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Implementation of Lean Manufacturing With A Value Stream Mapping Approach to Improve The Efficiency of The Production Process

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Abstract – **This research is based on the fact that many domestic sugar industries operate inefficiently and have low productivity, which is seen when compared to other countries such as Thailand, India and Australia. This study aims to identify and analyze problems along the flow of the white crystal sugar production process that cause waste and then make suggestions for improvements to reduce existing waste to increase cost efficiency in the production process. The national sugar factories generally have a basic problem, namely the low level of factory efficiency, which causes a lot of waste along the flow of the production process. The right concept for solving this problem is the implementation of the Lean manufacturing method, where this method focuses on efforts to reduce waste along the flow of the production process by making continuous improvements. The research begins with a literature study and field study and then conducts observations, analyzes, brainstorms, extracts and collects data from each work unit. The first stage begins with the define which will identify all forms of waste along the production process flow, measure to determine the most critical waste, analyze to identify the factors that cause waste in the production process, improve to carry out improvement plans, and reduce waste that occurs in the production process, and control as an evaluation of improvement results. The efficiency of the production process before the improvement is 78.7%, with improvements expected to increase production efficiency by 87.0% or an increase of 8.3 points.**

Keywords - *Lean Manufacturing, DMAIC, Value Stream Mapping, Waste, Production Efficiency*

INTRODUCTION

The national sugar factories generally have a basic problem, namely the low level of factory efficiency. The sugar production process in PG. Krebet Baru I is also still experiencing some problems that cause waste, this can be seen by the performance benchmarks that are not achieved, including the high sugar content in by-products such as molasses, cake, and bagasse, where the sugar content in molasses is still around 34.4% HK, while the standard is 30% HK, the sugar content in cake is 3.2% Pol while the standard is 2.0% Pol, the sugar content in the pulp is 2.56% Pol while the standard is 2.5% Pol.

The purpose of this research is to do a technical analysis to improve the efficiency of the sugar production process in PG. Krebet baru I Malang, which is implemented with the concept of lean manufacturing with a value stream mapping approach. In this research, identification of problems that cause waste along the flow of the production process is carried out, then proposed improvements are made to reduce the potential for waste that occurs in the sugar production process. This improvement proposal is complemented by the target of achieving production efficiency with the existing improvement proposals.

Waste also occurs in the use of auxiliary materials for the process, where the use of process auxiliary materials is still above the required standards, including the use of sulfur 43 kg / 100 tons of sugar cane the standard is 40 kg / 100 tons of sugar cane, the use of lime 135 kg / 100 tons of sugar cane the standard is 120 kg / 100 tons of sugar cane. Production efficiency can be increased through a continuous improvement process by analyzing and looking for the variability of problems in the production process, in this study the method used is Lean manufacturing using a value stream mapping approach which will analyze the flow of materials along the production process flow. So that the cause of waste can be determined, and continuous improvements will be made to achieve optimal process capability.

The main role of lean manufacturing is to determine the types of waste and eliminate them. The basic principles of lean manufacturing are applied by building a VSM to identify and eliminate waste with the formation of work teams, product selection, conceptual design, and formulation of the time frame through the calculation of talk time, [1].

Value Stream Mapping refers to a process that involves the wastage of the entire production flow, manufacturing, and company processes. With reduced wastage, overall performance and productivity will increase in the repaired system. Using this approach, redesigned and reformed processes become more efficient and effective, [2].

The Value Stream Mapping method as a tool in the Lean Manufacturing concept is used to map the production process and identify processes that contain waste so that existing waste can be eliminated. The advantage of VSM is that it can visualize the process flow of Value Added (VA), Necessary but Non-Value Added (NBN VA), and Non-Value Added (NVA), [3].

Lean Production has long been known and accepted in the industrial environment. This method considers the tight integration of human effort in planning manufacturing methods and continuous improvement with a target for value addition by avoiding all activity which leads to waste, this will make the system more effective by eliminating types of waste with smart technology which has grown rapidly, [4].

Lean Basic Concepts

Basically, the lean concept is the concept of streamlining or efficiency. This concept is applied to both manufacturing and service companies because basically the concept of efficiency will always be a target to be achieved by the company. Lean was originally a term used to describe the approach taken in the Japanese automotive industry, namely Toyota, to distinguish it from the mass production approach in the West. The lean concept is an attempt to establish a system that uses as few inputs as possible to create the same output, [5].

Waste

Waste is the result of excessive use of the resources needed to produce a product or service. The various types of Waste are Environmental, Health and Safety (EHS), Defects, Overproduction, Waiting, Not Utilizing employees knowledge, skills, and abilities, Transportation, Inventory, Motion, and Excess Processing, [6].

DMAIC Cycle

Is a key process in six sigma and lean thinking as an effort to make continuous and sustainable improvements by eliminating unproductive processes and focusing on measurement-measurement in implementing improvements for quality improvement towards the six sigma target, the stages of DMAIC are as follows; (1) Define, (2) Measure, (3) Analyze, (4) Improve, (5) Control, [6].

Value Stream Mapping

Value streams are all activities (value-added or non-value-added) needed to make a product through two main streams, namely: (1) production flow from raw materials to customers and (2) flow design and concept to implementation. Value stream mapping itself is a very important tool in the implementation of lean manufacturing, so it can be a good start for companies that want to implement a lean system because it can show activities that add value or do not add value to a product that uses resources that are not available together in the same process from raw materials to the hands of consumers, [5].

Productivity Concept

Productivity is defined variously by several experts. In general, productivity refers to the ratio of output and input. Inputs here include labor hours or costs, production costs, and equipment costs. The output consists of sales, revenue, market, and errors. Inputs are the resources used to obtain these results such as labor, capital, actors, raw materials, and so on. Output is the result of production in the form of goods or services produced by a production process. Productivity relates to the effectiveness and efficiency of utilization of production resources (inputs) with products or services produced (outputs), [7]. Efficiency production is also the result of technical efficiency and cost efficiency, so production efficiency can be formulated as follows, [8]:

$$EE = ET \times EH \quad (1)$$

Where:
EE = Production Efficiency
ET = Technical Efficiency
EH = Cost Efficiency

From the formulas and methods above, the efficiency of the Production Process can be calculated, namely the multiplication of technical efficiency (process) and cost-efficiency.

METHODS

The research was carried out in December 2020 at PT. Rajawali Nusantara Indonesia (Persero) PG unit. Krebet Baru I, Krebet Village, Bululawang District, Malang Regency, East Java. The research was conducted based on the basic problems that exist in the Production section, namely the number of waste along the value stream of the process. We need a method that can reduce waste and make continuous improvement process in all process flows along the value stream so that the production process runs more efficiently. The research method uses the concept of Lean manufacturing with a Value Stream mapping approach.

Preparation Stages

Before conducting further research, first, good preparation of the study is carried out in literature to understand the concepts or methods that are suitable for problem-solving. Also field studies conducted to better understand the conditions that exist in the company and the underlying problems in the company. At this stage, identification and formulation of problems are carried out from the background on the subject matter contained in the company, after that the objectives to be achieved in the research are determined, and the limitations and assumptions used in the research are determined.

Lean Manufacturing Implementation Stages

The implementation stages are as follows;
(1) Define, at this stage, details are made Value Stream Mapping and a description of the main process of the production process that occurs that describes the flow of the production process, consumer needs, physical flow, materials, and the relationship between the two, then identification of problems or types of waste that occur in the production process with the concept of lean manufacturing. (2) Measure, this process mapped the magnitude of the potential loss of costs for each type of waste along the flow of the sugar production process. Calculations are carried out to determine the potential loss of costs for each type of waste, and also to determine the measurement of critical waste to determine the waste that causes the most potential cost losses. (3) Analyze, analysis and identification of the factors that cause the problem of waste throughout the production process flow using lean manufacturing concepts. (4) Improve, made a plan improvement/ improvement of the main factors causing waste to reduce waste in the production process, this improvement has a sustainable rationale so it is necessary to evaluate and analyze the process so that the success rate of the improvement can be determined or other causes of waste in a work unit are also known. (5) Control, stage control is an evaluation of the planned or implemented improvements carried out, in this study the control process is carried out by calculating the efficiency of the production process after repairs have been made.

Conclusion and Suggestion Stage

From the results of the implementation of lean manufacturing with the value stream mapping approach, conclusions are drawn regarding the results of the research conducted and the success rate of the improvement process. At this stage, suggestions for further research and input for the company are also given.

RESULT AND DISCUSSION

In this chapter, the writer descuibes of an implementation lean Manufacturing concept includes Define stages, Measure stages, Analysis stages, Improvement stages, and Control stages. Data was obtained from observations, field studies, Brainstorming, and technical data from the production department.

Define

At stage define identification of waste that occurs along the flow of the sugar-making production process at the Krebet Baru I sugar factory. Making big picture mapping and production process flow diagrams serves to determine all activities that take place in the production process, then a type mapping will be made. waste and identification of problems that occur in all production activities. A schematic drawing of the white crystal sugar production process flow can be seen in figure 1.

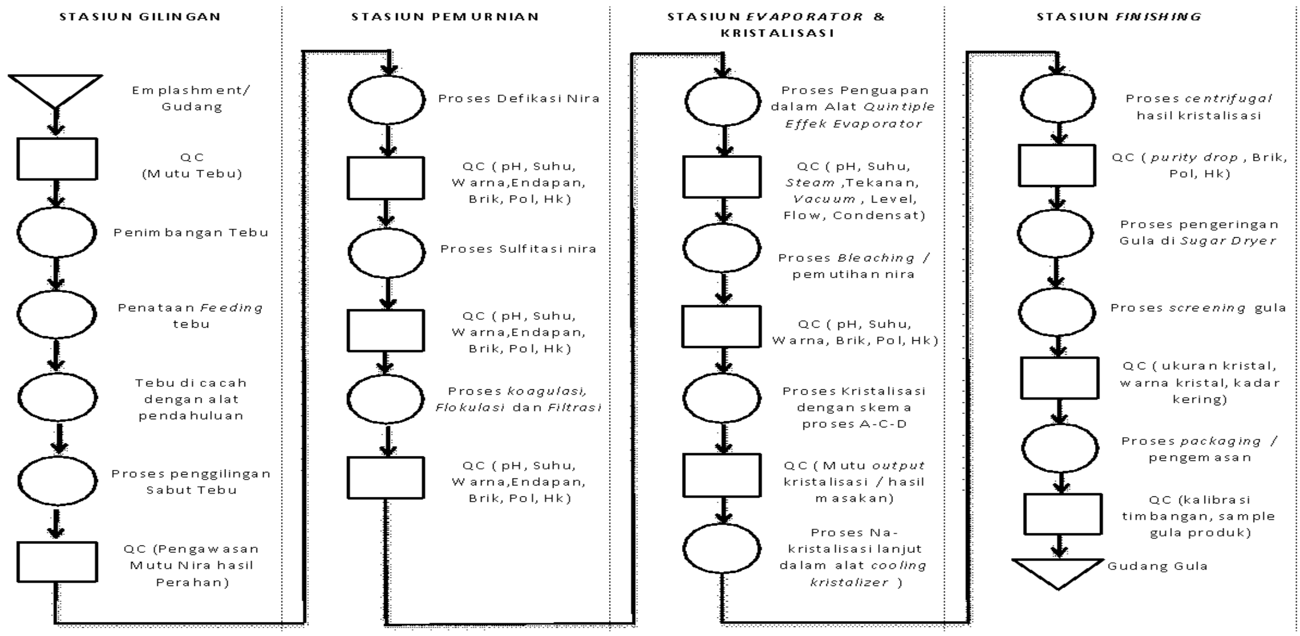

Figure 1. Production Process Flow Schematic

Big Picture Mapping is a tool of value stream mapping adopted from Toyota's production system. These tools are very helpful in identifying the occurrence of waste, visualizing the flow of information and materials as well as the relationship between the two. The big picture mapping can be seen in figure 2.

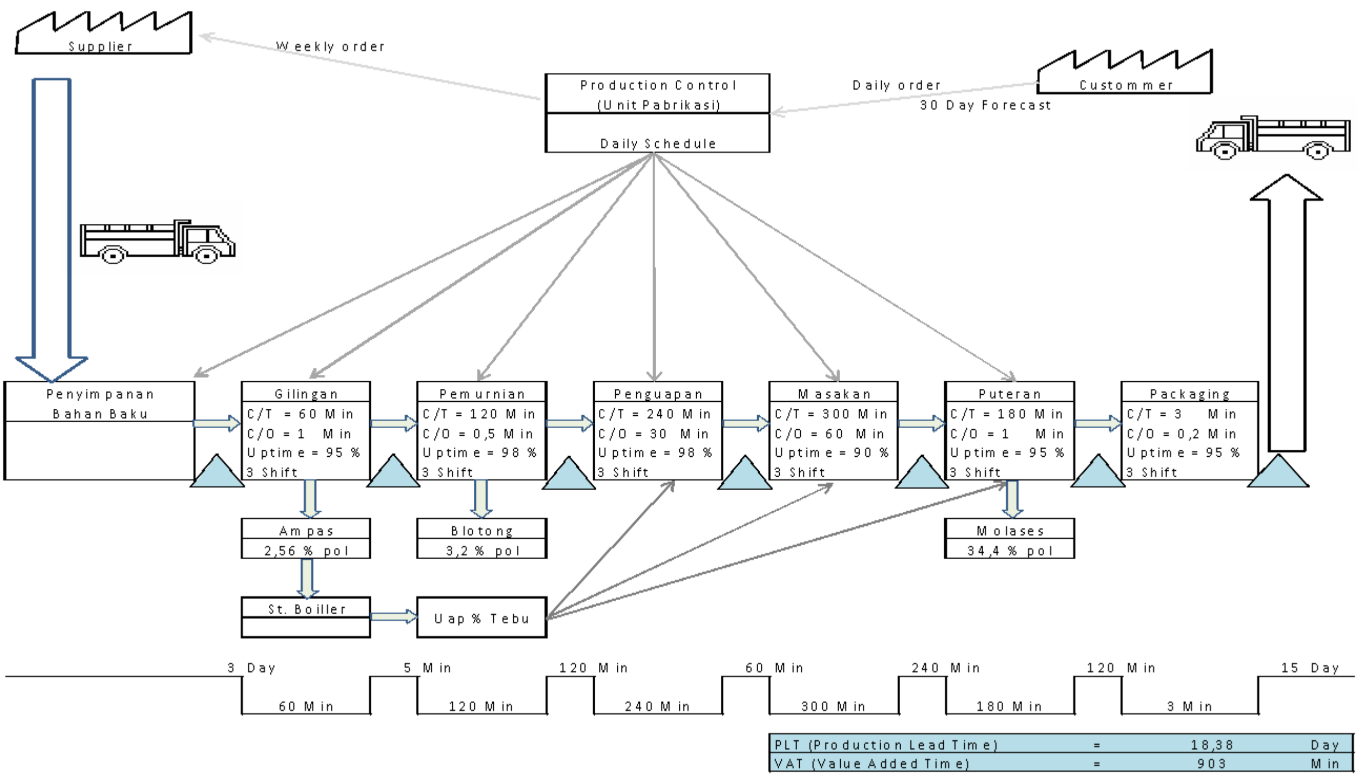

Figure 2. Value Stream Mapping of White Crystal Sugar Production

Waste Identification, it will be identified the occurrence of waste in the production process is accompanied by the potential for loss of costs as a result of the waste. The identification process begins with mapping all forms of species waste activities, then conducting field observations, surveys, study literature, brainstorming to get problems that cause waste in all production process flow activities. The types of waste and the things that cause potential losses according to the lean manufacturing concept are as follows:

(1). Environmental, Health, and safety (EHS), this type of waste is related to the existence of work accidents, which are mostly caused by negligence on the part of employees in carrying out their duties at work. From the data on the human resources (HR) of the K3 work unit in the 2020 miller year, there were several work accidents, including; electrocution, caught in a feed A mixer, exposed to hot steam from the kitchen boiler, and entangled tools of Hoist Crane. Work accidents that occur cause physical and psychological losses and cause waste for the company in the form of medical compensation costs and employee overtime to replace employees involved in accidents. (2). Defect, defect that occurs causes cost losses due to sugar that is not in accordance with the production standards, in the production department is often referred to as reject sugar. Reject sugar from the manufacturing section data produced from the 2020 milled year production process can be presented in table 1.

Table 1. Amount of Rejected Sugar in 2020

No	Sugar Defect	Amount [quintal]
1.	Wet sugar	525
2.	Oversize	960
3.	Lower size	242
4.	Dirty sugar/brown color	128

Overproduction

Overproduction is a type of waste caused by The company produces goods over consumer demand. In 2020 the production target of PG. New Krebet issued by the Ministry of BUMN amounted to 870,436 quintal GKP (white crystal sugar) this is related to the sugar self-sufficiency target targeted by the government, while the total production of PG sugar. The new Krebet I in 2020 is 659,901.49 quintal GKP (white crystal sugar). It can be seen that the production results are still lacking when compared to the company's production targets so that it can be concluded that PG. There is no waste overproduction in the new Krebet I.

Waiting

In a production process with a steady flow continue, this type of waste is related to the cessation of the production process due to waiting for repairs to equipment/machines that are experiencing disruption or damage. In the sugar industry, this is known as the milling stop clock. Mill stop data at each workstation can be seen in table 2.

Table 2. Factory Stop Hours at Each Station

No	Work Station	Waiting Time [hours]
1.	St. mill	46.8
2.	St. Boiler	43.2
3.	St. Electricity	21.6
4.	St. Purification	7.2
5.	St. Evaporator	14.4
6.	St. Crystallization	5.8
7.	St. Centrifugal	4.3
	Total	143.3

Not utilizing employees knowledge, skills, and abilities

This type of waste can be seen at the purification station, namely when setting the pH, where when adding lime, phosphoric acid, and SO2 gas is still manually adjusted using operator skill. Errors and a decrease in the accuracy of process settings are very easy to occur, when the operator experiences fatigue, does not concentrate, and when changing shifts, the pH and temperature control will experience quite large fluctuations. The impact of fluctuations in pH and temperature at this purification station is the unstable quality of GKP sugar (white crystal sugar). The fluctuation in sugar quality due to poor pH control at the purification station can be seen in table 3.

Table 3. Amount of Sugar Production According to Color Quality

No	Sugar Color [Iu]	Production Quantity [Tons]
1	130 – 140	12,076.20
2	140 – 150	15,243.72
3	150 – 160	15,837.64
4	160 – 170	12,934.07
5	> 170	9,898.52

Transportation

The delay in information from the production division of the FIFO team (first in – first out), so that the FIFO team was late to coordinate with the slash-and-transport department in the field. This led to an accumulation of sugar cane supplies, and a pile of sugarcane queues so that there was a subsidy to truck drivers of Rp. 25,000.00 if there is a queue for more than 12 hours. Subsidies from factory management to truck drivers when there is a queue that is more than 12 hours wherein the 2020 miller year this subsidy is 734 truck drivers, this makes factory management try to minimize the cost of subsidies by moving sugar cane which is transported by truck and then transferred to lorry transportation.

Inventory

This waste includes the remaining material from the 2020 production process, which causes losses due to immovable capital so that it can reduce the calculation of the company's profit at the end of the bookkeeping, in addition, leftover materials are very vulnerable to damage and loss. The list of remaining process auxiliary materials can be seen in table 4.

Table 4. Data for Remaining Material in Mill Year 2020 Production Process

No.	Leftover Material	Amount	Unit
1.	Phosphoric Acid	211	kg
2.	Calcium oxide	4.320	kg
3.	Sulfur	1,124	kg
4.	Flocculant	320	kg
5.	Biofast	242	Lt
6.	Biocide	221	kg
7.	Chlorine	168	Lt
8.	Bag	2,600	Unit
9.	Molding	24,020	kg
10.	Residue	37,000	Lt

Motion

In the production process, this type of waste occurs in the process of packaging sugar, which is when the sugar that has been packaged 50 kg per bag, is arranged first in the bag stamp floor (place to arrange sugar production) to calculate the amount of sugar, after that from the stamp floor it is transported to the warehouse, here it is seen that there is unnecessary material movement because there are two material movements.

Excess processing

This type of waste occurs because of the excessive use of auxiliary materials from the standard for the use of auxiliary materials in the production process. There are several auxiliary materials whose use is excessive as seen in table 5.

Table 5. Budget Realization Of Auxiliary Materials Compared to Company Budget In 2020

No.	Material	Company Budget [Kg/100 Tons of Sugarcane]	Budget Realization [Kg/100 Tons of Sugarcane]
1.	Sulfur	40	48.0
2.	Chalk	120	136
3.	Phosphoric Acid	10	11.8

Inappropriate Processing

The non-optimal performance of some factory equipment causes a large amount of sugar content to be included in by-products and production waste, thus causing sugar losses that exceed allowable process standards this will cause a decrease in yield, equipment performance which causes not to achieve process standards can be seen in table 6.

Table 6. Data Analysis % Pol Bagasse, % Pol Cake & %HK Molasses

No	Work Station	Waste	Standard [%]	Realization [%]
1.	Mill Station	Pol Bagasse	2.0	2.56
2.	Purification Station	Pol Cake	2.0	3.2
3.	Centrifugal Station	HK Molasses	30.0	34.4

Measure

This measure process maps the magnitude of the potential loss of costs for each type of waste along the flow of the sugar production process. Determination of the potential loss of costs for each type of waste and measurement of critical waste is also carried out to find out the waste that causes the most potential cost losses, where this critical waste must receive top priority for improvement efforts. Measuring the Amount of Waste, from result define with the identification of problems along the flow of the production process, can be calculated the amount of potential cost wastage for each type of waste, for the type of waste Overproduction there is no potential cost loss, this type of waste does not occur because the results of sugar production in the 2020 milled year are still below the target sugar production. determined by the Ministry of State-Owned Enterprises. The results of the cost risk data both from technical data and by calculating the potential for waste obtained the amount of risk of waste costs on each type of waste which can be seen in table 7.

Table 7. Types of Waste to The Amount of Cost Risk

No.	Waste Type	Cost Risk [Rp.]
1.	Environmental, Health and Safety (EHS)	12,731,70.00
2.	Defect	1,762,662,000.00
3.	Overproduction	0.00
4.	Waiting	8,115,379,200.00
5.	Not utilizing employees knowledge, skills, and abilities	494,926,120.00
6.	Transportation	27,510,040.00
7.	Inventory	268,210,020.00
8.	Motion	62,220,000.00
9.	excess processing	677,853,420.00
10.	Inappropriate Processing	27,237,266,601.00
	Total	38,658,759,101.00

Analysis

(1). Analysis of Waste Environmental, Health, and Safety (EHS). Work accidents that occur are influenced by many factors, including employee negligence, lack of safety equipment, unfavorable work environment, etc. The majority of work accidents occur due to employee negligence in carrying out their duties, the lack of pictures and warning symbols can also cause employees to act less carefully, resulting in work accidents.

(2) Waste Defect Analysis. Wet sugar, granulated sugar, and dirty sugar are types of waste defects that happened, this was caused by many factors, among others; (a). Wet Sugar From the results of analysis and field studies, the sugar dryer equipment works less than optimally and produces a dryness level above 0.05% if the thickness of feeding sugar entering the sugar dryer is > 12 cm, the sugar production meets the requirements. standard dryness 0.03%-0.05% for the thickness of feeding into the sugar dryer is about 10 cm. (b). Oversize & Lowersize Sugar Crystal. This is due to the large type of granular sugar crystallization of the product (cooking A) which does not meet the standard, non-uniform crystal size results from cooking A greatly affect the amount of coarse/fine sugar produced. The occurrence of non-uniform crystal size due to the crystallization process did not go well, where the cook operator was not observant in observing the crystal enlargement area. (c). Dirty Sugar/Brown Color. This is due to the HK analysis (purity price) resulting from the crystallization of sugar A (product sugar) which does not meet the requirements standard process, where the result of crystallization of sugar A (sugar product) should have an analytical standard of HK > 80% if the result of crystallization of sugar A (sugar product) has an analysis of HK < 76% then it can be ascertained Quite A (quite product) has a high viscosity, this causes the crystals to be difficult to separate from the solution so that the product sugar contains a lot of sugar solution so that the product sugar will be brown.

(3). Overproduction Waste Analysis. PG production results. Krebet Baru I is 659,901.49 Quintal GKP (white crystal sugar) which is still lacking when compared to the company's production target of 870,436 Quintal GKP (white crystal sugar) so it can be concluded PG. The new Krebet I did not occur in overproduction.

(4). Analysis Waste Waiting. This type of waste is related to the cessation of the production process due to waiting for repairs to equipment/machines that are experiencing disruption or damage. Machine damage that caused the production process to stop is due to weak predictive maintenance, supervision of critical tools, and equipment repair before fatal damage does not go well.

(5). Analysis Waste Not utilizing employees knowledge, skills, and abilities. This type of waste is found in the purification station where the pH setting is the setting of giving lime milk, phosphoric acid, and giving SO gas is still done manually, so it depends on the accuracy and skill of the refining operator.

(6). Transportation Waste Analysis. The occurrence of long queues due to factory stop hours because there was no good communication between the plant section as a sugar cane supplier and the manufacturing section in charge of grinding sugar cane, the delay in information resulted in the plant being late to stop cutting in the sugar cane plantations, which eventually causes the amount of sugar cane to be excessive.

(7). Analysis of Waste Inventory. Idle goods or leftovers from the production process are caused by inaccurate planning for the use of auxiliary materials used during the production process, resulting in at the end of the mill there being leftovers.

(8). Waste Motion Analysis. The wastage that occurs as a result of movements unnecessary material at the finishing station is due to different working hours between warehouse employees who only enter the morning shift, and manufacturing employees whose working hours are divided into 3 shifts, this causes production sugar cannot be directly entered into the warehouse and had to wait on the stamp floor.

(9). Excess processing. The use of auxiliaries of quicklime, sulfur, and phosphoric acid is excessive because the pH operator settings at the purification station are not well controlled, this fluctuating pH causes the high use of auxiliary materials.

(10). Waste Inappropriate Processing. This type of waste occurs in several workstations, Including: (a). Mill Station Causes of waste at the mill station is a condition of PI (Preparation Index) that is not optimal, PI (Preparation index) is a measure of the perfection of the opening of the bagasse coir cells, the results of the preliminary equipment performance, namely cane cutter and unigrator chopper, PI (Preparation index) analysis) which is good is in the range of > 90% where at that number the softness of the pulp is quite good and will facilitate the extraction process of sugar content in the dregs at the milling station, in PG. Krebet Baru I the PI (Preparation index). (b). Purification Station. Factors that lead to waste are the high vacuum condition on the rotary drum Vacuum Filter equipment. Equipment in PG. Krebet Baru I for High vacuum only reached 33 cmHg from High vacuum operating standard is 45-50 cmHg, this causes the absorption process of sap from the sludge (mud juice) is not optimal, resulting in high levels of sugar included in the filtered Cake. This high vacuum is not achieved because the capacity of the vacuum pump is not large enough. From the calculation results, a vacuum pump with a capacity of 2,500 m3/hour is needed, while the existing pump capacity is only 1,750 m3/hour. (c). Centrifugal Station. The cause of wastage at the spin station due to the Na-Crystallization process is an incomplete further crystallization process, in PG. Krebet Baru I has residence time for sugar solution D in the cooling device crystallizer about 28 hours, shorter than standard operating equipment is 36 hours, this is one of the causes of the high purity HK drops (molasses).

Improvement

Based on the results of the analysis, suggestions for improvement efforts can be given (improvement) to reduce the waste that has been determined.

(1). Improvement proposal to reduce Waste Environmental, Health, and Safety. From result brainstorming, field analysis, literature study, the suggestions for improvement can be given as follows; (a) Improve communication with the HR (human resources) unit K3 (occupational safety and health) to carry out regular supervision and control on the implementation of OHS procedures in the work environment. (b) Installation of warning pictures and warning signs on work tools that cause potential accidents.

(2). Improvement Proposal to Reduce Type Of Waste Defect. From result brainstorming, field analysis, literature study, the suggestions for improvement can be given as follows: (a) Installing the adjustment tool feeding sugar enters the sugar dryer with a maximum sugar thickness of 10 cm. (b) Adding a sugar stirrer inside the sugar dryer, serves to reverse the position of the dried sugar. (c) Reduce reject sugar production (oversize& lower size Crystal) by using Dried cooking seeds (d sugar crystallization) with the use 0.05 mm crystal core fondant. (d) Sending cooks (operators at crystallization stations) to take courses/training to improve their technical skills and competencies. (e) Manufacture of D2 Sugar smelting equipment at the Centrifugal station which is used to increase the HK (the price of purity) of thick sap so that the HK (the price of purity) of A's dish will be carried up.

(3). Improvement Proposal to Reduce Overproduction Waste, because there is no waste overproduction, it is not necessary to give suggestions for improvement.

(4). Improvement Proposals to Reduce Waiting. From result brainstorming, field analysis, literature study, the suggestions for improvement can be given as follows: (a) Manufacture checklist periodic observation of critical equipment, which has the potential to cause grinding stops in the event of a breakdown. (b) Formed a special team to make predictive maintenance effective.

(5). Improvement Proposal to Reduce Waste Not Utilizing Employees Knowledge, Skills, And Abilities, from result brainstorming, field analysis, literature study, the following improvements can be made; (1) Investment pH Controller for automatic pH adjustment.

(6). Improvement Proposal to Reduce Transportation Waste, from result brainstorming, field analysis, literature study, the suggestions for improvement can be given as follows; (a) Giving HT to FIFO team members (first in – first out) in the field to speed up communication with the production department and the cutting and transport department. (b) Data generation online in coming sugarcane which is connected to the computer in the manufacturing section, the remaining sugar cane data (sugarcane stock at the emplacement) will be able to be quickly responded to by the production department by setting the milling speed according to the specified milling capacity.

(7). Improvement Proposal to Reduce Waste Inventory, from result brainstorming, field analysis, literature study, the suggestions for improvement can be given as follows: (a) A plan for the procurement of auxiliary materials is made every 1 week which is adjusted to the needs of the process. (b) Evaluating the availability of process auxiliary materials every week. The above proposed improvement, it can be said that effectively to reduce waste in the field of inventory, is if the remaining material in the warehouse is not excessive with a range of 10% to 20% of the material needs for the production process.

(8). Improvement Proposal to Reduce Waste Motion, from result brainstorming, field analysis, literature study, the following improvements can be made: (a) Installation of conveyor equipment for transporting packaged products directly to the warehouse, in this way the company can reduce the number of employees by 8 people per shift, the lessened employees are workers who carry out manual transportation of production products to the warehouse by pushing with a product carrier. (b) Installation Counter Sugar (automatic sugar counter) to reduce miscalculation, this will reduce employee activities to recalculate if there is an inequality between the production jump from the processing section and the product warehouse section.

(9). Improvement Proposal to Reduce Waste Excess Processing, from result brainstorming, field analysis, literature study, the following improvements can be made; (a) Installation static mixer to replace equipment defector and defecator II.

(10). Improvement Proposal to Reduce Waste Inappropriate Processing, from result brainstorming, field analysis, literature study, the suggestions for improvement can be given as follows; (a) Installation of the chopper heavy duty shredder to replace the Unigrator machine which has been used so far. (b) Invest 1 unit of vacuum pump with a capacity of 2,500 m3/hour, to increase the low and high vacuum of the rotary drum vacuum filter. (c) Invest 1 unit cooling crystallizer with a volume of 500 Hl. (d) Tool making continuous vacuum cooling crystallizer.

Control

Control Carried out to evaluate the planning and implementation of improvements made, in this research the calculation of the efficiency target of the production process after the improvement will be carried out and will be compared with the realization of the efficiency of the production process before the repair.

(1). Calculation of Realized Production Efficiency Before Improvement.

Production Process Efficiency follow the formula = Cost Efficiency x Technical Efficiency (Process)
= 87.9 % x 89.59 %
= 78.7%

(2). Calculation of Production Efficiency Estimates After Improvement

Production Process Efficiency follow the formula = Cost Efficiency x Technical Efficiency (Process)
= 95.3 % x 91.28 %
= 87.0%

The efficiency of the 2020 milled realization production process is 78.7%, it is estimated that the proposed improvements will increase the efficiency of the production process by 87.0% or an increase of 8.3 points.

CONCLUSION

From the result of This research, it can be identified the problems that cause waste, with a total potential loss of Rp.38,658,759,101.00, where the problem that causes the greatest potential loss is inappropriate processing waste, with a potential loss of Rp.27,237,266,601.00. This inappropriate processing waste occurs at the Milling Station, Purification Station, and Centrifugal Station. The results of the analysis of the problems that occur along the flow of the production process, an improvement proposal is made to reduce the potential loss of costs. The type of waste that causes the greatest potential loss is inappropriate processing waste, to reduce potential losses due to inappropriate processing waste, At the mill station is proposed to replace the sugarcane chopper from the unigrator machine with a heavy-duty shredder.

At the boiling house station, it is proposed to invest in a vacuum pump with a capacity of 2500 m2/hour. At the Centrifugal station, it is proposed to invest 1 unit of cooling crystallizer with a volume of 500 Hl, and to manufacture a continuous vacuum cooling crystallizer. In this study, the planned production process efficiency target after the improvement was 87.0%, an increase of about 8.3 points from the realization of the production process efficiency achieved in the 2020 milling period, which was 78.7%.

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