type of semi-structured interview was implemented for finding some insights from the head of the installation department, human resources staff, financial staff, manufacturing supervisors in the field section. An observation was conducted for some periodical information of maintaining a machinery process between November to April. Finally, a critical review of some documents owned by the company was carried for the company's work plan and budget (RKAP) in 2016, 2016 financial statements, 2016 performance report, 2016 asset list report, 2016 milling daily report and the machine's Standard Operational Procedure (SOP) used in Madukismo PG.

In a stage of data analysis, a tabulation technique by [8] was implemented on interview transcripts, observation transcripts and documents' critical review working paper. on a critical review. Some steps, such as a data reduction, a data reorganizing, and a scheme of research finding based on data relationship. So, a triangulation technique in this study can be a testing instrument for a data credibility by checking data obtained through several sources [9].

4. SYMPTOMS

An engine maintenance carried out every year for 6 months had not been able to suppress the engine stop time. The 2016's engine stop time reached 179.44 hours. The engine stop time planned for 2016 was only 88.8 hours. An increasing of engine stop hours caused 6% increased of engine maintenance costs. A higher production cost affected a decreasing of company's profit in 2016 compared to a 66% decreased in 2015.

The machine used by Madukismo has a capacity of 3,500 tons of sugar cane per day. At the beginning of its establishment, P.G Madukismo could only grind sugarcane for 1,500 tons of sugar cane per day. P.G Madukismo has not been able to use the engine capacity optimally. Based on the results of the analysis in Table 1, P.G Madukismo can only use a machine of 94.1% of the existing engine capacity. The optimal engine capacity used is only 87.4%. The use of engine capacity that has not been optimal results in higher production costs which were also higher in the cost of sugar per kg. The high cost of production also makde the price of sugar produced by P. Madukismo cannot competed with imported sugar. In addition, P.G Madukismo has not been able to make efficiency on production costs. The increase in production costs was not proportional to the increase in the amount of production. This was based on the 2016 financial report, some production costs increased by 91% but the amount of production produced by P.G Madukismo only increased by around 2% compared to 2015.

Table 1. Box score

Operational	Dock to dock days	6 hours 10 minutes
	First Time Through	80%
	On time Shipment	92%
	Cost per kg	Rp 6452
Machine Capacity	Productive	87,4%
	Non Productive	6,7%
	Available	5,9%
Finance	Sale	Rp 240 182 562 430
	Production Cost	Rp 208 939 199 182
	Value Stream Profit	Rp 31 243 363 248

Source: Observation.

4.1. Machine Maintenace in P.G Madukismo

P.G Madukismo applied preventive maintenance and maintenance breakdown. Preventive maintenance was done by checking all the equipment used during production. This aimed to prevent the occurrence of damage during production and suppress the milling stop hours that were below 2.5% of the milling time during the production period. While maintenance breakdown was maintenance that carried out when the engine was damaged. If there was engine damage or symptoms of season engine damage, the damage was reported to the installation section. It aimed to minimize the stopping hours of the engine and the production process continues smoothly.

Based on the milling daily report in 2016, much damage occurred at the boiler station. The boiler station is a station that generates steam to drive turbines and electricity producers that will be used to operate production machinery in P.G Madukismo. The engine stop time caused by damage to the boiler station was 121.85 hours from the total stop time of 179.44 hours. This engine stop clock shows the time needed to repair the engine when there is damage.

4.2. Factors Causing Machine Maintenance Is Not Optimal

1. Man power (Labor)

Manpower is a factor that is related to the knowledge and skills of the labor. Employees who worked during machine maintenance consist of wholesale employees and permanent employees. Wholesale employees are non-permanent employees who usually work during production. Employees who worked in P.G Madukismo especially for machine maintenance when recruited had technical skills such as welding or graduating from Vocational High Schools (SMK).

In addition to the qualifications of each employee, P.G Madukismo also enhanced the ability of employees by providing training in the form of in-house training and other training conducted with third party collaboration. In-house training attended by all employees including certain time-working employees (KKWT) who only worked during the milling season. In addition, P.G Madukismo also provided training to permanent employees held at LPP Yogyakarta. Manufacturing and installation employees usually followed this training.

2. Machine

Machine are factors related to engine age and preventive maintenance of the engine used. Based on the analysis of the 2016 asset report document, 71% of the assets used for the production process of the book value were Rp. 0,-. In addition, based on observations, P.G Madukismo still used one of the rounds that have been in place since the mill was operated. This round served to separate sugar from the solution after going through the crystallization process.

P.G Madukismo applied preventive maintenance to prevent damage to production machinery during the milling season. Preventive maintenance was carried out not only outside the milling season but also during milling season. When outside the milling season, preventive maintenance was carried out by dismantling all production machines to check the engine condition after being used for almost 6 months. Whereas during the production period, preventive measures were carried out, it was checking and monitoring directly for 24 hours. However, preventive maintenance carried out outside the milling season was still unable to press the engine stop time. This was because the company cannot replaced all engine components that were damaged or worn. Before replaced the engine components, the installation part first considered whether the component must be replaced or only repaired. However, considerations were made not to replace the engine components sometimes, which cause engine damage during production.

3. Method

Factors that related to the method are the implementation of the Standard Operating Procedure (SOP) in machine maintenance and explanation of the machines used. The Standard Operating Procedure (SOP) is a guide made to ensure that an activity runs as expected. P.G Madukismo had a SOP related to the production process and the machine operating process. However, P.G Madukismo doid not have a SOP related to maintenance for each machine used. Routine maintenance that carried out every year was based on activities that was done in the previous year and reports of engine failure during the milling season. Routine maintenance that carried out every year has not been made into a document so that maintenance was carried out only based on the knowledge possessed by the employee. This was in accordance with the observations and the documents that carried out by the researchers found that the existing SOPs were only related to the machine operating process.

4. Material

Material is one factor that influences the quality of maintenance. The material referred to in maintenance activities is the availability of spare parts. Spare parts are components of the machine that are reserved for repair or replacement if the engine is damaged. Spare parts prepared by the company only for engine components that are often damaged.

Submission of spare parts to be purchased was proposed by each operator from each machine. Then, the head of the installation department would choose the spare parts components, which must be purchased immediately.

If the spare parts that needed were not available in the warehouse, the operator of the machine would do the engineering of the engine so that the machine continued to operate. Engineering can be done in the form of operating another machine or keep operating the machine that has been damaged but the operation was not optimal.

Engineering of engine that got damage would be done until the required spare parts are available. This engineering requires the expertise of each machine operator.

5. Media (Work Environment)

One of the factors that can affect employee performance is the media. The media in question is related to the time and environment of the workplace. The working environment conditions of P.G Madukismo were conducive. However, there were still some shortcomings such as the presence of puddles in the factory floor and the road that goes through to monitor and check the condition of each machine that has begun to break down so that it requires caution when passing through it. In addition, some employees also did not use safety helmets as long as they were in the factory and there were employees who hang their clothes on the cable next to the machine that was under repair.

6. Motivation

Factor that can affect the quality of maintenance is motivation. The intended motivation is giving employees reward or punishment in improving their performance. Reward and punishment are given based on performance. The performance of each employee is evaluated using a Performance Management System (SMK (*Sistem Manajemen Kinerja*))). Reward can be given in the form of salary increase, bonus or promotion. In addition, punishment is given in the form of reprimands, salary deductions to dismissal.

7. Money

P.G Madukismo cannot approved all parts parts purchase. However, the installation department, which was responsible for maintaining the machine, was given the authority to allocate the funds to another account in the installation section if the purchased parts were not included in the company's RKAP. In addition, if the funds provided for maintenance activities have been expired, the installation department can submit additional budgets to the board of directors with certain considerations.

Engine maintenance that was not optimal caused damage to the engine during the milling period. Damaged engine repairs had resulted in increasing engine stop hours. High engine stop hours can cause a decrease in sugar cane yield so that the amount of production produced also decreases [10].

P.G Madukismo has only focused on machine maintenance by replacing engine parts that have been damaged. Madukismo P.G has difficulty in revitalizing the engine because of the limited funds available and it was difficult to find third party funds loans. This can be seen from the financial ratio of debt to equity in 2016 was 2.17 times. This figure showed that the greater the burden of the company to repay the loan. In addition, the source of debt owned by Madukismo P.G in 2016 only came from PT. Bank Rakyat Indonesia and PT. Rajawali Nusantara Indonesia. Debt from PT. Bank Rakyat Indonesia aims for farmers' working capital for the milling season in 2017. PT. Rajawali Nusantara Indonesia as the shareholder also provides debt for additional working capital.

The P.G Madukismo policy, which was unable to revitalize the production machine, has an impact on the engine stop and production costs have increased. The low capacity of production machinery and the quality of raw materials resulted in decreased sugar production. This has an impact on government policy to export every

year because the amount of sugar production in Indonesia cannot meet the needs of all people [11].

5. EFFORTS THAT CARRIED OUT

Below are the efforts that have been done by P.G Madukismo:

a. The Implementation of preventive maintenance

Preventive maintenance in P.G Madukismo was done for 6 months. This maintenance is usually carried out from November to April. Preventive maintenance was done by checking all engine components used during the production process. In addition to preventive maintenance that carried out outside the milling season, P.G Madukismo also carried out preventive maintenance when the milling season. The action taken was to make improvements to the engine when symptoms arisen that can caused the engine to stop operating.

b. Implementation of maintenance and production processes in accordance with standard operating procedure

The implementation of the standard operating procedure (SOP) aimed to minimize errors in the production process. P.G Madukismo has a SOP related to the operation and condition of the machine used during the production process.

c. Employees Training

In improving the quality of maintenance, P.G Madukismo was not only focused on providing spare parts. However, P.G Madukismo also focused on improving the quality of human resources. This can be seen from the provision of training to installation employees who were tasked with checking and repairing production machines. Every year, P.G Madukismo provided an opportunity for employees to attend training hold by the Yogyakarta Plantation Education Institute (LPP).

6. CONCLUSION

The conclusions of this study refer to the main objective of this study is to identify and analyze the factors that cause maintenance of the machine in the Madukismo P.G has not been optimal and analyze the efforts that have been made P.G Madukismo in optimizing machine maintenance. The conclusions of this study are as follows.

1. Machine maintenance is not optimal due to the useful life of the machine used by P.G Madukismo have been expired. Therefore, P.G Madukismo applies preventive maintenance for 6 months to minimize engine damage during the milling season. However, preventive maintenance has not been able to minimize engine damage during the milling season. Limited spare parts owned by P.G Madukismo cannot replace engine components that have been damaged. In addition, P.G Madukismo also does not have a SOP related to the maintenance of the machines used. The SOP that is owned is limited to the operation of the machine.

Engine maintenance that is not optimal caused damage to the engine during milling. Machine damage can result in a decrease in sugar cane yield because the waiting time for processing sugar cane become longer. The decrease in sugar cane rendement causes the amount of sugar production to decrease. P.G Madukismo step to revitalize production machinery has difficulty due to limited funds and it is difficult to find for third party loans. The Madukismo P.G policy which is unable to revitalize the production machine has an impact on the engine stop and production increased

costs. In addition to the engine stop hours, low production engine capacity and quality of raw materials caused decreased sugar production.

2. Efforts made to make sure optimum engine maintenance that is preventive maintenance measures. It carried out not only outside the milling season but also during the milling season. P.G Madukismo employees monitor and check 24 hours during the milling season. It aims to detect symptoms of engine damage, if there are symptoms of direct damage repairs are made. Furthermore, employees of P.G Madukismo also carry out production processes in accordance with existing SOP to minimize engine damage. In terms of improving the ability or skills of employees, P.G Madukismo also provides training to employees who that held with third parties. Training is usually given to engineers and supervisors from production machines. The training was held in collaboration with the Yogyakarta Educational Institution (LPP) when the season was outside.

7. RECOMENDATIONS

Based on the conclusions that have been explained before, the research recommendation is that P.G Madukismo can make back up funds for the replacement of production machinery. P.G Madukismo can also use general reserve funds for machine replacement. General reserve funds should not only be used to distribute dividends to shareholders but are used for repair and replacement of production machines. Replacement of production machines can be done in stages. The machines that can be mounted first are machines that experience a high level of damage every year, for example the machines that are in the boiler station. Therefore, the problem of high engine stops hours every year, especially the boiler station can be minimized.

The replacement of production machines to be more modern can also reduce production costs as has been done by PT Gunung Madu Plantations. The milling capacity when it began operating in 1978 was 4,000 TCD but currently it has reached 16,000 TCD. The use of advanced production machines and technology both at the factory and when planting sugar can increase sugar production which reaches 190,000 tons per year with production costs only around Rp. 488,000,000 [12].

Furthermore, P.G Madukismo can make a Standard Operational Procedure (SOP) related to machine maintenance. Activities carried out related to machine maintenance such as dismantling machines are made into a SOP document. The making of this SOP is aimed at the steps that are carried out related to machine maintenance in accordance with predetermined standards, not only based on certain employee information.

8. RESEARCH LIMITATIONS

1. This research is only limited to the whole maintenance of production machines in P.G Madukismo, not on the maintenance activities of each machine used.
2. Researchers cannot observe during the milling season to see the effectiveness of the use of production machines. This is because, the P.G Madukismo milling season in 2017 ends in October 2017.

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Aims and Objectives

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