

Methods for Applying the Sigma Ethodology to Reduce Drilling Waste Water Wasteroperational Treatment in PT. RST (Case Study of Chemical Companies)

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Abstract:- One method is used to improve the process and provide to minimize solutions to improvement of the company's internal standards that are flawed or inappropriate and reduce the trend of increasing waste products so that it increases for each period using the Six Sigma method. Through the implementation of the DMAIC cycle (Determine, Measure, Improve, Analyze and Control) in Six Sigma, a problem can be clearly seen at the root of the problem and can be fixed structured. This research was carried out at PT. Tangerang RST, in the Waste Water Treatment section by analyzing the cost requirements for wastewater treatment for purposes, where there were several ineffective and efficient costs so that it could produce waste on the costs allocated for the operation of Wastewater Treatment during the year 2015 From the results of the research that has been carried out successfully found several root problems and several solutions have been set to overcome the problem of wasting operational costs of WWT. At the end of the study it was also issued which succeeded in reducing the operational costs of Wastewater Treatment by 360 million in the 6-month Phase of Time Control.

Keywords:- Quality Control, Six Sigma, DMAIC, Waste Water Management.

I. INTRODUCTION

In the process of processing wastewater in Waste Water Treatment, of course, costs for operations are needed such as electricity, labor, purchasing chemicals for the process, repairing machinery and infrastructure (maintenance), and other operational support costs. In the year 2015 the total operational cost of Waste Water Treatment Reached 5.3 billion a year, a significant increase is from operating costs in 2014 of 4.1 billion. This is Considered by the Management of PT. RST problems occur that must be resolved in a structured manner so that things like this do not happen later on. From the results of previous studies in the journal written about Six Sigma by Cindy Marika Amalia Wibowo in the year 2013 in the garment company PT. X managed to reduce the cost of making products by Rp. 4,877,443 ($\pm 10\%$) in the period January - June 2013. Based on this,

➤ Identification of problems

Some of the impacts of the Increase in operating costs in 2015 of 1.2 billion Compared to 2014 that occurred will Affect the selling price of products / CPI, Because The operational costs of Waste Water Treatment are one of the components that will be converted to Determine the selling price of the product. the large operational cost of Waste Water Treatment will increase of the selling price of the product per kg. There was no change in production capacity in 2014 and 2015. In 2014 it produced a total production of 41.197 tons with wastewater discharge of 65.753 m3 and total load of 39.4 tons / m3.

Whereas in 2015 the total production was 33.244 tons with wastewater discharge of 64 161 m3 and total load of 41.6 tons / m3. But the cost of operational Waste Water Treatment is greater in 2015.

➤ Formulation of the problem

Based on the background underlying this research, Several issues will be Discussed items, namely:

- How do you apply the Six Sigma methodology to reduce the waste of the operational costs of Waste Water Treatment in 2015 in a structured manner?
- What was the root cause of the 2015 increase is in the operational costs of Waste Water Treatment?
- What precautions are taken so that the problem does not occur again?

➤ Research purposes

This study aims to analyze the application of the Six Sigma methodology at PT. RST, so that it can be Obtained:

- Knowing how to apply Six Sigma methodology (DMAIC) to reduce waste of operational costs in the Waste Water Treatment section of PT. RST company as a continuous improvement program.
- Knowing the root problem of a problem that Occurs from a problem.
- Establish a good solution to Prevent problems from reappearing.

II. LITERATURE REVIEW

In accounting, costs are a very important component, therefore costs must be considered. Cost is Also a component that is Also very influential in the company, if the company can control costs to a minimum, the company can survive and be Able to optimize its revenue. In addition, with the management of costs, the company is expected to have the ability to develop and be Able to maintain its business continuity.

A. Elements of Operational Costs

➤ Factory cost (factory cost)

Namely all costs incurred and found in the environment where the production process takes place, consisting of raw material costs (direct material), direct labor wages, indirect factory costs (factory overhead).

➤ Administration costs (administration expense)

That is, all costs that occur within the corporate administration office, as well as other costs that are of the nature for the overall administration of the company. Office insurance costs, are insurance costs for administrative buildings and office equipment,

B. Definition of Six Sigma

Six sigma is a statistical concept that measures a process related to defects or damage. Reaching six sigma means that the process that runs only produces 3.4 defects per million opportunities, in other words the process runs almost perfectly (Gomez and Nunez 2009). Six Sigma is a Recognized as a problem-solving method that uses statistical tools for basic quality and process improvements (Kunal, Ganguli, 2012). Sigma (18th Greek alphabet letter) is a term in statistics to indicate standard deviation (Greg Brue, 2002: 2), Six Sigma is the right, focused, and effective implementation in proving quality principles and techniques. By freeing elements from the results of discussions of various quality experts, Six Sigma seeks to create business performance without errors (Pyzdek, 2002). Sigma, σ , is a Greek alphabet used by statisticians to measure variability in the process. Company performance is taken by using the sigma level of the company's business processes. Traditional companies receive a performance level of three or four sigma as standard, According to the process required 6,200 to 67,000 questions per one million opportunities.

➤ DMAIC - (Determine, Measure, Analyze, Improve and Control) is a process

Carried out for further improvement. DMAIC is systematic, scientific, and fact-based processes (sefyan, 2015). Based on DMAIC the which consists of 5 stages play items, namely: Determine (D), Measure (M), Analysis (A), Increase (I), Control (C).

DMAIC Roadmap

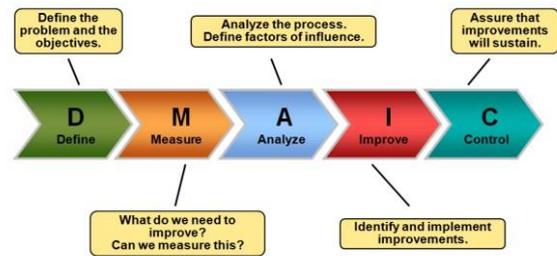


Fig 1:- Tools SixSigma

The concept in implementing Six Sigma is a continuous effort to Eliminate Waste and Increase the added value (value 4 added) of products (goods and / or services) in order to provide value to customers (customer value). The aim is to increase of customer value through a continuous Increase in the value-to-waste ratio by focusing on identifying and eliminating non-value adding activities in design, production (for manufacturing) or operations (for services), and supply chain management that is directly related to customers (Gaspersz & Avanti, 2011).

Activities that consume more than needed resources are classified as waste and have the opportunity to be improved. The types of activities contained in the process are Described below (Sarkar 2008):

1. Value-added activities Value-added activities
2. Business-value-added activities Business-value-added activities
3. Non-value-added activities

C. Six Sigma Stages

1. Define

Define phase is the initial stage in Determining the problem and provide the limits of the improvement project. The steps taken in this stage include identifying processes that provide added value or not and identifying waste that Occurs (Rahman et al, 2010).

This phase aims to formulate the problem of what happened. In the Define stage, the six sigma tools commonly used is the Project Charter, SIPOC, Project Frame, Specify Customer Requirements. After a six sigma project is selected, the first step that must be done is to define the problem by describing the problem and what goals to Achieve. with a SMART approach (Specific, Measurable, Agreed to, Realistic, Time Bound).

2. Measure

This phase aims to find out how big the problem is. This process phase focuses on how to measure the internal processes that Affect CTQ. This requires an understanding of the causal relationship between process performance and the value of the violations. Six Sigma methodology uses the terms function in mathematics to describe relationships.

3. Analyze

This phase aims to find out the root of any problem that causes problems to occur. Six sigma tools commonly used in this phase are Fishbone / cause effect diagrams, 5 time why, Hypothesis Analysis, Statistical analysis. The main disadvantage to most problem solving approaches is the lack of emphasis on sharp analysis. Often what happens is that we jump directly to Certain solutions without fully understanding a problem and identifying the source, or the root cause of the problem. This phase focuses on the question of why excessive defects, errors or variations occur.

4. Improve

After the root of the problem can be understood, the analysis or the team that handles it must gather ideas to Eliminate or solve the problem and improve the measurement performance of the variable X, thereby improving CTQ. This phase of gathering ideas is an activity that desperately needs creativity, Because most solutions are not Clearly visible. One of the Difficulties of this task is the spontaneous instinct to assess ideas before fully evaluating them.

5. Control

The control phase focuses on how to keep improvements in progress, Including incorporating the device in place to Ensure that the main variables Werner within the maximum area that can be received in the process being modified. Determining Reviews These improvements can include new standards and procedures, conducting training for employees, and establishing a control system to Ensure that repairs are timeless (James R. Evans and William M. Lindsay, 2007: 50-51).

III. DATA ANALYSIS TECHNIQUES

Data analysis is done using Several six sigma tools, Including the following:

1. Pareto diagrams are used to identify the costs Reviews largest to the smallest so that in getting 80% of operational costs to be spread more focused in doing repairs.
2. Project charter is used to Briefly explain what is the background of the problem, the real thing is like and what goals you want to Achieve.
3. SIPOC is used to Determine the process started and the final process of a process that will be Carried out research.
4. Fishbone is used to find the root cause of the problem that Occurs.
5. The third tool is used to analyze the root cause of the problem whether it is valid or not before the solution is Decided.
6. The Operational Definition is used to explain what is the measurement output so that it is clear and agreed upon. Aim so that there is no difference in perception about the the data and measurements.

IV. ANALYSIS AND DISCUSSION

After all the required the data is collected, the Data will be processed through five phases in Six Sigma called the Six Sigma Improvement Framework or Six Sigma Breakthrough Strategy. To analyze the waste that Occurs in the Waste Water Treatment department of PT. RST using Six Sigma methodology must be included in the research phase According to the DMAIC Six Sigma methodology (Define, Measure, Analyze, Improve, Control). Before the research Began, the Gemba was estimated to be a temporary estimate of waste that resulted in waste of operational costs Waste Water treatment. Looking for the process flow and the opening of the SAP reports in 2016. Gemba, who has pain from the process. The process owner Also Gives an input to cause problems during the year2016 so get the initial guess as follows:

- High electricity consumption
- Solid Content of press cake is low
- High chemical consumption for process and adjustment
- Maintenance costs are high

From the above estimates can be used as an initial reference so that it can focus and prioritize research. But Because this is only the initial sigma, it is a defective measure, DMAIC (Define, Measure, Analyze, Improve, Control). The following are the results of analysis and discussion using Six Sigma methodology and statistical tools:

A. Define

Define phase aims to explain what problems occur in the Six Sigma project. Performed background deflation of the problem that occurred, what was the problem, what was the purpose, how long the timeline was and set a team member who would assist in completing the project included in the project charter. Team members come from related processes Because they are expected to be Able to provide input and ideas from the existing processes that are being done. The six sigma tools used in the define phase acre project charter, SIPOC diagram, and TOOL 1 customer needs.

a. Business case / Background: Cost is what is very important for the company's operationsincluding the Waste Water Treatment section. Waste water treatment requires a cost for chemical purchases, sludge disposal, machine repairs, employee costs, purchase of spare parts and electricity payments. But the use must be Carried out Effectively and efficiently Because It will have an impact on the price of the products produced Because The Waste Water Treatment cost is one part that is converted to the selling price of the product. In 2015, the operational cost of the Waste Water Treatment department spent 5.3 billion per year, a significant increase of Compared to 2014 of 4.1 billion. There was no change in production capacity in 2014 and 2015. In 2014 it produced a total production of 41.197 tons with wastewater discharge of 65, 753 m³ and total load of 39.4 tons / m³. Whereas in 2015 the total production amounted to 33,244 tons of waste water with discharge 64,161 m³ and total load of 41.6 tons / m³. But in the operational cost of Waste Water Treatment is greater in 2015. It is Necessary to

b. TOOL I (one) Customer Needs The next tool in the Define phase is the first tool, commonly called customer need. This is important Because it will be known what the customer's desires will be fulfilled for the achievement of his satisfaction. But based on research conducted by the Waste Water Treatment, it does not directly relate to maleinkan business customers, the customer is related to the management or process owner who has pain Because It offer section with business. CTB (critical to business) is Formulated from the voice of stakeholders or commonly called the VOB (voice of business). The formulation can be seen from the picture below.

Tabel 4.1 VOB & CTB

VOB (Voice of the business)	Key Issue ("True Need")	CTB's (Critical to business)
<p><i>WWT Manager :</i> "unclear allocation of cost in WWT CCs, no transparency what are the significant cost drivers & too significant increased cost in 2015"</p>	<p><i>WWT correct cost allocation & optimization</i></p>	<p><i>Clear, correct allocation of all WWT process related cost & must not be > 4.7 Bio IDR per year.</i></p>

Sumber : Project Workbook Six Sigma

Table 1

B. Measure

Phase Measure aims to find out how much the problem occurred. Provisional Data that can be previously validated in this phase. Statistical tools are important to use Because in this phase a lot of the data is related. Six Sigma tools that are used are Tool II, Operational Definition, Measuring System Analysis, Data Collection Plan, Process Performance. It is important to use all the tools above so that what has been measured is validated Correctly before going to the Analyze phase.

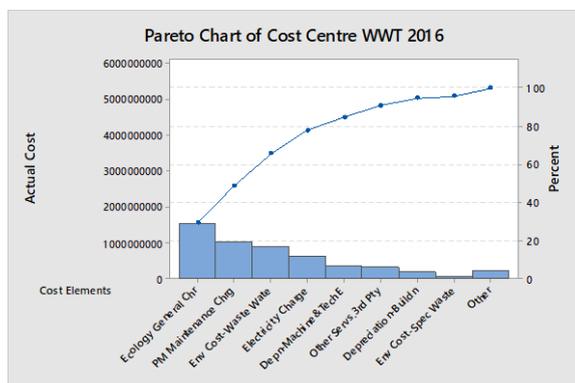


Fig 2:- Pareto diagram

From the Pareto chart above, 80% of the highest costs were used in the Waste Water Treatment operation in 2015, out of a total of 30 cost elements there were 4 roomates biggest costs will be focused in the later analysis phase. takes a long time and is not efficient. 4 the cost elements of the large-identified uses are:

- a) *General ecology charge*
- b) *PM Maintenance charge*
- c) *Env. cost of waste water*
- d) *Electricity charge*

C. Analyze

After what the problem is and how much it has been found in the previous phase, in this phase it aims to find the potential root cause and verify the root of the problem so that it can be really determined - the root cause of the problem. The six sigma tools used is Fishbone (causal diagram). ISHIKAWA Fishbone or is used as a first step to accumulate the root potential of problems by brainstorming and brainwriting involving all team members who work daily. The root of the problem will be explored as deeply as possible to really find a clear root cause using the 5x why the method so that it can be visualized between the problem and the root cause. Specific problems have been set to fill-in the head of the fish "why does the operational cost of Waste Water Treatment in 2015 reach 5.3 billion?" The root cause of the problem comes from the team members who work everyday, the project leader's task is to only lead the Fishbone workshop and verify Whether the root of the problem is Expressed According to the problem or not. In Determining the root of the problem can also be Categorized into three parts items, namely:

- a.C = Constant
- b.N = Noise
- c.X = Variable

This is important to do so that it is more conceptual and focused on finding solutions to the variable problems. The root problem of priority that will be determined by the solution is the root of the problem variables taking into account the effort and benefit. The root of the problem Formulated Also Refers to 5M items, namely materials, methods, machines, money, mother nature.

No	Methode	Man	Material	Mother Nature
1	No work instructions for chemical dosing (variable x1)	Autonomous maintenance has not been introduced to the waste water treatment operator (variable x3)	There are still many wastewater treatment processes in continuous process (noise 4)	The collection of pit wastewater is not closed so that rainwater enters the WWTP (noise 3)
2	Trickling filter is still operated even though there is already an aeration tank (Noise 1)	Maintenance costs have never been reviewed regularly (variable x2)	Low solid content filter press cake (Noise 2)	
3	Too much sample checking (Variable x5)			
4	Too fast change of filter press cloth (variable x6)			
5	Improper adjustment of PH so that wasteful use of chemicals for processes (variable x7)			
6	Repeat experiment conducted by lab analyzer (variable x4)			
7	the shift system does not change despite changes in work (Noise 5)			

Table 2:- root potential problems

D. Improve Repair

Improve phase or phase improvement is related to the determination and implementation of solutions based on the results of the analysis that has been done before in the Analyze phase. In this study, the activities Carried out in the improve phase are the determination of solutions or actions to Overcome the high cost problems in the Waste Water treatment department. On this stage the author Provides input regarding the Efforts to improve the process based on the results of the analysis that has been Obtained from the previous stage. In the project implementation of DMAIC analysis after knowing what actions can be taken, the action will be implemented a as an effort to solve the problem that occurred.

No	Solutions	Which root cause is impacted
1	Make WI to dosing chemicals into the waste process	There is no work intruction for chemical dosing
2	Trickling filter shutdown and only use aeration tanks for biological processes	Trickling filters are still operated even though there are aeration tanks
3	Maintenance costs are reviewed every month and discussed every monthly meeting	Maintenance costs have never been reviewed regularly
4	Autonomous maintenance training for all waste water treatment operators	Autonomous maintenance has not been implemented at the WWTP department
5	Processing wastewater only in manual treatment	there is still a lot of doing waste processing in a continuous process
6	change the shift system from 6 - 2 to 5 - 2	the shift system doesn't change even though there are job changes

Table 3:- Solution

From the solutions the agreed upon above, the objective will be implemented a Gradually to focus on implementing the solution and its control, before entering into the control phase of the solution implemented a must be properly evaluated. It takes Approximately 3 months in the evaluation to prepare carefully Whether there is anything that needs to be made, purchasing new tools, Investigating the possibility of other problems will Arise and of course must be Discussed with safety if there is anything related to safety issues by making MOC (management of change). Later, before entering into the Control phase project leader, it must Ensure that all the solutions above the agreed upon will align well. This is important to do so that other problems do not Arise.

E. Control

Phase Control or control phase is the stage that aims to continuously Evaluate and monitor the results of the previous stage of implementation or the results that have been Carried out in the improve phase. Also This stage aims to Ensure that the conditions that have been repaired can take place continuously or continuously, and do not run in a short time. After the solutions are implemented a in the improve phase to improve process performance, the control phase keeps the performance from falling back down. In this phase the author tries to provide input to the company about how to control and monitor the process. Activities Carried out at this stage are checking the performance measurement standards used, and checking the required documents or reports.

Statistical tools are needed in this phase such as a run chart to Evaluate the results that have been done in improving the Six Sigma project. Everything that has been repaired in the previous phase is included in the SOP and monitored for 1 year to Ensure that the Waste Water Treatment costs are no longer a problem. Here are the results of the control in the run chart for the first 3 months of the project implementation that has been documented.



Fig 4:- Run Chart Improvement

From the chart above explain the results of improvement that have been done and documented in the chart. The average cost spent in the Waste Water Treatment department in 2015 was 441 million / month, the reduction target of 10% per month (44 million / month) to max 397 million / month. But the achievement results are better, the which is less than the target of max. Up to 6 months the benefits claimed control the hard phase is 326 million. Reviews These results will continue to be monitored until the next 12 months / end of 2017. If the results are still consistent, the six sigma project undertaken has succeeded, but if there is a problem, the project leader must Evaluate and react to the problem. Some of the action plans that have been specified in the Control phase are:

1. If the maintenance costs are high, then check the notifications that have been made Whether they are in accordance with the budget or exceed. If Appropriate, check uploading documents from the Finance in the cost center. If it exceeds, it is seen that there is a modification or breakdown of the engine or pump.
2. If the electricity costs are high, then check the actual electricity consumption in the Utility section SCADA. If Appropriate, check the upload of documents posted by Finance. If it exceeds, then check for any activity that Occurs in Internal Waste Water Treatment.
3. If the cost of purchasing chemicals is high then check the chemical consumption used for the process in Waste Water Treatment. If Appropriate, check the document posted by Finance. If it exceeds the check for discharge of wastewater that goes into Waste Water Treatment and its parameters.

V. CONCLUSION

Based on the research that has been done at PT. RST regarding the application of Six Sigma to reduce waste of operational costs can be summed up as follows:

1. It is well known and Clearly defined about how to apply the Six Sigma methodology in a structured manner to reduce the waste of the operational costs of Waste Water Treatment

so that the desired results can be Achieved. DMAIC stages are Carried out in a structured manner with a clear timeline, and in each phase of six sigma tools are used to Facilitate the data collection, the data analysis or to Determine the root of the problem and the solutions Obtained from the meeting workshop. a. Define phase is the beginning of the implementation of Six Sigma starting with explaining the background of the project, formulating problems and objectives, Determining the project team and time clear lines summarized in the project charter SIPOC then form the which aims to find out the initial description of the process to be Analyzed and the customer needs to be Achieved.

b. Measure phase is the stage of the data collection that aims to understand how much the problem occurred. In this phase all the collected Data is Analyzed using the Pareto diagram of six sigma tools to find out what costs the most in Contribute Waste Water Treatment cost center.

c. The third phase is Analyze, in this phase Several roots are collected

Obtained from the Fishbone problems workshops with the team and champion the project. After the potential root problems are collected then in the cluster to prioritize the root of any problem that will be Followed first as a priority.

d. The fourth phase is Improve, this phase sets out solutions - solutions to Overcome the root problems that have been collected and agreed upon by all teams.

e. The last phase is Control, this phase is the stage where all the improvements that have been made in the control of all the solutions that have been set and benefits - benefits that have been Obtained. If there is a discrepancy, the project leader will conduct an evaluation by compiling an action list if the repair performance decreases or the repaired problem returns again.

2. It is well known that all the root causes of the waste are the operating costs of Waste Water Treatment from Fishbone workshop with all the teams Involved. The root of the problem that has been collected is then divided into three criteria items, namely Constant, Noise, Variable. Then grouped into 5 parts Man, Method, Machine, Material, Mather Nature.

3. Solutions have been set up to follow up on the root of the problem that was collected and agreed upon by all teams. The implemented a solution is expected to be Able to solve the problems that occur regarding the waste management of the operational costs of Waste Water Treatment so that in the future the problem will not occur again in the future.

SUGGESTION

Based on the results of the research Obtained Several things can be suggested as follows:

- a. Team members can do yellow belt training as a basisand full understanding ofcontinuous improvement.
- b. Increasing awareness and involvement of Waste Water Treatment operators in controlling operational costs.
- c. Integrate continuous improvement programs with employee rewarding programs so that they feel more ownership and are motivated to do something better
- d. Having a system and involving all operators to Overcome excessive maintenance costs, doing more internal training involves representatives from the Engineering team.

- e. Further research is needed to verify some of the root problems that have not been found a solution with other six sigma tools.

REFERENCES

- [1]. Cindy, Marika. 2014, Application of six sigma and activity based costing in a garment company PT. X.
- [2]. Gomez Nunez, 2009. Implementation of Six Sigma in a Manufacturing Process: A Case Study
- [3]. Kunal, Ganguli, 2012, Improvement process for rolling mill through the DMAIC Six Sigma approach.
- [4]. Brue, G., 2002, Six Sigma for Managers, Canary, Jakarta.
- [5]. Pyzdek, Thomas, 2002, The Six Sigma Handbook, The Complete Guide To
- [6]. Greenbelts, Blackbelts, and Managers at All Levels, Jakarta,
- [7]. Salemba Four.
- [8]. Gaspersz, Vincent and Avanti Fontana. 2011. Lean Six Sigma for Manufacturing
- [9]. and Service Industries. Bogor: Vinchristo Publisher Publication.
- [10]. Sarkar, D. 2008, Lean for Service Organizations and Offices: A Holistic Approach for Achieving Operational Excellence and Improvements. ASQ Quality Press, Milwaukee.
- [11]. Evans, James R. and William M. Lindsay. 2007. An Introduction to Six Sigma Improvement and Process. Jakarta: Salemba empar
- [12]. Seftyan, Irawan. 2015 Approach to the six sigma (DMAIC) method and the audit process (capp) for quality improvement at pt. IGP
- [13]. Rahman, et al. 2010, Lean Sigma approach as an effort to minimize waste in the pharmaceutical industrial packaging process.