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Safety Analysis Using Seven Basic Quality Tools Fishbone Diagram

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ABSTRACT
Workplace hazards have the potential to cause occupational diseases. Occupational diseases are illnesses caused by work and/or the work environment (Presidential Regulation Number 7 of 2019 on Occupational Diseases). The importance of knowledge about occupational diseases is crucial because many people do not realize that the health problems they experience are the result of their work. Occupational diseases can be prevented, but if they are detected too late, they can lead to more serious health problems, which will have a greater impact on the workforce and increase healthcare management costs, ultimately reducing work productivity. The aim of this research is to prevent the occurrence of occupational diseases using the Decision Support System (DSS) method with the Seven Basic Quality Tools Fishbone Diagram, which helps analyze various issues related to the impact of occupational diseases. Moreover, this method has many other functions and benefits, as it identifies the cause-and-effect relationships between the variables (factors) causing the problem (X) and the resulting variables. Several methods were used in this research to gather data and perform appropriate analysis. This approach can assist fieldwork and be used to experience the process of work safety and health directly. The Fishbone Diagram, also known as the Ishikawa diagram or cause-and-effect diagram, is a tool used to identify the root causes of problems. The name comes from Kaoru Ishikawa, a Japanese quality control expert who developed this concept in the 1960s. Organizations across various industries, including manufacturing, healthcare, and services, use the Fishbone Diagram to identify and analyze the factors contributing to specific problems or issues. Teams typically use the diagram to identify all possible causes of a problem or effect. They label these causes based on major contributing factors, such as people, equipment, materials, environment, and methods. Once all the causes are identified and listed, the next step is to analyze the relationships between them to identify the root cause of the issue. This can be done using various techniques, such as the "5 Whys" method, where one repeatedly asks why a problem occurred until the root cause is identified. The results of the research showed that the risk value for occupational diseases, specifically respiratory disorders, before the implementation of the Fishbone Diagram was 12 incidents, and after the implementation, the number of incidents decreased to 4.

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INTRODUCTION

Workplace Hazards and Occupational Diseases

In the workplace, there are potential hazards that can affect workers' health. These hazards can lead to occupational diseases, which are illnesses caused by the work itself and/or the work environment. The importance of understanding occupational diseases is significant, as many workers do not realize that the health issues they experience are related to their jobs. Occupational diseases can be prevented, but if they are discovered too late, they can lead to more severe health problems, which have a greater impact on the workforce. This increases healthcare management costs and decreases work productivity. Occupational diseases generally involve a specific link between exposure and the illness, with a higher frequency in the workforce compared to the general population. These diseases can typically be prevented. Prevention measures for occupational diseases include elimination (removing hazardous exposure sources), substitution (replacing hazardous materials with safer ones), engineering controls (such as isolation, ventilation, and air conditioning), administrative controls (such as regular health check-ups, safe work practices, working hours, job rotation, and education for workers), and the use of personal protective equipment (PPE) according to standards. Recognizing potential hazards in the workplace that can impact health, it is crucial to implement prevention and early detection strategies for health issues, including occupational diseases, by conducting regular medical check-ups based on workplace exposure.

Occupational Health and Safety (K3):

Occupational Health and Safety (K3) is a cooperative effort between employers and workers to implement mutual responsibilities in the area of workplace safety, health, and security in order to increase productivity. By applying K3, it is hoped that a safe and healthy workplace will be created, benefiting employees, customers, and visitors, thus reducing or preventing workplace accidents and occupational diseases.

Fishbone Diagram:

The Fishbone Diagram, also known as the Cause-and-Effect Diagram or Ishikawa Diagram, is a graphic representation of the potential causes of a specific problem or defect. This tool, developed by Kaoru Ishikawa, is used to identify causal factors as sources of variation. By grouping these factors, the Fishbone Diagram allows for the classification of various sources of variation, helping to narrow down the root cause of a problem. It is widely used to prevent quality defects. The diagram is shaped like a fish, with the defect represented as the fish's head, and the main causes identified as the fishbones. Sub-causes are displayed as smaller ribs. This tool is ideal for visually representing brainstorming sessions where the root causes of an issue are identified by a team. All causes and contributing factors are easily represented and quickly available for review.

Purpose of Using the Fishbone Diagram:

The purpose of using the Fishbone Diagram is to help identify the factors that contribute to defects and prevent their recurrence. The diagram helps teams visualize their ideas about the root causes and contributing factors of potential defects. This graphical technique is useful in solving quality-related problems and is considered one of the seven basic quality control tools. It is applied in various fields, including product development, manufacturing, customer

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service, document management, healthcare, and problem-solving. The visualization technique can be effective for overall process improvement.

Applications of the Fishbone Diagram :

The Fishbone Diagram is easy to draw and can be adopted by many teams and industries to facilitate the identification of root causes and the impacts of defects. Some practical applications include:

1. In Manufacturing :
   The Fishbone Diagram is useful for analyzing the cause-and-effect of problems in manufacturing. It serves as an effective brainstorming tool when there is insufficient data to support problem-solving efforts.
2. In Healthcare :
3. The Fishbone Diagram can be applied in the medical field to identify inefficiencies such as delayed diagnoses or diagnostic errors.
4. In Laboratories :It is used to determine the root causes of laboratory issues, such as incorrect test results or inefficient laboratory data management.

Fishbone Diagram in Problem Solving: By identifying the root causes and contributing factors, and analyzing them, the Ishikawa Diagram supports problem-solving. This tool is used in the analysis phase of the Six Sigma approach for problem-solving and is one of the root cause analysis techniques. By answering questions about the root causes of an event or the factors causing variability within a system, the diagram helps narrow down the team's problem-solving efforts.

Advantages of the Fishbone Diagram :

The Fishbone Diagram offers several benefits for process improvement and problem-solving due to its visual completeness. Some of its advantages include:

a. It visually represents the problem statement, its main causes, and supporting sub-causes.
b. It facilitates brainstorming by representing ideas visually in one central hub.
c. This graphical tool provides an overview of the problem state that is readily available to team members and stakeholders.

Limitations of the Fishbone Diagram :

While the Fishbone Diagram has clear advantages, it can also present challenges if not used correctly. Some limitations include:

a. Designing complex problems with many causes and sub-causes can lead to a diagram that is overly cluttered and difficult to interpret.
b. Brainstorming sessions may generate so many causes and potential factors that are not relevant, wasting time.
c. Identifying relationships between different causes and factors can sometimes be difficult.

Fishbone Diagram in Manufacturing :

The core of the Fishbone method lies in eliminating waste and aims to reduce completion times. Due to its completeness and visual appeal, the Fishbone Diagram is widely used to identify quality-related problems and as a tool for achieving continuous process improvement. In manufacturing, the Ishikawa Diagram often uses the 6M framework for

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analyzing root causes. This framework helps identify sources of variation within a process and find its root problems. The components of the 6M framework in manufacturing include:

a. Manpower, Refers to the physical labor or knowledge work of personnel.
b. Method, Refers to the production process.
c. Machine, Refers to all equipment, tools, and facilities used in production.
d. Material, Refers to the raw materials used to create the final product.
e. Medium (Environment), Refers to unpredictable environmental factors such as weather, flooding, or humidity.

Fishbone diagrams can be created using various tools available in the market, such as Excel, Word, PowerPoint, or more sophisticated graphic design software. You can start with a simple whiteboard and sticky notes for categorizing the causes. There are also several online software solutions available to create cause-and-effect diagrams, such as Canva, Figma, Edraw Max, XMind, Miro, and others. One easy way to start root cause analysis is to use a Fishbone Diagram template, which includes graphical elements where the problem statement, main cause categories, and sub-causes should be shown. Fishbone diagrams also use arrows to indicate the cause-and-effect relationships between different elements, including their connection to the problematic event

METHOD

Problem-Solving Framework :

The Fishbone Diagram is a method used to analyze the root causes of problems and identify risks from the outset. The core of Lean production methods lies in eliminating waste, with the goal of reducing completion time. Thanks to its completeness and visual appeal, the Fishbone Diagram is widely used to identify quality-related issues and as a tool for achieving continuous process improvement. One of the key applications of the Fishbone Diagram is for investigating workplace accidents. Brainstorming potential causes from various team member perspectives is an essential asset for analyzing the situation. This approach helps reveal the true causes of the accident while also encouraging improvement efforts and directing corrective action plans. Manufacturers also use the Ishikawa Diagram to investigate problematic events. In the example diagram below, it was found that the production assembly line process was inefficient. The analysis team has agreed on the problem statement, identified the main cause categories using the 6M framework, and potential causes were identified through brainstorming. All elements have been mapped to the designated places on the diagram.

Steps to Create a Fishbone Diagram

1. Identify the Problem
   The first step in creating a Fishbone Diagram is to identify the problem that needs to be addressed. Create a box on the right-hand side of the diagram with the problem inside it, leaving space to develop the problem further.
2. Identify Major Cause Categories
   From the main horizontal line, draw diagonal lines branching out. These branches represent the major causes of the problem that were identified earlier. Major cause categories are organized in a way that makes sense according to the situation. Some

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factors that can be included in the major cause categories are people, methods, materials, and environment.

3. Brainstorm Potential Reasons
   Each category will have reasons that need to be brainstormed. Once the reasons are presented, the team decides together where each reason should be placed in the Fishbone Diagram.
4. Write the Causes on the Horizontal Line
   Causes are written on the horizontal line, with many smaller "bones" extending from the main horizontal line. A cause can be written in more than one main cause category.

Review Each Major Cause Category

After filling in each category, look for causes that appear in more than one category. These causes indicate the most likely contributors and should be circled in the diagram as the most probable causes.

Fishbone Diagram as a Root Cause Analysis Tool

The Fishbone Diagram is part of a set of tools for root cause analysis. The cause-and-effect graph is used to map out significant events or causes of a specific problem or defect. Due to its visual nature, the Fishbone Diagram makes it easier to understand the relationships between various causes. This tool can be used in reactive management to quickly identify and resolve problems, as well as in preventive management, as it considers additional contributing factors. The system provides a set of tools that support not only problem-solving and decision-making but also workflow efficiency and process improvement.

While techniques like the Fishbone Diagram directly impact workflow efficiency, there are some tips to keep in mind when using this tool to solve problems:

a. Use the Fishbone Diagram to keep the team focused on the root causes rather than just the symptoms of the problem.
b. Make sure to leave enough space between the main categories on the diagram to add smaller, specific pointers later.
c. Ask team members to write each cause on sticky notes during brainstorming sessions. Go around the team and ask for specific reasons from each person. Keep repeating the process, gathering more clues before any suggestions are discarded.
d. Encourage everyone to participate in the brainstorming exercise and voice their opinions.
e. Other strategies are often used alongside the Fishbone Diagram to enhance its effectiveness.

In conclusion, the Fishbone Diagram is a powerful tool for analyzing problems and identifying their root causes. It promotes collaborative problem-solving, helps focus efforts on the underlying issues, and supports continuous process improvement. By following the outlined steps and keeping the tips in mind, teams can effectively use this tool to address quality-related issues and prevent future occurrences.

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RESULTS AND DISCUSSION

Problem Identification

Picture 1 Work Safety Identification Flow Process

Table 1 Operator Production Work Hazard Table

No	Work Area	Work Hazard	Potential Risk
1	Area A	Large Bags	Crushed, Inhaled
		Knife (Tool)	Cut
2	Area B	Carbon & Filter Addition	Ergonomics, Inhaled
		Jet Stove	Contact Burn
3	Area C	Smooth Floor	Slip
4	Area D	Chemicals	Skin Contact

Based on the data above, there are risks to the production operator during their work activities. Our team has chosen to control the hazards in Area A, specifically in the slurry mixing/preparation area. The slurry preparation process consists of several steps:

1. Pouring flour into the dumping area using a hoist crane → screw conveyor → sieve → starch tank, which is then moved to the liquefaction area.
2. More specifically, the process of pouring flour into the dumping area with the hoist crane.

Table 2 Big Bag Flour Pouring Process into Dumping Area

Month	Cassava	Sago	Corn	Total
January	5,891,092.60	0.00	7,533,516.00	13,424,608.60
February	4,418,859.50	0.00	7,797,818.30	12,216,677.80
March	6,545,215.20	0.00	8,219,763.30	14,764,978.50
April	5,278,249.30	0.00	5,842,300.20	11,120,549.50
May	3,375,756.00	0.00	5,372,784.00	8,748,540.00

This data provides the monthly amounts of different types of flour (Cassava, Sago, and Corn) being poured into the dumping area as part of the slurry preparation process.

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Picture 2 : Flour Pouring Equipment in Dumping

Based on the data and photo above, there is flour flying around, causing it to fall outside the starch-sugar dumping area.

Issue Certification

Table 3: Risk Value for Work in the Pouring Process

No	Work Hazard	Risk	Initial Risk Value (L/S/RFN)	Current Control Measures	Residual Risk Value (L/S/RFN)
1	Work Equipment	Scratched	3 / 3 / 9	Wearing Gloves	1 / 2 / 3
2					
3	Large bag falls	Flour Dust	Crushed, Respiratory Issues	4 / 2 / 8	4 / 4 / 16
				Big Bag Support	2 / 2 / 2
				Mask Use	4 / 3 / 12

Based on the data above, the presence of flying flour/dust results in a medium risk category for work-related diseases.

Determining Problem Priorities

Based on the issue stratification, the flying flour and falling outside the pouring point can result in work-related diseases and add extra work for operators, such as collecting scattered flour.

Problem Priority Setting

Based on the identification and stratification of the issues, the theme is set: “Reducing Flour Dust and Spillage in the Dumping Pouring Process.”

Factors

Factor	Before Improvement	Goal	Predicted Potential Benefits	Predicted Potential Problems
Quality	Flying flour falling outside the dumping point, becoming scattered flour	No Flying Flour	Reduction in flour falling outside the dumping point	No Problems
Cost	Flour dust is spread around	Flour that is caught is cleaner	No waste or scattered flour	No Problems

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Factor	Before Improvement	Goal	Predicted Potential Benefits	Predicted Potential Problems
Delivery	Flour dust flying around	No scattered flour	No flour loss outside the dumping point	No Problems
Safety	Risk of work-related diseases during big bag pouring	Risk minimized	Reduced possibility of inhaled flour by operators during pouring	No Problems
Morale	N/A	N/A	N/A	N/A
Environment	Flour scattered on the floor	No flour spillage	Clean floor without scattered flour	No Problems

Analyzing Impact and Expectations

Goal Setting Based on "SMART":

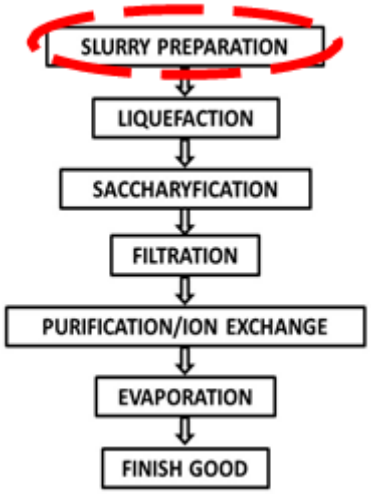
1. SPECIFIC: Reduce flying flour.
2. MEASURABLE: Target is calculated as follows: Flying flour can be minimized.
3. ACHIEVABLE: Desired achievement: No flour will be spilled outside the dumping point due to flying dust.
4. REALISTIC: The target is realistic because flour waste will be reduced.
5. TIME TABLE: Improvements and evaluations will be carried out over 6 months.

Activity Schedule

No	Activity Name	Month
1	Data Collection/Observation	
2	Analyzing Causes	
3	Testing Causes	
4	Planning Improvements	
5	Implementing Improvements	√
6	Evaluating Results	
7	Standardizing	

Identifying Causes

Reviewing the Problem Object



Picture 3 : Production Process at Big Bag Pouring Point in the Dumping Area

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The improvement area is in the slurry mixing/preparation area. The slurry preparation process consists of several steps: Pouring flour with a hoist crane into the dumping → screw conveyor → siever → starch tank, which is then drawn into the liquefaction area. More specifically, it refers to the flour pouring process using the hoist crane into the dumping.

Identifying Possible Causes

Table 4: Possible Causes of Work Hazards

Condition Analysis	Standard	Observation Results	Responsible Person	When	Conclusion
Flour dust flying during the big bag pouring process	Operator doing extra work by collecting scattered flour	Not much flour flying around	No scattered flour	Pouring process creates a dusty/floury cloud	No tools to reduce flour flying around

Stratification of Work Hazard Causes

Table 5: Stratification of Causes of Work Hazards for Production Operators

Factor	Control Analysis	Standard	Observation Results	PIC	When	Conclusion
Method	Flour flying during the big bag pouring process	Operator doing extra work to collect scattered flour	No flour flying around	No scattered flour	No tools to reduce flying flour during pouring	Agung
Man	Same as above	No significant change	No flour flying around	No scattered flour	No tools for reducing flour dust	Agung
Machine	Flour flying during the big bag pouring process	No tools for reducing flying flour	No significant change in process	No tools for reducing dust	Agung	Didik
Material	None	None	No change in material usage	None	None	None
Environment	None	None	No environmental factors affecting process	None	None	None

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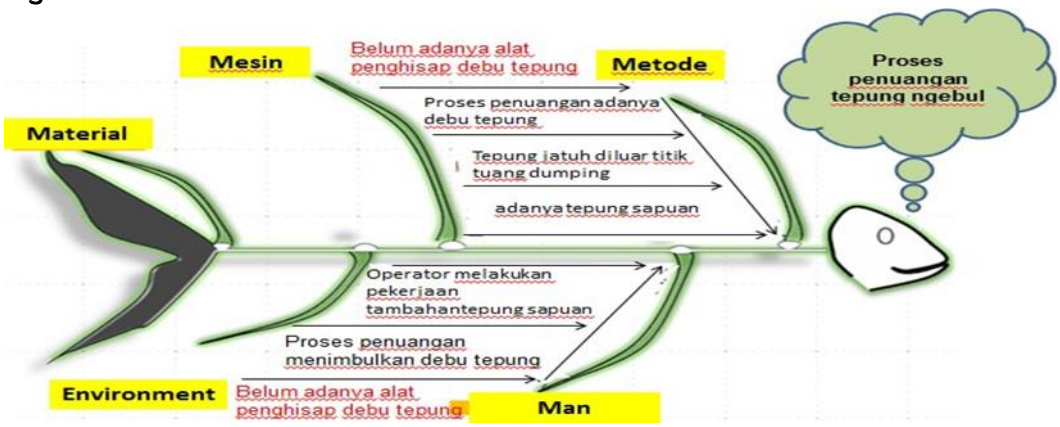
Mapping Cause and Effect



Picture 4 : Fishbone Diagram for Identifying Risk Causes

Determining Possible Root Causes

Table 6: Possible Root Causes

No	Category	Root Cause	Direct Consequence	Description
1	Method	Big bag pouring creates a dusty cloud	Flour falling outside the dumping point	Flour falling outside the dumping point requires additional work to collect the scattered flour, which takes a significant amount of time.
2	Man	Big bag pouring creates a dusty cloud	Flour falling outside the dumping point	Additional work is required to collect flour outside the dumping point for a considerable amount of time.
3	Machine	No specific root cause identified	No immediate consequence	None
4	Material	No specific root cause identified	No immediate consequence	None
5	Environment	No specific root cause identified	No immediate consequence	None

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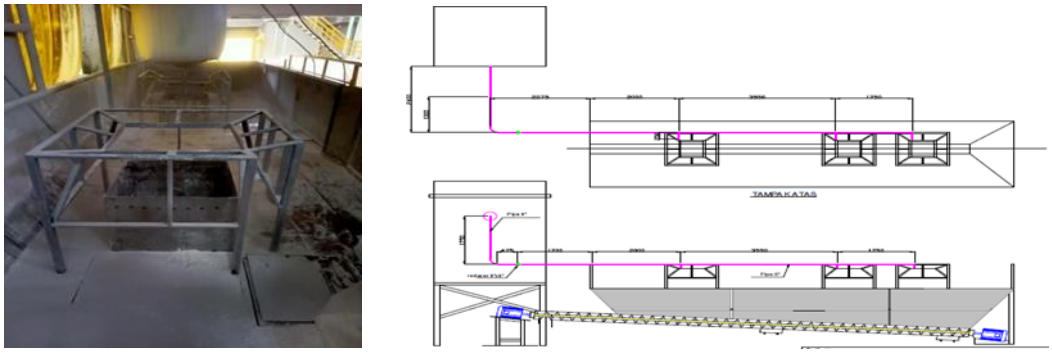
Collecting Facts & Data on Root Causes
Big Bag Pouring Process at the Dumping Point

Picture 5: Big Bag Pouring Process at the Dumping Point

Based on the photo and field observations, during the pouring of the big bag at the dumping point, there is a cloud of dust/ scattered flour, with some flour falling outside the dumping point. From the cause analysis, the dominant cause is the dusty cloud during the big bag pouring process, which results in flour falling outside the dumping point.

Analyzing Alternative Risks and Selected Solutions

a. Create a hood and install a dust collector pipe at the dumping point.
b. Additional work will be required for the operator in area A.



Picture 6 : Creation of Big Bag Pouring Equipment at the Dumping Point

Before	After
	

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Titik tuang dumping sebelum ada hood dan instalasi pipa mesin dust colektor.	**Titik tuang dumping setelah terpasang hood dan instalasi pipa mesin dust colektor.**

Picture 7 : Repair Process Before and After

After the installation of the hood and dust collector pipe system to capture flying flour, the flour that falls outside the dumping point has decreased because it is captured by the dust collector machine.

Measuring the Progress Results of Improvements

Table 7: Risk Value of Improvement Results in the Pouring Process

No.	Job Hazard	Risk	Initial Risk Value (L / S / RFN)	Current Control Measure	Remaining Risk Value (L / S / RFN)
1	Work Equipment	Scratches	3 / 3 / 9	Wearing Gloves	1 / 2 / 3
2	Big Bag Falling	Flour Dust	4 / 2 / 8	Big Bag Support	2 / 2 / 2
		Respiratory Disorder	4 / 4 / 16	Installation of Dust Collector and Mask Usage	1 / 3 / 4

Likelihood/Kemungkinan (L)	Severity / Keparahan (S)
1 Rare / Sangat Jarang	1 Negligible - Sangat Rendah
2 Unlikely / Jarang	2 Minor - Rendah
3 Moderate / Sedang	3 Moderate / Sedang
4 Likely / Mungkin terjadi	4 Major - Besar
5 Almost Certain / Terjadi	5 Catastrophic - Sangat Besar

Risk Factor Number – RFN = L x S	Kondisi
1 - 5 : Low	R : Rutin
6 - 15 : Moderate	NR : Non Rutin
16 - 25 : High	E : Emergency

Evaluation of Work/Improvement Results

Evaluation of the work/improvement results is essential to measure the effectiveness of the implemented improvements. It is important to determine whether the corrective actions taken are able to resolve the issue or not. From the table above, the risk value for work-related diseases, specifically respiratory disorders, was 12 before the implementation of the research,

and after the implementation, it decreased to 4. In addition to the decrease in the risk value for work-related diseases, there was also flour that was inhaled/captured by the dust collector machine.

CONCLUSIONS

Based on the results of the research activities that have been conducted, the following conclusions can be drawn: From the table, the risk value for work-related diseases, specifically respiratory disorders, was 12 before the implementation of the research using the fishbone diagram, and after the research implementation using the fishbone diagram, it decreased to 4.In addition to reducing the risk of work-related diseases, there was also flour that was sucked/captured by the dust collector machine.

REFERENCE

[1] Lisensi Sandard Australia. (1999).AZ/NZS 4360 : 1999 Manajemen Risiko dalam Analisis Risiko Keamanan, Brisbane, Australia, ISMCPI
[2] Indonesia. Undang-Undang Nomor 9 Tahun 1960 tentang Pohon Kesehatan
[3] Indonesia. Undang-undang Nomor 1 Tahun 1970 tentang Keselamatan Kerja
[4] Analysis Techniques Author: Dewi Kurniasih Yudi Rusfiana Agus Subagyo Rira Nuradhawati Publisher: ALFABETA, cv Jl. Gegerkalong Hilir No. 84 Bandung Website: www.cvalfabeta.com ISBN: 978-602-289 Cetakan Pertama: 2021
[5] Sulasih, M.Si, Maman Sulaiman, M.M. Analisis Swat Konsep dan Praktek Bidang Bisnis, Rizkuna Banyumas. 2020..ISBN 978-623-7678. 2021.
[6] Wiratna Sujarweni, Research Methodology: Complete, Practical, and Easy to Understand, Pustaka Baru, Yogyakarta, 2014
[7] Rosa A.S dan M. Shalahuddin Rekayasa Perangkat Lunak Terstruktur dan Berorientasi Objek (Bandung, Informatika. 2018
[8] Coccia, M. (2020). Fishbone diagram for technological analysis and foresight. International Journal of Foresight and Innovation Policy, 14(2-4), 225-247.
[9] Chang, H. (2015). Evaluation framework for telemedicine using the logical framework approach and a fishbone diagram. Healthcare informatics research, 21(4), 230-238.
[10] Sakdiyah, S. H., Eltivia, N., & Afandi, A. (2022). Root cause analysis using fishbone diagram: company management decision making. Journal of Applied Business, Taxation and Economics Research, 1(6), 566-576.
[11] Ishii, K., & Lee, B. H. (1996, August). Reverse fishbone diagram: a tool in aid of design for product retirement. In International Design Engineering Technical Conferences and Computers and Information in Engineering Conference (Vol. 80494, p. V001T01A008). American Society of Mechanical Engineers.