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Reducing CIP (Cleaning in Place) Time on Spray Drier Machine with DMAIC Method

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Abstract:- PT XYZ is a company engaged in manufacturing that produces Food Flavors. The main problem that occurs is the water consumption during cleaning (Product Changeover) is very high. The purpose of this study is to reduce the use of water during cleaning and reduce cleaning time, and productivity can be improved by the DMAIC method. The first step is to analyze each product characteristic and collect CIP Record data. From this data, it can be seen how long it takes for CIP. This improvement involves the Quality Team to verify the results of the CIP time reduction. As a result of the improvement, the time required for CIP from 3 hours dropped to 2 hours. As well as water consumption from 1,088 M3 to 762 M3 (Saving 366 EUR).

Keywords:- *Lean Six Sigma, DMAIC, Quality, Efficiency, Food Industry.*

I. INTRODUCTION

PT XYZ is one of the companies engaged in the Flavor manufacturing industry for multinational companies engaged in the Food industry. One of the problems that occurs is the high use of water during CIP. So it is necessary to make improvements that can reduce water usage during CIP. On the other hand, reducing water usage during CIP can speed up CIP time (waste) and increase productivity. With the DMAIC Method, it is expected to overcome the problem so that it can reduce water usage, speed up the time required, and increase productivity. The production system used by PT XYZ is a make to order system, which is a production system that is carried out based on the existence and number of incoming orders from customers.

II. THEORETICAL FOUNDATION

There are 5 stages that Six Sigma uses in problem solving known as the DMAIC Method. The following are the 5 DMAIC Stages:

- *Define*

The first DMAIC stage in Six Sigma is DEFINE, which is the stage for defining and selecting problems to be solved along with costs, benefits and impacts on customers.

- *Measure*

Measurement is the stage of measuring the problems that have been defined to be solved. In this stage there is data collection which then measures the characteristics and capabilities of the current process to determine what steps must be taken to make further improvements and improvements.

- *Analysis*

The Analysis stage is the stage to find solutions to solve problems based on the Root Cause that has been identified. In this stage, we must be able to analyze and validate Root Causes or Solutions through Hypothesis statements.

- *Improve*

After getting the Root Causes and Solutions and validating them, the next stage is to take corrective action on the problem by testing and experimenting to be able to optimize the solution so that it is really useful for solving the problems we experience.

- *Control*

The purpose of the Control stage is to establish standardization and control and maintain the process that has been implemented.

- *Research Objective*

Cleaning In Place (CIP) is a cleaning method in which equipment used in the food, beverage, pharmaceutical and other industries is cleaned without dismantling the machine. Cleaning In Place systems are installed, so that specialized detergent and sanitizing solutions can be circulated throughout the equipment to remove dirt, and bacteria. The system circulates the cleaning solution using 4 factors, namely temperature, contact time, concentration and specific flow rate. This ensures that the cleaning process is consistent and effective, reducing the risk of contamination and ensuring high levels of cleanliness are maintained. The objectives to be achieved in this study are to reduce water usage during CIP, speed up CIP time, and increase productivity with the DMAIC method.

III. RESEARCH METHODS

DMAIC is a methodology used for process improvement adopted from Six Sigma, a framework that aims to improve quality and efficiency by identifying and eliminating the causes of defects or problems in business processes. DMAIC is an acronym for the five main phases in process improvement: Define, Measure, Analyze, Improve, and Control. This study was conducted by collecting CIP Record data for the last 6 Months for data collection before making improvements.

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IV. DISCUSSION RESULTS

➢ *Define*

At this stage, the goals and objectives of improvement are determined, the object of research is to reduce expenses from water consumption. Identification is developed from specifications sourced from the Finance team in the company. The following product defect data is presented in the form of a pareto diagram.

- *Pareto Diagram of Company Expenses:*

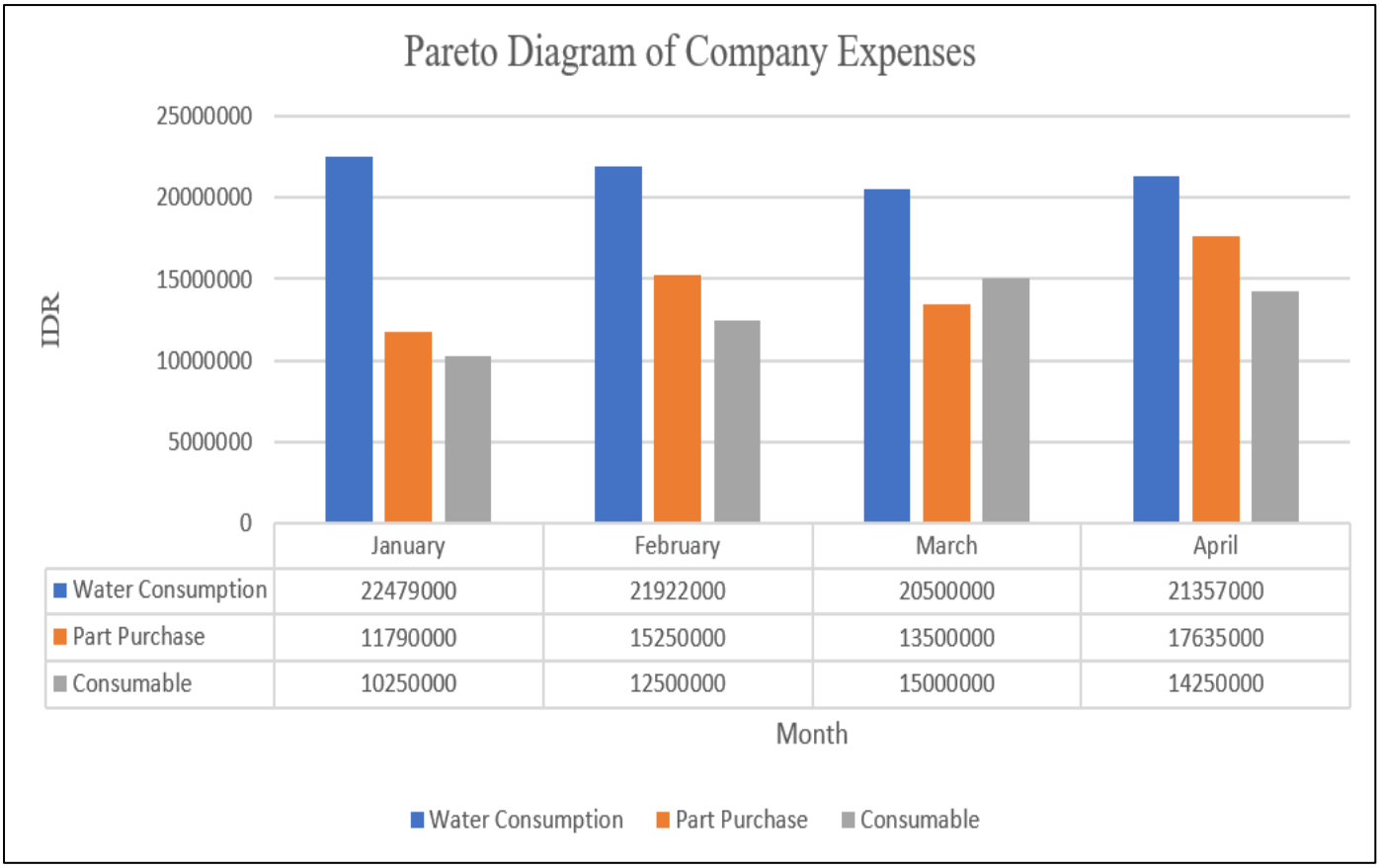

Fig 1 Company Expenditure Data

➢ *Measure*

This stage is a validation stage carried out by the Quality team to be further checked by internal Quality and External Lab to ensure the cleaning results are free from unwanted molecules and microbiology through sampling. Samples that will be tested include:

- The temperature of the water used (50 ° C-70 ° C)
- Chemical concentration used
- Water from the final cleaning rinse

➢ *There are 2 Types of Swabs that are Done to Validate the Cleaning Results, Including:*

- ATP (Adenosine Triphosphate) Swab, is a molecule that exists in living things (animals, plants, bacteria, etc.). ATP swab is done as an indicator of the presence or absence of living things residue after the cleaning process. The ATP swab uses Hygiena Ultrasnap ATP Surface Swabs with a result of <10 RLU.

Fig 2 SWAB ATP

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- Swab Microbiology, conducted to determine the presence or absence of microbiology that grows after the cleaning process.

Fig 3 SWAB Microbiology

➢ *Analysis*

At this stage, the cause of high water usage during cleaning is the absence of standard parameters for cleaning activities. The use of high water flow, long contact time, and the use of high chemical concentrations cause high water consumption waste. Of the many root causes of the problem, the dominant causal factor is then determined to find a solution. Fishbone diagram is used before making improvements.

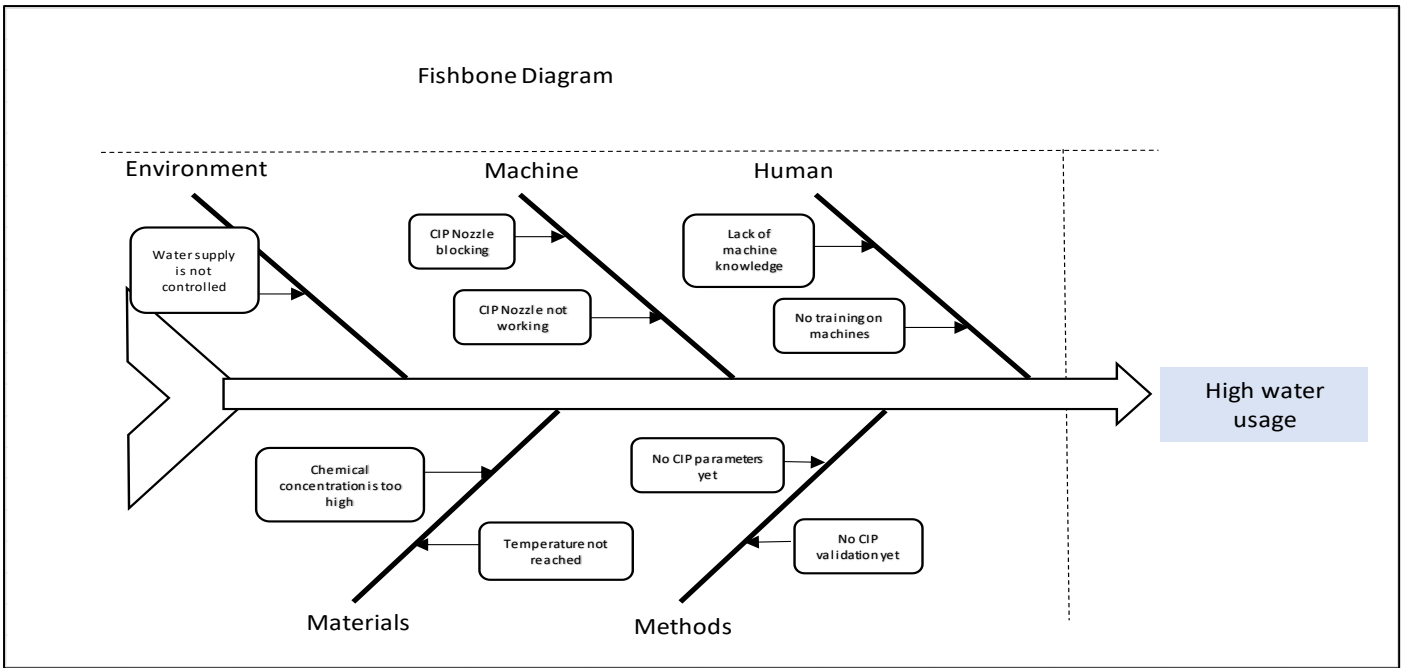

Fig 4 Root Cause Fishbone Diagram

➢ *Improve*

From the CIP process record, it can be seen that the time required to carry out CIP before making improvements is 81 hours in 1 month as shown in Table 2.

- *CIP Record Table in 1 Month:*

Table 1 CIP Record Table in 1 Month

Saving Calculation:							
MYR	Jul	Aug	Sep	Oct	Nov	Dec	Total
Method of calculation: Accelerate justification							
Baseline - 2024							
CIP before improvement (hours)	81	81	81	81	81	81	486
Water Consumption (M3/CIP)		1,088	1,088	1,088	1,088	1,088	5,440

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This stage is an activity to determine alternative improvements to reduce water usage during CIP and improve company performance. The following Improve proposals can be applied, including reducing the duration of each pipe line which was previously 600 sec, to 300 sec. The results of reducing the duration of each pipe line show a decrease in water usage, from the previous 1,088m3 down to 762m3 or saving 326m3 of water. In terms of costs incurred for 1 time CIP from the previous 1,219 eur to 854 eur or save 366 eur. The following data on the results of improvements that have been made can be seen from the table below:

- *Table Data on Water usage Results before and after Improvement*

Table 2 Data on Water usage Results before and after Improvement

Water consumption - Before (M3 / CIP)				1,088	1,088	1,088	1,088	1,088	5,441
Water consumption - After (M3 / CIP)				762	762	762	762	762	3,808
Different (M3 / CIP)				326	326	326	326	326	1,632
Water cost/M3 (EUR / M3)				1.12	1.12	1.12	1.12	1.12	1.12
Water saving (EUR)				366	366	366	366	366	1,832
Total saving (IDR)	-	-	-	175,317,835	175,317,835	175,317,835	175,317,835	175,317,835	1,010,849,999
Total saving (Eur)	-	-	-	10,706	10,706	10,706	10,706	10,706	61,731

The productivity side has also increased, from 81 hours of CIP time per month down to 57.40 hours or saving 23.67 hours. From the savings of 23.67 hours, it can produce 774 kg of Finish Goods products, and reduce the selling price of products per kg from 10.27 euros to 7.946 euros. The following data on the results of productivity improvement can be seen from the table below:

- *Data on Productivity Improvement Results after Improvement:*

Table 3 Data on Productivity Improvement Results after Improvement

Output/Online Hr (Kg/Hr)				45.00	45.00	45.00	45.00	45.00	45.00
CIP after improvement (Hr)				57.40	57.40	57.40	57.40	57.40	287.00
Saving CIP hours				23.67	23.67	23.67	23.67	23.67	199.40
Capacity utilization				73%	73%	73%	73%	73%	73%
Potential Kg produced (Kg)				774	774	774	774	774	6,519
Margin (EUR/kg)				10.27	10.27	10.27	10.27	10.27	10.27
Potential Margin (EUR)				7,946	7,946	7,946	7,946	7,946	39,732

The cost of the production process also decreased from the previous 4.83 eur down to 4.68 eur. Production volume increased from 14,648Kg per month up to 15,432Kg. Can be seen from the table below:

- *Table of Decrease in Production Cost after Improvement:*

Table 4 Decrease in Production Cost after Improvement

Direct cost per kg				4.83	4.83	4.83	4.83	4.83	4.83
Energy cost per kg				1.74	1.74	1.74	1.74	1.74	1.74
additional energy cost				1,346	1,346	1,346	1,346	1,346	11,344
Total new direct factory cost				72,201	72,201	72,201	72,201	72,201	365,615
Base volume				14,658	14,658	14,658	14,658	14,658	73,292
New volume				15,432	15,432	15,432	15,432	15,432	79,811
New direct cost per kg				4.68	4.68	4.68	4.68	4.68	4.58
Operating leverage savings (EUR)				2,394	2,394	2,394	2,394	2,394	20,167

➢ *Control*

At this stage it is very important to do so that the CIP process that has been improved can be maintained, namely by:

- Conduct an ATP SWAB after completing the CIP.
- Perform Cleaning Validation at least once a month.
- Analyze the product to ensure there is no contamination in the product.

V. CONCLUSION

Based on this research, it can be concluded that it is important to determine the parameters when doing CIP so as not to cause waste in terms of time and cost. Based on the results of the improvement, it can be seen that water usage can be reduced so that water consumption can be more efficient, from the previous 1,088m3 down to 762m3 or saving 326m3 of water. CIP time is faster than before 3 hours, to 2 hours or save 1 hour. And the costs incurred are

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smaller, previously 1,219 eur to 854 eur or saving 366 eur. With validation results remaining OK, and can produce higher Finish Goods from the previous 14,648Kg per month up to 15,432Kg. The suggestion from this journal is to perform validation cleaning at least once every 3 months to ensure the cleaning results are still consistent.

REFERENCES

[1]. Ida Rinjani, Wahyudin Wahyudin, Billy Nugraha (2021), Analisis Pengendalian Kualitas Produk Cacat pada Lensa Tipe X Menggunakan Lean Six Sigma dengan Konsep DMAIC, 8(1), 18-31

[2]. Rizka Oktaviani, Heru Rachman, Muhammad Rifky Zulfikar, Muchammad Fauzi, (2022), Pengendalian Kualitas Produk Sachet Minuman Serbuk Menggunakan Metode Six Sigma DMAIC,2(1), 122-130

[3]. Sumiharni Batubara, Raden Abdurrahman Halimuddin (2016), Penerapan Lean Manufacturing Untuk Meningkatkan Kapasitas Produksi Dengan Cara Mengurangi Manufacturing Lead Time Studi Kasus: Pt Oriental Manufacturing Indonesia, 1(01), 49-56

[4]. Diko Ryanda Nasution, Abdurozzaq Hasibuan, Siti Rahma Sibuea (2023), Pengendalian Kualitas CPO untuk Meminimumkan ALB Menggunakan Metode DMAIC, 1(4), 333-343

[5]. Suseno, Taufik Alfin Ashari (2022), Analisis Pengendalian Kualitas Produk Base Plate Dengan Menggunakan Metode Lean Six Sigma (DMAIC) Pada PT XYZ, 1(6), 1321-1333

[6]. Tegar Septiawan, Ricky Permadi,Yudi Prastyo (2024), Menganalisis Penyebab Produk NG (Not Good) Pada PT. XYZ Dengan Metode DMAIC, 3(1), 44-51

[7]. Mayesti Kurnianingtias, Abdul Rohman Heryadi, Dinarisni Purwanningrum, Galuh Yuli Astrini, Hasna Khairunnisa, Lailin Nur Indah Sari (2021), Analisis Penyelesaian Permasalahan Bottleneck Pada Lini Produksi Di Pabrik Tekstil Dengan Metode Kaizen, 9(2), 23-30

[8]. Joko Susetyo, Winarni, Catur Hartanto (2011), Aplikasi Six Sigma DMAIC Dan Kaizen Sebagai Metode Pengendalian Dan Perbaikan Kualitas Produk, 4(1), 78-87

[9]. Zaharah Wahid, Mohd Radzi Che Daud,Kartini Ahmad (2020), Study Of Productivity Improvement Of Manual Operations In Soya Sauce Factory, 21(1), 202-211

[10]. Erry Rimawan Damsiar, Yudi Prastyo (2018), Reduce Reject Painting Process Using Six Sigma Method with DMAIC Approach and Experiments on Brake Disc Products (1 Rc Hub) (Case Study PT. XYZ), 3(10), 327-337

[11]. Putri Kartika, Annisa Marwa, Tri Wahyuningsih, Yudi Prastyo, Tri Ngudi Wiyatno (2024), Lowering Customer Claim &; Ng Ratio on Jack Bracket Part Using Lean Six Sigma-DMAIC Method at PT. XYZ, 9(1), 3319-3329