ISSN No:-2456-2165

Operational Analysis of Green Batching Plant Using Dmaic Tools to Improve Company Performance

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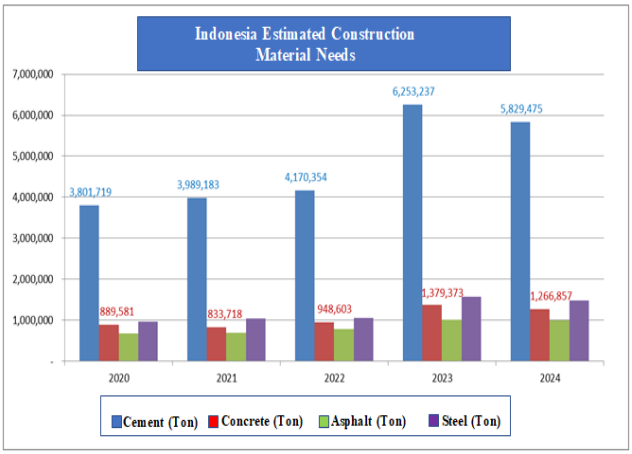
Abstract:- It is inevitable that a batching plant used to produce ready-mix concrete can support the expansion of infrastructure in both urban and rural areas. However, due to the fact that the plant is perceived as environmentally unfriendly due to its material use and waste production, and impacting to operational performance. The purpose of this study is to identify the variables that affect performance and evaluate them both before and after greenfication using a sample of a batching plant located in Serpong, Tangerang, which is one of PT. SBB's 28 batching plant units. To ensure that the research provides the expected results for the author and reader, the DMAIC (Define-Measure-Analyze-Improvement-Control) strategy was applied in this study. This research findings indicate that utilizing fly ash and iron slag as a 15% substitute for cement for concrete can lower consumption costs by 13.5%. Furthermore, using 20% less of the recycle water can lower fresh water cost consumption until 6.84% to retain the availability of clean water in nature while simultaneously improving performance in terms of production costs without lowering the quality of the concrete produced.

Keywords:- *Green Batching Plant, DMAIC, Operational Performance.*

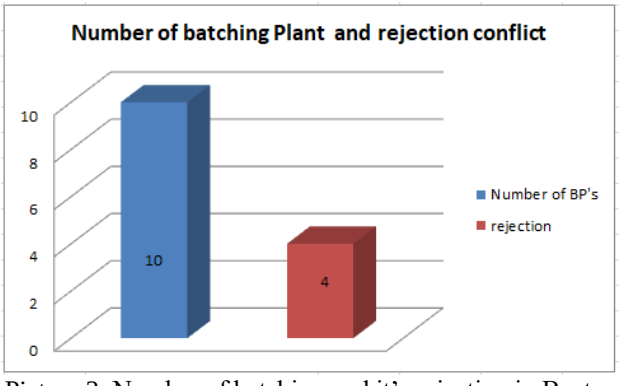
I. INTRODUCTION

The growth of urban infrastructure is inevitably dependent on the presence of a batching plant, which is a factory that produces ready-mix concrete. A typical cubic yard (0.7643 m3) of concrete includes around 10% by weight of cement, and every ton of cement produced results in about 0.9 tons of CO2 emissions. Many papers have been written regarding the usage of supplemental cementitious materials (SCM) such as fly ash and slag in place of cement, with the primary goal of lowering the CO2 emissions from concrete[1]. In this era of open information and globalization, industry competitiveness is more intense amongst businesses. Every business needs to have an advantage in the industry rivalry. The relevance of implementing environmentally friendly concepts in businesses and reducing the amount of pollutants that originate from those businesses' upstream to downstream operational operations is currently one of the demands made by customers.[2] Given the global population growth and the accelerated urbanization occurring everywhere, more concrete is predicted to be needed and produced more frequently. Increased resource consumption and environmental damage will result from continuing to increase the production of concrete. [3]According to the Indonesian Ministry of public works and citizens residential, the demand for building supplies, particularly concrete, is expected to rise by 8% in the 2020–2024 fiscal year.



Picture 1. Indonesia Estimated Construction Material Needs 2020 – 2024

There are 28 batching facilities located throughout the island of Java owned by SBB company, a Jakarta-based ready-mix or ready-mix concrete company. Because of persistent rumors that the presence of batching factories severely disrupted the raw materials and production process by products, some of these developments were initially rejected by the local population. Four of PT. SBB's ten batching plants in the Banten region, which are located in the center of residential neighborhoods, were denied permission to operate because the waste they were using was unable to be recycled and was leaking into the surrounding area.



Picture 2. Number of batching and it's rejection in Banten Area

Using environmentally friendly sources willing to find out and analyze the operational comparison of green batching plants with batching plants in order to increase the efficiency of operational activities using the DMAIC method, and to find out and analyze the results of implementing green batching plants when applied to improve operational performance.

II. LITERATURE REVIEW

➢ *Green Process*

Within the American construction business, the sustainability and green building movement has gained traction. Assessing the sustainability of developed facilities through the use of certain green grading systems is also becoming traditional. In an effort to mitigate the environmental effects of material consumption, the majority of green rating systems encourage the repurposing and recycling of waste materials throughout construction and infrastructure projects[4]. Green industry is a process or operational activity that complies with norms and attitudes to achieve smaller resource savings and can be verified by applying green building principles in accordance with each implementation capability and existing industrial purpose and classification. This definition is based on the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 02/PRT/M/2015. Retrofitting is an effort to change the performance of a building so that it complies with green building standards.

➢ *Production Operational*

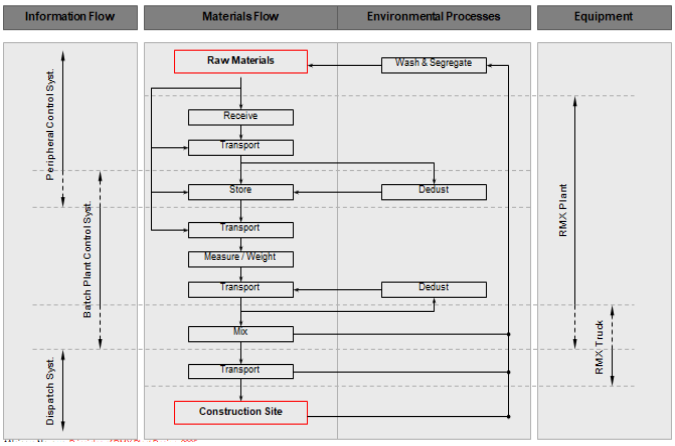
High-quality, high-performing building materials are essential for building construction. Concrete is one of them; it is a composition of cement, stone, sand, water, and various extra elements blended in specific ratios. Depending on the intended use and necessary aesthetics, this material is also available in a variety of options. Concrete produced in a batching plant produces better and more accurate measurements, making it the ideal choice for basic construction materials, and willingness to assist clients and deliver timely service. Being responsive means having the desire to assist clients and offer suitable services (speed and usability)[5]. For a variety of reasons, concrete goods created with this equipment are superior to traditional varieties or those produced through manually. A batching plant's ability to maintain the standards of the concrete it produces is a key component of its quality. The main advantages of ready-mix concrete (RMC) over site-mixed concrete are its superior quality, reduced life cycle costs, speed of construction, and environmental friendliness. However, when RMC quality is inadequate there is a risk of various issues leading to poor or worthless concrete.[6]

➢ *Waste*

Waste includes materials that are useless or have no value at all, as well as products that were harmed or flawed during the production process. Waste is defined as anything that is discarded once a process has finished using it, whether it be a liquid, solid, or gas. If waste is not properly managed or treated during the production process, it may have a negative impact on both persons and the environment where operations take place. As we produce ready-mix concrete, we are accustomed to disposing of manufacturing residue and waste while also cleaning up the surroundings. As a result, the product If it is polluted, specific handling or control measures must be taken.[7]

➢ *Green Batching Plant*

A batching plant is a small factory that produces concrete, the fundamental building material. Depending on the needs, it is typically situated in the center of a residential area or in the middle of an ongoing project.



Picture 3. Principle of Ready-mix Design

It is possible to set up a batching plant nearby in order to expedite and reduce the cost of shipping both the raw materials and the concrete itself. Furthermore some standard, nicknamed as 'three star standard', is the first national standard on green building and became effective on 1 June 2006. It covers both residential and public structures (including office buildings, mall buildings, and hotel buildings) and takes into account every stage of a building's life cycle. With regard to the following six aspects—land conservation and outdoor environment, energy conservation and utilization, water conservation and utilization, material conservation and utilization, indoor environment, operation and management—the goal is to reduce the overall resource, water, energy, and land use for one building.[8]

➢ *DMAIC*

Six Sigma application is measured using the DMAIC (Define-Measure-Analyze-Improve-Control) approach, which consists of The DMAIC process is widely used in organizations to improve operational performance, including client fulfillment, quality product manufacturing, delivery time reduction, and operational cost minimization.[9].

III. METHODOLOGY

This study used a non-probability sampling approach with a purposive sampling technique, this means that the number of samples analyzed was determined by taking specific aspects into account in accordance with the intended parameters. Serpong Batching Plant in South Tangerang, Indonesia, serves as the study's sample or object. Methods for data analysis are required in order to accomplish the goals of this study and produce the anticipated outcomes. The DMAIC method (which stands for define, measure, analyze,

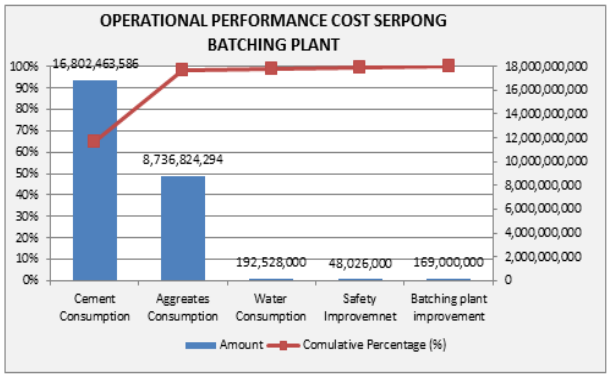
improve, and control) was the analysis technique to solve this problem.

In this paper, DMAIC is used to determine which green activity factors can enhance the performance of concrete products produced by PT. SBB. These is done by computing comparisons between the performance of the concrete products before and after modifications are made to the conventional operational system and the operational flow of the batching plant activities during the operation of the batching plant. The results of these calculations are used to provide input for future improvements that aim to reduce wasted residue and maximize the use of other materials.

IV. RESULT AND DISCUSION

A. Define

Finding issues or phenomena at the SBB Serpong batching facility is the goal of this step. This step's objective is to investigate the problem that arose at the Serpong batching plant, which is a green batching facility. The volume of demand will rise if current materials that are unconventional are given priority as replacements; nevertheless, this can also greatly lessen the production load and contribute to sustainability. The employee team may assess the caliber of the output generated, make any adjustments, and cut down on potential expenses. This stage entails a number of sequential procedures, including gathering business needs and customer requests along with FGD (Focus Group Discussion) analysis and VOA (Voice of Customer) and served on Pareto Diagrams.

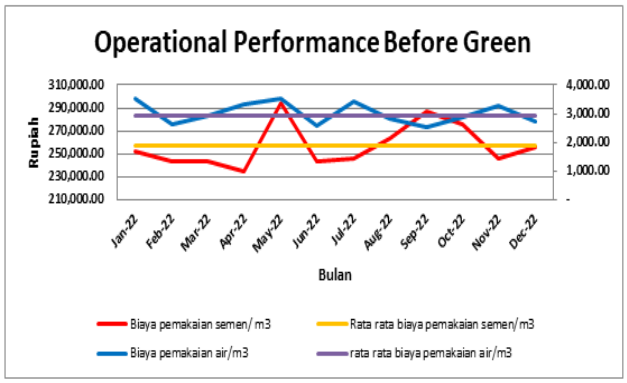


Picture 4. Pareto diagram of operational performance cost

The costs associated with using and consuming cement, using aggregate, and utilizing clean water are the three components of the problem that have the highest costs, according to the Pareto diagram that has been provided. At the Serpong batching plant, the use of cement accounts for 65% of total material consumption. Aggregate requirements come in at 34%, and the use of clean water in the concrete mix accounts for 1%. We will examine the two aforementioned points which is cement and fresh water consumption in order to identify ways to improve Serpong Batching Plant operations and cut costs while maximizing the use of remaining resources.

B. Measure

In order to plan changes and ensure that the company's objectives are clear, this Measure step needs processing data determined from numerous occurrences as a reference. A smaller team discusses the occurrence before deciding to take it on. Water use expenses and cement replacement materials are two issues that the batching plant faces in its production process, based on the proportion of all issues that have been conducted. Thus, in order to lower production costs, identification and solutions are required.

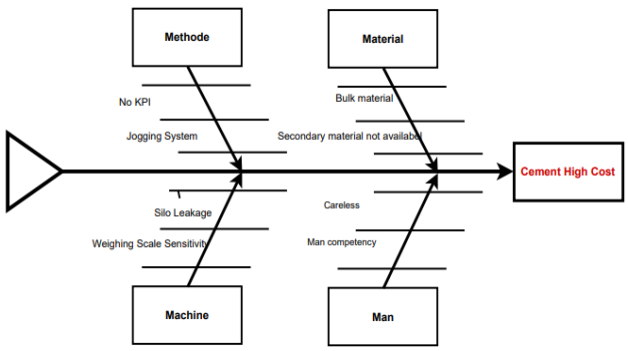


Picture 5. Operational performance before green activities

Based on the picture above, it can be seen that the average cost per cubic meter of concrete is IDR. 399,306.64 for cement and fresh water only. The cost per cubic meter of concrete experiences anomalies that change according to the composition of the product sent in the current month. This needs to be reduced to improve operational performance if the green batching plant has been implemented in Serpong.

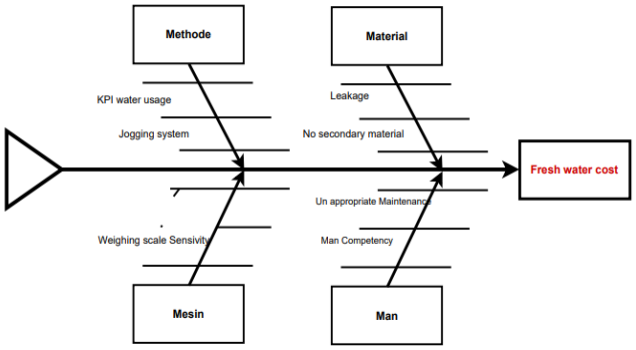
C. Analyze

At the analyze step, an analysis is carried out of the cause and effect correlation and why the performance of a batching plant is not increasing. The analysis used to determine this problem is using fishbone diagram. To search the problem and effect correlation obtained from FGD (Focus Group Discussion), the results of interviews using research and related parties. The Fishbone Diagram can be seen in the following picture. The first diagram relates to the high costs of using cement following fish bone diagram related fresh water consumption in the batching plant at BP. Serpong.



Picture 6. Fish bone diagram cement consumption cost

ISSN No:-2456-2165



Picture 7. Fish bone diagram water consumption cost

D. Improvement

This phase involves making adjustments in order to solve current issues and attain performance goals. During this phase of development, the study team and researchers hunt for easy-to-implement yet highly impactful remedies to issues pertaining to excessive material consumption.

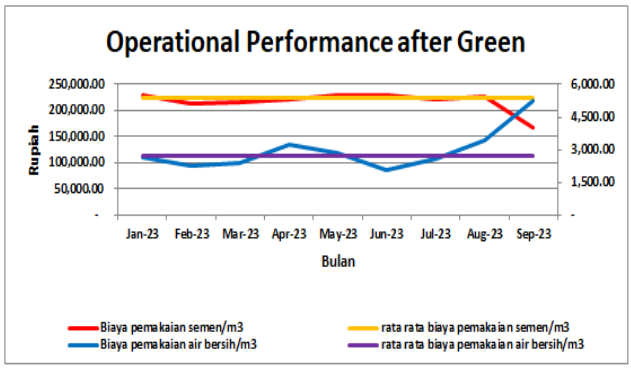
Performance Issue	Solution	Area Improvement	Effort	Impact
Maintenance team competency	Improve the acceptance criteria for new mechanics	Maintenance Department	High	Low
	Conduct training to existing mechanics	Maintenance Department	High	Low
	Provide/Agree on the Service Level Agreement (SLA) created	Operation Department	High	Medium
	Perform weekly maintenance according to schedule	Maintenance Department	Medium	High
Green Environment secondary material	Looking for alternative materials at low prices	Technical Department	High	High
	Trial mix with green secondary materials	Technical Department	**Low**	**High**
	Trial mix with green waste materials	Technical Department	**Low**	**High**
	Trial mix with recycled material	Operation Department	**Low**	**High**
	Increase number of stockpile/silo	Operation Department	High	Medium
	Build Settling pond for water recycling	Operation Department	**Low**	**High**
	Anouncement board regarding material receiving criteria	Operation Department	Medium	Low
Weighing system improvement	repairing production equipment	Bussines Developmnet Dept.	Medium	High
	Calibration of weighing scale from 1 times per year to 2 times/year	Maintenance Department	Low	Medium
	Upgrade weighing operation system	Bussines Developmnet Dept.	High	High
	SOP for operator while material weighing out of tolerance	Operation Department	Low	Medium

Picture 8. Improvement area

From picture 8 explained that trial mix with green secondary material have low effort but has high impact to increase operational improvement.

E. Control

The batching plant's operational activities are increasing in tandem with the modifications made to recycle water (also known as grey water) and replace raw materials in the form of iron slag. It is envisaged that it can be optimized to meet the goals set by the company. Since the change solution effort is still in its early stages of development, the monthly Profit and Loss reports provide a good approach to track the progress made in these areas. Initiatives and improvement mindsets were still in the planning stages at the time this research was conducted, and funds was also being used to construct infrastructure, particularly for water ponds.



Picture 9. Operational performance after green activities

Implementation related to green batching plants can be applied to several batching plants by improving :

- Carrying out SWP (Standard Working Procedure) regarding the acceptance of secondary materials (fly ash and iron slag) in accordance with the specified criteria.
- Provide settling ponds at the batching plant to collect waste water and use it so it does not flowing into surface water and saving cost for fresh water consumption.
- Controlling materials used by not weighing out of tolerance

V. CONCLUSION AND RECOMMENDATION

This research describes how to analyze the performance improvement of the batching plant through green operations to achieve its targets in terms of performance, through the DMAIC process improvement method. Based on the analysis, it is concluded that:

- Factors that influence the performance of a green batching plant which are related to the cost of using materials so that the concrete produced is cheaper and does not affect the quality of the concrete produced by using recycled water, iron slag and fly ash which reduces the global impact on environmental damage related to water use clean as much as 20% and pure cement used as much as 15%.
- It is possible to minimize the amount of cement used by nearly 15% by using fly ash and iron slag as substitute raw materials for concrete. This replacement material can lower production costs by an average of 13.5% of the material used, which will lessen the impact on the environment worldwide. The DMAIC process allows recycled water to replace up to 20% of the total water used, however clean water is still required as a minimum level to prevent environmental damage and is an important material in concrete. Other way 6.84% cost reduction in the use of clean water can be achieved by using recycled water, which will save costs on fresh water purchases and preserve the availability of natural water sources.

ACKNOWLEDGMENT

Special thanks to my family, my wife and my children. Many thanks to my colleagues at batching plants in Banten and West Java for the data, references, and time to discussion. I am particularly grateful for the guidance I received from Mrs. Tukhas Shilul Imaroh as my lecturer and Mr. Agustinus Hariadi for the support. Thank you to the entire Operational Class team, my fellow students at Mercu Buana University of Master Management program, and all of the lecturers who have helped me learn. I really appreciate your cooperation. May God grant you a great reward for all your kindness to everyone who has supported and assisted with this research, as well as helped and encouraged me through out.

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