Analysis of Obstacles in The Unloading Process with Failure Mode and Effect Analysis (FMEA) in PT. XYZ

Khawarita Siregar¹, Ukurta Tarigan², Richard Spencer³

¹,²,³Department of Industrial Engineering, Faculty of Engineering, Universitas Sumatera Utara, Medan, Indonesia

E-mail: richardspencer756@gmail.com khawarita@usu.ac.id

Abstract. Distraction that occur can have a bad effect on time, financially and product quality. This disorder can be caused by various factors such as the influence of human factors, machinery and production equipment, work environment, and work methods. Based on preliminary observations, many obstacles occur during the unloading process both mechanically and electrically. Thus, an analysis is carried out on the process of unloading wheat from the ship to the silo with FMEA. Based on the analysis after calculating the RPN, the recommendation for problem on silo is to increase the number of silos so that the production process is more efficient. Based on the calculation of the RPN, obtained that resistance at PT. XYZ the weigher to be aware of is the sensor that is often damaged. Recommendations for improvement are regular checks on the sensors weigher.

1. Introduction

Quality is defined as the totality of the characteristics of a product that supports its ability to satisfy specified or defined needs [1]. Based on the basic understanding of quality, quality is always customer focused (customer focused quality). Thus products are designed and manufactured to meet the desires of customers. Because quality refers to everything that determines customer satisfaction, a product that is produced can only be said to be of quality if it is in accordance with customer desires, can be used properly, and is produced in a good and correct way [2].

A company who wanted to achieve maximum profits should improve various aspects. One aspect to be considered is the production process. In the production process problems often occur, causing a bottleneck. Distraction that occur can inhibit the production process so as not optimal.

Research conducted on the company which based on observation that there are distractions on the unloading process that cause bottleneck. This bottleneck occurs because of problems in the mechanical and electrical machinery and equipment used. Obstacle that occur in the unloading process can lead to the whole process stops. This is because wheat is not transported to the production floor so that the process is not optimal. If this problem continues, it will create financial loss and bad quality of material to company.

According to research conducted by G.S. Sawadadkar that FMEA is an analytical methodology used to ensure that potential problems have been considered throughout the product and process development cycle. A process or a design should be analyzed first before the process or design implemented and also before operating a machine the failure modes and effect must be analyzed.
critically. In his work the process analysis is done on general welding process. The result is reducing breakdown and increasing the equipment availability at low cost [3].

According to research conducted by Charan Tej.R that FMEA is deductive method, the risks has been analyzed without any shortcomings and remedial measures being taken. The results of the study recommended that there is an essential need for more standardization which addresses issues of clarity, fairness, roles and responsibilities, allocation of risks, dispute resolution and payment. More effort should be made to properly apply risk management in the construction industry. Based on the findings, a number of recommendations facilitating more effective risk management can be developed for the industry practitioners [4].

According to research conducted by Eko Krisdiono that FMEA to identify consequences for the process of repairing KRI in Surabaya Lantamal V, so that it is expected that the application of this method can improve the operational performance of Fasharkan to eliminate or reduce the risks that occur in the repair process ships in the eastern region of the fleet [5].

According to research conducted by Aulia Ishak that the GRA and FMEA methods are flexibility in calculating the weight of each factor in FMEA. Processing linguistic information based on expert knowledge and experience allows a pragmatic, thoughtful, and flexible way to suggest judgment [6].

According to research conducted by Khawarita Siregar that FMEA can be used to identify the sources and root causes of quality problems that can be used to propose improvements for quality of product. The proposed improvements are doing improvement in the sorting of fruit, made some improvements to the machine, make improvements in the form of checks each parameter standard compliant or not [7].

The method used in this research is the method Failure Mode and Effect Analysis (FMEA). Because this method is suitable for analyzing the obstacles that occurred during the unloading process in PT. XYZ where we can analyze the barriers by way of treatment, condition and the number of events. The study will analyze also using Statistical Process Control that researchers focused on the most important issues.

2. Method
Quality control is a combination of all the tools and techniques used to control the quality of a product at the lowest possible cost and meet the requirements of the customer. Quality control is an engineering and management activity, by which the characteristics of product quality are measured. The factors that influence quality control include[8]:

- In terms of operators: the skills and expertise of people who handle products.
- In terms of raw materials: raw materials supplied by the seller.
- In terms of machines: the types of machines and machine elements used in the production process.

In any production process, an inherent or natural amount of variability will always exist regardless of how well it is designed and maintained. Natural variability or background noise is a cumulative effect whose basic cause cannot be avoided. In the context of statistical quality control, this natural variability is often called the stable system of chance causes. A process operating with only variation in chance causes is said to be under statistical control. In other words, chance causes are an inherent part of the process [9].

Cause and effect diagram or fishbone diagram was first introduced by Kaoru Ishikawa and this diagram is used to help organize information about the potential causes of a problem. The fishbone diagram consists of the main problems and the main causes [10].

Pareto chart is a distribution of frequencies or data attributes arranged by category. Using this method, users can quickly identify the types of defects that occur most frequently. For the record, the pareto chart does not automatically identify the most influential types of defects but the types that occur most frequently [11].
Failure Mode Effects Analysis (FMEA) is a risk analysis technique used to evaluate the loss resulting from the failure terms of the effect occurs. Basically FMEA adapted for materials and equipment failure, but in line with the needs, FMEA can be used to analyze failures due to human error (human error) and Performance. Scoring on each of the components, is done by giving prior assessment of the severity, occurrence, detection, and the end result in the form of risk priority number. Value risk priority number (RPN) is obtained by multiplying the value of severity (severity), events (occurrence), and detection (detection) [12].

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RPN = \text{Severity (S)} \times \text{Occurrence (O)} \times \text{Detection (D)}
\]

3. Results and Discussion
The following is a discussion of the problem that occurred in the factory.

3.1. Unloading Process
The first process is done were unloading wheat (unloading). Wheat is imported from other countries and shipped to the ports belonging to Bogasari accommodated in the hatch in the ship. Party boats will be checked administratively by the Indonesian port before leaning in Bogasari owned port.

Wheat will be transported using material handling tools such as belt conveyor with a capacity of 1000 tons / hour each track that where there are two lanes. Before getting into the silo, grain passing through cross belt transfer where there is a screening process waste transported at the time of unloading. Then the grain is filtered by a magnetic separator to separate iron plates that is in wheat. Then wheat put into the hopper which serves to accommodate the grain while before getting on the scale (Weigher Distribution House). Then it will go into the scales with a capacity of 4,000 kg/tip. Weighing intended as a system to control the transportation and entry to the grain silo, so there will be excess capacity in a conveyance and the situation inside the silo can be controlled.

Furthermore, the wheat will enter the silo will be taken to a separator machine. Separator machine is used to cleanse the wheat from foreign materials such as gravel, paper, grain, iron, etc. After cleaning the grain will be transported by conveyor belt and raised to the top by using bucket elevators, will be included in a wheat silo using conveyor chain.

In the process unloading there is some disturbance that was not optimal. Disturbance can give bad effect either time, financial and product quality. This disorder can be caused by various factors such as the influence of the human factor, machinery and production equipment, working environment and work methods. The company continues to strive to improve the quality in terms of production in order to minimize the costs to be incurred.

Observations were made only limited problems in the process of unloading the wheat from the ship up into the silo. This is because many of the barriers that occur during the process of unloading both mechanical as well as electrical. This causes if frequent obstacles on the machines, it can reduce the economic age of the equipment and machines so that the machine more easily damaged.

3.2. Problem
The problems that occurred in PT. XYZ with direct observation and use historical data to support the research. Direct observation also to look at the issue directly, so knowing what is happening on the ground. Here is the total of bottleneck that occurred in 2018 and 2019 can be seen in Figure 1.
Check sheet is a tool to collect data to be analyzed. Is the purpose of this tool is to simplify the process of collecting data to be analyzed. Check sheet amount of resistance that occurs during the unloading process can be seen in Table 1.

Table 1. Check sheet barriers when unloading process

| No. | Machine       | Total Problems |
|-----|---------------|----------------|
| 1   | Belt Conveyor |                |
| 2   | Neuero        |                |
| 3   | Weigher       |                |
| 4   | Silo          |                |
| 5   | Elevator      |                |
| 6   | Chain Conveyor|                |

From the results of the check sheet can be seen that the weigher often encountered resistance from others then the second most is a bottleneck in the silo. The histogram is a diagram to show the spread or standard deviation of a process. The data obtained from the measurement frequency shows a peak at a certain value. Histogram of the amount of resistance that occurs during the process of unloading in Figure 2.
Figure 2. Histogram of unloading process

From the image histogram above can be seen that the weigher often encountered resistance from others then the second most is a bottleneck in the silo.

3.4. Pareto Diagram
This diagram is used to find the barriers that should be prioritized for investigation. In Pareto diagrams, disability sorted from largest to smallest percentage and looked upon the cumulative percentage of any defective product, the cumulative percentage of 100% indicates the total resistance of a process. Percentage of priority of the obstacles in the process of unloading can be seen in Table 2.

Table 2. Calculation for pareto diagram

| No. | Machine     | Total Distraction | Percentage (%) | Cumulative Percentage (%) |
|-----|-------------|-------------------|----------------|---------------------------|
| 1   | Weigher     | 167               | 22.18          | 22.18                     |
| 2   | Silo        | 155               | 20.58          | 42.76                     |
| 3   | Neurous     | 130               | 17.26          | 60.03                     |
| 4   | Elevator    | 114               | 15.14          | 75.17                     |
| 5   | Belt Conveyor| 108              | 14.34          | 89.51                     |
| 6   | Chain Conveyor| 97               | 10.49          | 100.00                    |

These barriers percentage data priorities would be incorporated into the Pareto diagram. Pareto diagram the amount of resistance in the unloading process can be seen in Figure 3.
From the Pareto diagram above, it can be seen that the percentage of obstacles in the problem that occurs is not dominant, so the Pareto diagram cannot be used so that the problem to be investigated is 3 problems with the largest number of problems.

3.5. Cause and Effect Diagram
Cause and Effect Diagram or Ishikawa diagrams were introduced by Prof. Kaoru Ishikawa. Cause and Effect Diagram (causal diagram) is a tool used to systematically put the root cause of quality problems.

Settlement method with the use of this diagram is used to analyze and determine the factors that cause the bottleneck submarine unloading process. To determine the cause of the bottleneck aspect submarine unloading process obtained from historical data and direct discussions between the supervising field with the field manager at PT. XYZ. Cause-effect diagram (fishbone) for the obstacles that occur in the unloading process can be seen in Figure 4 to Figure 6.

![Fishbone Diagram](image)

**Figure 4.** Diagram of cause and effect (fishbone) cause obstacle in weigher

Based on the above fishbone diagram can be seen that the factors affecting the obstacles that occur in the weigher is material, human and machine.
Based on the above fishbone diagram can be seen that the factors affecting the obstacles that occur in the silo are materials, methods and machines.

**Figure 5.** Diagram of cause and effect (fishbone) cause obstacle in silo

Based on the above fishbone diagram can be seen that the factors affecting the obstacles that occur in neuero is material, human and machine.

**Figure 6.** Diagram of cause and effect (fishbone) cause obstacle in neuero

3.6. **Failure Mode Effects Analysis (FMEA)**

Failure Mode Effects Analysis (FMEA) is a risk analysis technique were used to evaluate the loss resulting from the failure terms of the effect occurs. The calculation of RPN can be seen in Table 3 until Table 5.
Table 3. Percentage of obstacle process priority unloading (weigher)

| Category Causes | Risk | As a Result of the Risk | Severity | Cause                                      | Occurrence | Control               | Detectability | RPN |
|-----------------|------|-------------------------|----------|--------------------------------------------|------------|-----------------------|---------------|-----|
| Material        | weigher problematic | weigher clogged | 3        | Wheat, which is a lot of dust and chaff     | 3          | Cleaning routine      | 4             | 36  |
| Machine         | Sensor broken       | The results do not match the target weigher | 5        | The presence of electrical problems in engines | 3          | Inspection regularly  | 4             | 60  |
| Human           | The results do not match the scales | Actual results that differ from the accounting | 2        | Less scrupulous operators                   | 2          | Inspection periodically monitors | 5             | 20  |

According to the table, drag on the weigher to be aware of is the sensor that is often damaged. Recommendations for improvement are regular checks on the sensors weigher.

Table 4. Percentage of obstacle process priority unloading (silo)

| Category Causes | Risk       | As a Result of the Risk | Severity | Cause                                      | Occurrence | Control               | Detectability | RPN |
|-----------------|------------|-------------------------|----------|--------------------------------------------|------------|-----------------------|---------------|-----|
| Material        | full silo  | Delays in the production process | 8        | Less grain silos to accommodate           | 4          | Increasing the number of silos | 3             | 96  |
| Machine         | Slidegate jammed | Longer grain filling | 3        | The presence of electrical problems in engines | 3          | Pengecakan regularly  | 4             | 36  |
| Method          | Slidegate clogged | Can not be filled grain silo | 4        | Less routine cleaning schedule            | 2          | Slidegate more routine cleaning | 5             | 40  |

According to the table, drag on the silo should be noted that the silos are full. Recommendations for improvement is the addition of the number of silos.

Table 5. Percentage of obstacle process priority unloading (neuro)

| Category Causes | Risk                                      | As a Result of the Risk | Severity | Cause                                      | Occurrence | Control               | Detectability | RPN |
|-----------------|-------------------------------------------|-------------------------|----------|--------------------------------------------|------------|-----------------------|---------------|-----|
| Material        | Aspiration of wheat is hard               | Unloading time becomes longer | 5        | Wheat has a cold temperature               | 2          | Checking the temperature when unloading | 5             | 50  |
| Machine         | Suctioning is not the maximum             | Vacuming time longer    | 7        | Pipes do not hold up to basic hatch         | 3          | Modifications intakes | 3             | 63  |
| Human           | Less scrupulous operators                 | Aspiration is not optimal | 3        | Been less attention to indicators of engine capacity | 4          | Periodically checking indicator | 4             | 48  |

According to the table, drag on the engine neuro to note is that no maximum suction machine. Recommendations improvement is a modification of pipe cleaners.

4. Conclusion
From the results it can be seen that the percentage of obstacles in the problem that occurs is not dominant so that the problem to be investigated is 3 problems with the largest number of problems. Based on the calculation of the RPN, obtained that resistance at PT. XYZ the weigher to be aware of is
the sensor that is often damaged. Recommendations for improvement are regular checks on the sensors weigher. Obstacle in silos that must be considered are the silos are full. Recommendations for improvement is the addition of the number of silos. Constraints on neureo machine that must be considered is the suction machine that is not optimal. Recommendations improvement is a modification of pipe cleansers. Companies should tighten the maintenance schedule on machinery and equipment in order to reduce the problems that can occur in the company. We recommend the addition of silos by companies accelerated so that the production process more efficient.

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Reference
[1] Gaspersz V 2007 Total Quality Management (Jakarta : PT. Gramedia Pustaka Utama)
[2] Grant E L, Leavenworth, Richard S 1996 International Edition Statistical Quality Control 7th Edition Mc Graw-Hill
[3] Sawadadkar G S 2019 Failure Mode and Effect Analysis on Welding Assembly Process (India: JSPM Narhe Technival Campus)
[4] Charan T and Krishnamoorthi A 2019 Analysis of Risk Management in Construction Sector Using Fault Tree Analysis and Failure Mode Effects Analysis (India : Adhiparasakthi Engineering College)
[5] Krisdiono E 2019 An Analysis on Kri Improvement Project in Indonesian Naval Main Base No. V Surabaya Fasharkan (Navy’s Battleships Maintenance and Repairing Facilities Using Fuzzy FMEA Method (Surabaya : Indonesia Defense University)
[6] Ishak A et al 2019 IOP Conf. Ser.: Mater. Sci. Eng. 505 012057
[7] Siregar K et al 2020 IOP Conf. Ser.: Mater. Sci. Eng. 801 012121
[8] Besterfield D H 1998 Quality Control 5th Edition (Carbondale: Southern University at Carbondale)
[9] Montgomery D C 2009 Introduction to Statistical Quality Control 6th Edition (United State of America: John Wiley & Sons)
[10] Besterfield D H 1998 Quality Control 5th Edition (Carbondale : Southern University at Carbondale)
[11] Montgomery D C 2009 Introduction to Statistical Quality Control 6th Edition (United State of America: John Wiley & Sons)
[12] McDermot R E 2009 The Basic of FMEA Edisi 2 (USA : CRC Press)