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Accidents Analysis in Sugar Factories: Causes Using Government Regulation and Human Factor and Classification System (HFACS)

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A B S T R A C T

The Sugar Factory uses more than 150 pieces of equipment in production process. With so many tools, the possibility of accidents also very large, especially because of the age of mechine and equipment. On July 22 2022, an accident occurred which resulted 1 (one) person dying as a result of being hit by a lifting beam and sugarcane scale due to a broken wire rope. Investigation and analysis of the causes of accidents as well as follow-up actions must be carried out, because the production process must continue. This research aims to analyze accidents that occur based on human factors using Government Regulation and Human Factor Analysis and Classification System (HFACS) approach. Government regulations are used to identify the types of accidents with a major impact on lost work hours and fatalities. Government regulations are used to determine the types of accidents that have a major impact on lost work hours and deaths. Using data from sugar factories and interview results, this study shows that accidents with the greatest impact are caused by lifting equipment. Using the Human Factor And Classification System (HFACS) method to analyze the 6 accidents, the results show that at level 1, the biggest causes of accidents are at the sub-level decision error, skill-based error, perceptual error and routine violation. At level 2, the biggest causes of accidents are at the sub-level technological environment and personal readiness. While at levels 3 and 4, Failed to correct problem and supervisory violation have the largest percentage at level 3 and resource management at level 4. The conclusion shows that there are still various problems from the human factor to implementate occupational safety which could potentially lead to accidents.

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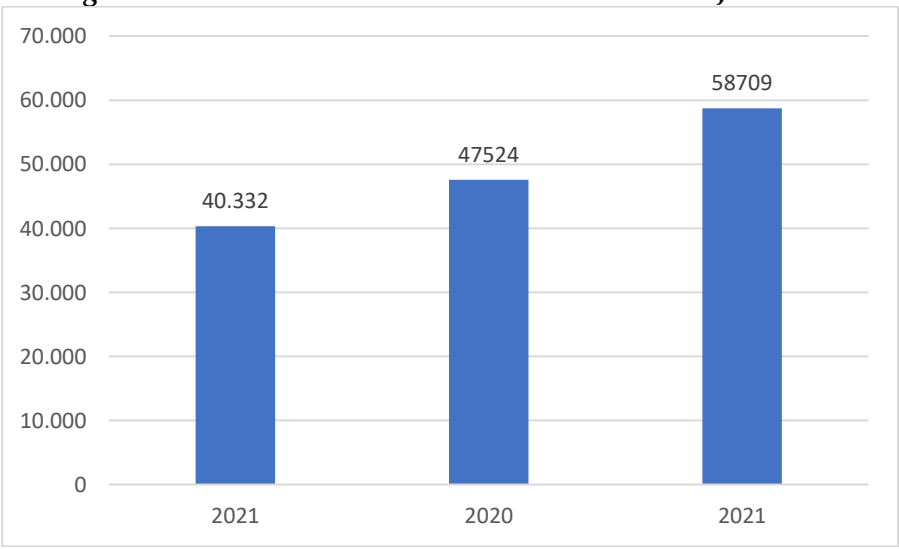
INTRODUCTION

Occupational Safety and Health are all activities to ensure and protect the safety and health of the workforce through efforts to prevent occupational accidents and diseases, in accordance with Government Regulation Number 5 of 2012 concerning the Occupational Safety and Health Management System. Basically, the implementation of K3 aims to protect workers from potential hazards in the workplace, namely work accidents and occupational diseases so that production can run smoothly which has an impact on increasing the company's productivity. The K3 program is very necessary to be implemented in the workplace, because every day workers spend their time at work and will always be faced with potential hazards in the workplace. Most companies have implemented OSH in the workplace. However, the number of work accidents is still relatively high. According to global data released by the International Labour Organization (ILO), the number of work accident cases in the world reaches 430 million per year. This number consists of 270 million (62.8%) work accident cases and 160 million (37.2%) cases of occupational diseases, with 2.78 million worker deaths every year. (Indonesia National Occupational Safety and Health Profile 2022, 2023)

East Java Province is one of the provinces in Indonesia that contributes a considerable number of work accidents. Almost 20% of national work accident cases occur in East Java Province. BP Jamsostek East Java Regional Office released data on the number of accidents that occurred in East Java. In 2021, the number of work accidents in East Java reached 40,332 cases. This figure rose to 47,524 cases in 2022 and 58,709 cases in 2023. Of the thousands of cases, Sidoarjo, Gresik and Mojokerto Regencies contributed the largest number of accidents with a total of 27,818 cases for Sidoarjo Regency, 18,182 cases for Gresik Regency and 17,570 cases for Mojokerto Regency. More complete cases of work accidents that occurred in East Java in the 2021 – 2023 period can be seen in Figure 1.2 below. (Data from BP Jamsostek East Java Regional Office, 2023)

Figure 1.2 Work accident cases 2021 – 2023 in East Java



(Source: BP Jamsostek East Java Regional Office Data, 2023)

The sugar industry is one of the industries that falls into the category of various industries. This industry is an extactive industry that processes natural resources into other products that have better benefits. This industry is one of the national strategic industries that supports the fulfillment of the basic needs of the people of Indonesia. So far, national sugar production has still not been able to meet national sugar needs. In 2021, BPS reported that national sugar production reached 2.35 million tons, which was supplied by state-owned sugar mills of 1.06 million tons and private sugar mills of 1.29 million tons. Meanwhile, sugar demand in 2022 will reach 6.48 million tons (BPS, 2022). From this data, we can see that the national sugar industry is still unable to meet the national sugar needs, so the government has to import sugar from abroad to meet the sugar needs.

This research refers to previous research conducted by Dr. Iftikar Zahedi Sutalaksana (2018) in a journal entitled Preliminary Study of the Occupational Safety System in Accident Cases at SBU ITS PT. X using the Human Factor Analysis And Classifiacation System (HFACS) methodology. In the study, researchers have not yet explored the root cause of the accident. In this study, the researcher tried to explore the cause of the problem by using the Fault Tree Analysis (FTA) method.

The analysis of the causes of failure using the Fault Tree Analysis (FTA) method was carried out at each level of HFACS. FTA is a technique used to identify a risk that plays a direct role in the occurrence of a failure with a top-down approach through a graphical depiction of an event starting from the top event, continuing to the next event until a basic event is found which is the root cause of the failure that occurs. The FTA method is used to find the basic cause of the incident occurring. After the basic events of each level are found, then control measures are developed based on applicable regulations and several sources. By analyzing and studying the occurrence of accidents using the 2 methods above, it is hoped that the basic causes that cause accidents to occur in the company will be known, so that corrective actions can be developed so that the same accident will not be repeated.

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THEORETICAL OVERVIEW

Work Accidents

According to the Regulation of the Minister of Manpower Number: 03/MEN/1998 concerning Procedures for Reporting and Examining Work Accidents (1998), the definition of an accident is an unintended and unexpected event that can cause human and/or property casualties. Work accidents themselves are divided into two, namely work accidents themselves and accidents at work. A workplace accident is an accident that occurs in the workplace. Meanwhile, work accidents include accidents related to work relationships, occupational diseases and accidents experienced by workers when leaving and returning from work, as long as they are through the usual route.

Crane

A crane is a tool for lifting a combination of a hoisting machine that is installed on a frame or special construction as a support in its function as a lifting device or a combination of a lifting machine that works alone or has a driving machine and a frame for lifting and transferring loads that can be in its operation.

METHODOLOGY

In order for the research process to run smoothly and be structured in an effort to solve existing problems, a framework of thinking or systematic steps is needed. The steps that are prepared are starting from the initial identification of the problem to the stage of solving the problem. Before carrying out the research, the researcher conducted an initial survey of the company. After the initial survey, the next step is to look for literature as a basis and reference to solve problems. After conducting an initial survey and literature review, the next stage is to determine the problems that will be solved through this research.

Data Collection The next stage in this study is data collection. The data used in this study are primary data and secondary data. Primary Data The primary data used in this study was obtained from data from observations, observations and interviews. The data in question includes data on the chronology of accidents, as well as the determination of categories in the HFACS table. Secondary data Accident data for the last 3 years The accident data in question is the type of accident that occurs in the workplace, both those with fatalities and those without fatalities. This data is used to find out what types of accidents have been the most dominant over the past 3 years. In companies, the category of accidents is divided into two, namely machine stop hours and loss of working days due to accidents that result in the worker being unable to work. Based on data sourced from the company, the data on engine downtime for 3 years is as shown in Table 3.1, 3.2 and 3.3 below:

Table 3.4. Data on accidents that resulted in fatalities

No	Time of Occurrence	Victim's Initials	Scene	Impact
1	09/11/2020	HT	St. Ketel	Wound
2	10/12/2020	AW	St. Gilingan	Wound
3	05/07/2021	HM	St. Besali	Wound
4	16/08/2021	DS	Road. Raya Pagu-Plemahan	Wound
5	23/08/2021	RH	St. Ketel	Wound
6	27/07/2022	AI	Scale Crane TMA	Die
7	15/12/2022	SA	St. Ketel	Wound

Source: Company Data, 2022

Equipment Data

Based on data obtained from the company, the number of equipment used in the company reached 153 units consisting of boilers, lifting aircraft, pumps, transport aircraft, evaporator generators, condensers, bucket elevators, slings, and others.

Identify Accidents with the HFACS Method

Analysis of the cause of the accident using the Human Factor Analysis and Classification System (HFACS) method. HFACS was developed by Dr. Scott Shappel and Dr. Doug Wiegmann and is used to measure the level of human error in depth. The output of the analysis with the HFACS method is the cause of the accident in terms of human factors. The stages in conducting an accident analysis are:

1. Identify the factors that cause the accident
2. Creating HFACS tables
3. Categorizing the factors causing accidents into HFACS sublevels
4. Entering the accident category into the HFACS table

Find the Most Dominant Accident Factors at Each Level

This process uses calculations on each level. Based on the identification of labor activities or foremen in the field, we then group them into each sub-level for each level. Of course, not all conditions on the field can be included in the category of each sub-level. Next, from the frequency of each sub-level, we add up and we divide by the total number per level. From this, the percentage of each sub-level will be obtained which is the material for determining how dominant the sub-level is.

Create an FTA graphic model Furthermore, to find the root cause of the failure of the overhead crane operation, an analysis was carried out using the Fault Tree Analysis (FTA) method. The first step in the analysis is to model the conditions in the field into the FTA graphical model. The steps in creating a graphic model are as follows:

1. Identify the FTA object being researched
2. Identifying top events for FTAs
3. Structuring the FTA tree structure
4. Focus Group Discussion (FGD) with experts to approve the structure of the FTA tree and its recommendations for improvement

RESULTS AND DISCUSSION

Identification of Accident Cases

Sugar Production Process

The sugar production process at the sugar factory located in one of the regencies in East Java and established in 1895 by the Netherlands and taken by Indonesia in 1957 started from raw materials in the form of sugarcane. To get to sugar, you have to go through 7 (seven) stations. In general, the stages in sugar production are starting from the entry of sugarcane from farmers, which are usually carried by trucks through sugarcane weighing stations and factory emplacements, continuing to milling stations, sap refining stations, evaporation stations, cooking stations, cooling stations, and spinning stations. From the length of the manufacturing process, it can be imagined that there are also a lot of machines and equipment used. The number of machines and equipment used reached 153 pieces of various types, consisting of steam planes to produce steam and heat, lifting planes and transport aircraft to assist in the lifting and transportation process, pumps, conveyors to transfer materials to the next station, production machines, milling machines, condensers, evaporators, generator sets as power generators, and other equipment.

Accident Identification and Analysis

The definition of an accident is an unintended and unexpected event that can cause human and/or property casualties (Permenaker Number Per.03/MEN/1998,1998). Based on this understanding, incidents that fall into the category of accidents are downtime due to engine breakdowns and loss of working days due to injuries.

Calculation of Engine Downtime

There are 12 categories of equipment and machinery that are the source of accidents in accordance with the Decree of the Director General of Industrial Relations Development and Manpower Supervision of the Republic of Indonesia Number Kep.84/BW/1998 concerning How to Fill Out Accident Forms and Accident Statistical Analysis. During 2020, the number of machine downtime hours was 99.39 hours with a milling time of 4 months, with the largest percentage occurring in production machines which reached 61.91 hours. The recapitulation of engine downtime data during 2020 can be seen in Table 4.2 below:

Table 4.2 Recapitulation of engine downtime in 2020

Sources of Accidents	Month				Total
	June	July	August	September	
Production Machinery	15,92	34,58	11,41	0	61,91
Starter drive and pump	0	0	0,83	0	0,83

Lift	0	0	0	0	0
Lift Aircraft	0	1	3,67	0	4,67
Conveyor	0	0	0,58	0	0,58
Transport Aircraft	0	0	0	0	0
Mechanical Transmission	0,83	0,33	0,75	2,58	4,49
Hand tools	0	0	0	0	0
Steam planes and pressure vessels	9,34	10,57	2,25	0	22,16
Electrical appliances	0,59	2,16	2	0	4,75
Chemicals	0	0	0	0	0
Hazardous dust	0	0	0	0	0
Total	26,68	48,64	21,49	2,58	99,39

Source : Company Data, 2022

Engine downtime has increased slightly in 2021. When compared to the previous period, engine downtime in 2021 increased to 229.4 hours for the 4-month milling period. The recapitulation of engine downtime in 2021 can be seen in Table 4.3 below:

Table 4.3 Recapitulation of engine downtime in 2021

Sources of Accidents	Month				Total
	June	July	August	September	
Production Machinery	35,6	16,34	1,33	10,67	63,94
Starter drive and pump	0	0	0	0	0
Lift	0	0	0	0	0
Lift Aircraft	0	0	0	0	0
Conveyor	1,83	0	0	0	1,83
Transport Aircraft	0	0	0	0	0
Mechanical Transmission	1,67	0,42	0	0	2,09
Hand tools	0	0	0	0	0
Steam planes and pressure vessels	99,34	15,83	19	13,25	147,42
Electrical appliances	14,16	0	0	0	14,16
Chemicals	0	0	0	0	0
Hazardous dust	0	0	0	0	0
Total	152,6	32,59	20,33	23,92	229,44

Source : Company Data, 2022

Meanwhile, in 2023, with a milling period of 5 months from June to October, there will be an increase in engine downtime. When compared to 2021, the number of engine downtime hours in 2022 increased to 377.54 hours as seen in the following Table 4.4:

Table 4.4 Recapitulation of engine downtime in 2022

Sources of Accidents	Month					Total
	June	July	August	September	October	
Production Machinery	16,99	11,25	5,5	7,83	5,5	47,07

Starter drive and pump	4	0	0	0	0	4
Lift	0	0	0	0	0	0
Lift Aircraft	0	120	10,58	0	8,42	139
Conveyor	0	1,5	3,58	4	0,58	9,66
Transport Aircraft	0	0	5,83	0	0	5,83
Mechanical Transmission	0,33	6,08	0	0	0	6,41
Hand tools	0	0	12,92	0	0	12,92
Steam planes and pressure vessels	4,67	0,33	7,08	8,17	5	25,25
Electrical appliances	4,58	8,83	0	7,92	2,17	23,5
Chemicals	0	0	0	0	0	0
Hazardous dust	0	0	103,9	0	0	103,9
Total	30,57	147,99	149,39	27,92	21,67	377,54

Source : Company Data, 2022

From the three Tables 4.2, 4.3 and 4.4 above, it can be seen that the largest engine downtime occurred in steam aircraft and pressure vessels with a total of 194.83 hours of downtime, followed by production engines and lift aircraft. Recapitulation of engine downtime during the 2020, 2021 and 2022 periods as shown in Table 4.5 and figure 4.1 below:

Calculation of the Number of Days Lost Due to Accidents Experienced by Workers

As a basis for calculating the number of days lost due to an accident is the number of days lost due to an accident that causes workers to be unable to work. As for the case of an accident that cannot be counted as lost days, the conversion table is used in accordance with the Decree of the Director General of Industrial Relations Development and Manpower Supervision of the Republic of Indonesia Number Kep.84/BW/1998 concerning How to Fill Out the Accident Form and Analyze Accident Statistics. Based on data obtained from the Company, during the period 2020 to 2022, there were 7 cases of accidents that caused injuries or deaths of workers as seen in the following Table 4.6:

Table 4.6 Recapitulation of accidents in 2020 - 2022

No	Time of Occurrence	Victim's Initials	Scene	Cause	Impact	Number of Days Lost
1	09/11/2020	HT	St. Ketel	Heel (ankle) of the fall of the iron plate	Wound	1
2	10/12/2020	AW	St. Grinding	The eye is exposed to gram iron when using a grinding machine	Wound	1
3	05/07/2021	HM	St. Besali	Fingers pinched by the lathe	Wound	1
4	16/08/2021	DS	Road. Raya Pagu-Plemahan	While going to work, a traffic accident occurred in Padangan	Wound	2

				Village, Kayen Kidul District		
5	23/08/2021	RH	St. Ketel	Slipped while going through the stairs to bagase house	Wound	1
6	27/07/2022	AI	Scale Crane TMA	The person concerned was hit by the DCS scale because the sling broke	Die	6000
7	15/12/2022	SA	St. Ketel	Saiful Anwar was riding a 5 dim iron pipe when he was suddenly hit by a gram of iron splash on his right eye, causing his eyes to sting and red.	Wound	1

Sumber : Data Perusahaan, 2022

If the accident occurrence as in Table 4.6 is grouped according to the cause of the accident, the result is obtained that the largest number of missing days is caused by the overhead travelling crane which causes 1 (one) person to die.

Study of Accidents Caused by Lift Aircraft

Based on Table 4.8 above, it can be seen that the most severe impact of the accident was caused by a lift aircraft which resulted in the death of 1 (one) person and the loss of working hours due to the cessation of engine operation for the investigation of the accident. The total loss caused by the accident caused by the lift aircraft is the loss of 6005.9 working days. In the period of 2020, 2021 and 2022, there were 6 (six) cases of accidents caused by lift aircraft. The case occurred in the sugarcane table area, bucket elevator, and crane area of the sugarcane scale. Cases of accidents due to lifting aircraft as seen in Table 4.9 below:

Table 4.9 Accidents caused by lifting aircraft

No	Date	Types of accidents	Casualties (people)	Number of downtime (hours)
1	28 July 2020	Broken sugarcane table crane sling	0	0,17
2	30 July 2020	Broken sugarcane table crane sling	0	0,08
3	05 August 2021	Trouble sugarcane table crane	0	1,17
4	06 August 2021	Trouble sugarcane table crane	0	2,5
5	08 October 2022	Trouble mill elevator bucket	0	8,42
6	27 July 2022	Wire rope crane break scale	1	120

Source: Company Data, 2022

Based on Table 4.9 above, an investigation was subsequently carried out into 6 (six) accidents caused by the operation of equipment that is included in the category of lifting aircraft. An investigation was carried out to find out the chronology of the accident so that the cause of the accident could be determined. The tool used is the accident study data form contained in appendix 2 of the Regulation of the Minister of Manpower Number: 03/MEN/1998 concerning Procedures for Reporting and Examining Work Accidents.

Table 4.15 Calculation of percentages for each sub-level

HFACS Category	n	Prosentase
Organizational Influence (Level) 4	**8**	
- Operational Process	2	25%
- Organizational Climate	0	0%
- Resource management	6	75%
Unsafe Supervision (Level 3	**19**	
- Inadequate Supervision	6	32%
- Planned Inappropriate Supervision	-	11%
- Failed To Correct Problem	6	32%
- Supervisory violation	6	32%
Precondition of unsafe action (level 2)	**22**	
- **Environmental Factor**		
- Phisical Environment	2	9%
- Technological Environment	6	27%
- **Substandard Condition Of Operator**		
- Adverse mental states	-	
- Adverse physiological states	-	
- Phisical / Mental Limitation	-	
- **Substandard Practices Of Operator**		
- Crew Resources Mis management	6	27%
- Personal readiness	6	27%
Unsave Action (Level 1)	**27**	
- **Error**		
- Decision error	6	22%
- Skill Based Error	6	22%
- Perceptual Error	6	22%
- **Violation**		
- Routine	6	22%
- Exceptional	0	-

Table 4.15 above, presents the recapitulation data of the results of the HFACS Analysis. At level 1, decision errors and perceptual errors as well as skill-based errors, are quite a large contributor, which is 22%, with a total of 6 incidents. In the field, it can be seen that the workforce often makes mistakes in operations due to lack of knowledge and information. In addition, they work only based on previous experience, because in general, the PKWT workforce is the same every year. Furthermore, in sub-level violation, it can be seen that sub-level routines are often carried out with a percentage of 22%. This condition is

shown by the number of violations, ranging from operations that do not comply with SOPs, to operators and contractors and technicians who do not have K3 licenses, meaning that the Company violates the provisions of the Regulation of the Minister of Manpower Number 8 of 2020 concerning K3 for Lift Aircraft and Transport Aircraft. Certification of operators, contractors, and technicians can help the Company to reduce these incidents. Regular socialization and coaching as well as increased supervision of workforce performance will also reduce the level of mistakes made by workers.

Technological environment, crew resources e.g. management and personal readiness contributed the largest percentage at the precondition of unsafe action level or level 2 with a percentage of 27%. This condition is shown by the number of equipment that is more than 5 years old which reflects that the technological environment plays a fairly important role as a contributor to the cause of accidents. Supported by a lack of knowledge from the operator so that it operates unsafely, it will eventually contribute to the occurrence of accidents. This condition can be controlled by conducting periodic inspections and tests of tools that are vulnerable or often cause accidents, as an effort to ensure that the tools are safe to operate. Crew resources e.g. management and personal readiness are shown by the lack of certification and authority shown by operators and conductors and technicians who do not have K3 licenses. This can happen because there is no budget from the Company to prepare a workforce that will work in terms of safety in operation and maintenance as well as binding goods. In addition, the foreman's lack of knowledge about the implementation of K3 in the field.

Level 3 has a smaller percentage than level 1 and level 2. At this level, the largest sub-level that causes accidents is failed to correct problems and supervisory violations and inadequate supervision. The lack of supervision from the foreman and the assumption that the current operation is safe is one of the behaviors that cause this level to have a considerable process. This can happen due to the lack of knowledge from the foreman, as well as the reluctance of the workforce to learn new things. The budget allocation from the Company for training mador as a form of knowledge upgrading is one of the solutions that can be done by the Company.

In general, the Company has committed to implementing occupational safety and health. However, the lack of facilities and infrastructure as well as personnel who understand K3 is the trigger for the emergence of the resource management sub-level has the largest percentage at this level. This is shown by the lack of certification for personnel who operate hazardous equipment. Coaching is only carried out by K3 experts in the Company in the form of internal coaching.

Of the many sub-levels at each level, the ones that need special attention because they have the largest percentage of accident causes are decision errors and perceptual errors at level 1 and the technological environment also at level 2. Furthermore, at level 3, failed to correct problems and supervisory violations must also be considered. As well as improvements in terms of resource management, to control the cause of accidents at level 1.

Analysis of the Causes of Accident Triggering Factors Using Fault Tree Analysis (FTA)

Based on the results of the grouping in Table 4.14, the triggering factors for the occurrence of events for each sub-level are then analyzed. The method used is Fault Tree Analysis (FTA). The steps in the development of an accident cause analysis using the FTA method are as follows:

1. Identify the FTA object being researched
2. Identifying top events for FTAs
3. Structuring the FTA tree structure
4. Focus Group Discussion (FGD) with experts to approve the structure of the FTA tree and its recommendations for improvement
   The first step that must be taken is to compile an FTA tree for each sub-level for each event per event date, starting from the top event to the basic event. Furthermore, based on the preparation of the event tree, we continue by looking for a minimum cut set by using FTA top event software. The final step is to prepare improvement recommendations for each of these basic events.

Recommendations Based On Development Results Using Fault Tree Analysis Method

Based on the analysis using the Fault Tree Analysis method for the 6 accidents above, the following improvement recommendations were obtained:

- At level 1, in the sub-level decision error, the recommendations submitted are:
  a. When recruiting workers, it must be based on competence, not just experience in the mill last year. In addition, workers must also undergo an initial health check, including the psychological condition of workers in accordance with the provisions of Law No. 1 of 1970 concerning Occupational Safety Article 8 Jo. Pemenaker No.Per-02/MEN/1980 concerning Labor Health Examination
  b. Minimum education must also be used as a requirement in the recruitment process, because in Ministerial Regulation Number 08 of 2020 concerning K3 Lift Aircraft and Transport Aircraft.
  c. Adding personnel who are specifically responsible for the implementation of K3 in the workplace, in accordance with the provisions of Law No. 1 of 1970 Article 5
  d. Improve the ability of the foreman by providing coaching and training, so that the foreman can become an extension of the K3 Expert in the Company in accordance with Law No. 1 of 1970 Article 9
  e. Ensuring that the workforce is working in a healthy condition by conducting health checks in accordance with Permenaker Number Per.02/MEN/1980.
- At the sub-level of perceptual error, the recommendations submitted are:
  a. Create a work accident reporting system, and socialize the results of work accident analysis to the workforce so that all understand

the potential dangers in the workplace, in accordance with the provisions of Permenaker Number 03/MEN/1998

b. Routinely conducting safety briefings to foremen and workers in accordance with Article 9 of Law No. 1 of 1970
c. Compile a workforce recruitment schedule that is adjusted to the milling schedule, which can be interpreted as planning must be carried out in the recruitment process in accordance with Government Regulation Number 50 of 2012 concerning SMK3.

- In the sub-level routine violation, to avoid routine violations, the recommendations submitted are:
  a. Conducting intensive coaching for foremen and workers in accordance with Article 9 of Law No. 1 of 1970
  b. The operation of the machine must be carried out by an operator who has a K3 license in accordance with Permenaker Number 08 of 2020. Therefore, the level of education must be taken into consideration in the recruitment process.
  c. Increase supervision by ensuring that the number of K3 personnel is sufficient, in accordance with the provisions of Permenaker Number Per.02/MEN/1992 concerning Procedures for Appointing Obligations and Authorities of Occupational Safety and Health Experts
- At level 2, for the sublevel technological environment, some of the recommendations submitted are:
  a. Allocating a budget to conduct a test inspection of the equipment, to ensure that the equipment is safe to use in accordance with the provisions of Government Regulation No. 5 of 2012 concerning SMK3
  b. Ensuring operation by authorized operators in accordance with the Regulation of the Minister of Manpower Number 8 of 2020 concerning K3 Lift Aircraft and Transport Aircraft.
  c. Carry out maintenance of equipment periodically and is carried out by technicians who have a K3 license in accordance with the Regulation of the Minister of Manpower Number 8 of 2020 concerning K3 Lift Aircraft and Transport Aircraft
  d. SOPs must be made for the operation and storage methods so that the equipment and lifting aids are not damaged in accordance with the provisions of Government Regulation No. 50 of 2012
- At the sub-level of personal readiness, some of the recommendations submitted to ensure workers' readiness at work include:
  a. The readiness of the workforce, both in terms of ability, health, and compliance with regulations must be ensured by conducting guidance and health checks for workers in accordance with Law No. 1 of 1970 concerning Occupational Safety Articles 8 and 9.
  b. The company must allocate a budget to upgrade the capabilities of the workforce and foremen and K3 personnel in accordance

with Article 9 of Law No. 1 of 1970 and Government Regulation No. 5 of 2012 concerning SMK3

- In the sub-level failed to correct problem, to avoid the condition of failure in correcting errors in the previous period, some recommendations submitted to ensure the readiness of workers in work include:
  a. Ensure that all workers and foremen understand the importance of K3 in the workplace. Therefore, guidance must always be given to workers and foremen in accordance with Article 9 of Law No. 1 of 1970
  b. Allocating a budget to improve the ability of foremen and workers in accordance with the provisions of Government Regulation No. 50 of 2012 Increase supervision of the implementation of K3 in the workplace by K3 personnel in accordance with Article 5 of Law No. 1 of 1970
  c. Creating an accident reporting system so that it can be analyzed to avoid the same accident from happening again in accordance with the provisions of Law No.1 of 1970 Article 11 and Permenaker Number Per.03/MEN/1998 concerning Procedures for Reporting Work Accidents
- In the sub-level supervisory violation, to avoid mistakes in supervision by the leadership, several recommendations were put forward to ensure the readiness of workers at work, including:
  a. Foremen must improve their understanding in terms of the implementation of regulations in the field of K3. For this reason, the leadership must coordinate with relevant agencies in charge of manpower to socialize about regulations in accordance with Law No. 1 of 1970 Article 9 paragraph 1
  b. By applying sanctions for anyone who violates the rules or works not according to procedures. For this reason, supervision must be further improved, by adding K3 personnel, considering that the milling process runs for 24 hours. This provision is in accordance with Government Regulation No. 50 of 2012
- Next, at the management level, some recommendations for corrective actions to prevent work accidents include:
  a. The company is committed to the implementation of K3. For this reason, in the formulation of policies and in the planning of the milling process, elements of the implementation of K3 must be included in the planning (Government Regulation No. 50 of 2012 concerning SMK3)
  b. The Sugar Mill must always coordinate with the parent management to provide input by presenting data on the implementation of K3 in the previous period (Government Regulation No. 50 of 2012 concerning SMK3)

c. Involving the K3 section in the preparation of the budget before the milling process begins (Government Regulation No. 50 of 2012 concerning SMK3)

- Based on some of the recommendations above, in general, the results of research that can be recommended to companies to prevent the same accidents from the human factor are:
  a. Providing guidance to foremen and workers in accordance with the Company's obligations in Article 9 of Law No. 1 of 1970
  b. Conduct health checks for workers before admission in accordance with the provisions of Article 8 of Law No. 1 of 1970
  c. Entering the budget for the implementation of K3 in the Company in the preparation of the budget in accordance with the provisions of Government Regulation No. 50 of 2012 concerning SMK3
  d. Conducting inspections and tests on lift aircraft in accordance with the Company's obligations in Permenaker Number 08 of 2020 concerning Lift Aircraft and Transport Aircraft
  e. Adding personnel responsible for K3, such as operators, conductors, technicians, fire role officers, P3K officers, general K3 experts.
  f. Involve operators, contractors and technicians in related training in order to obtain a K3 license in accordance with the Regulation of the Minister of Manpower Number 08 of 2020 concerning Lift Aircraft and Transport Aircraft
  g. Making SOPs for the operation of equipment to minimize the occurrence of accidents (PP No. 50 of 2012)

CONCLUSIONS

Based on the results of the analysis and discussion, it can be concluded as follows:

1. The results of the calculation of the severity of the accident that occurred at the Sugar Mill which was used as the object of research by using the method in the Decree of the Director General of Industrial Relations Development and Manpower Supervision of the Republic of Indonesia Number Kep.84/BW/1998 concerning How to Fill Out the Accident Form and Accident Statistical Analysis for accidents over the last 3 years, starting in 2020, 2021 and 2022 obtained the results that the accident that had the greatest impact caused by equipment that is included in the category of lift aircraft with a total of 143.67 hours of engine downtime and the number of lost working days of 6000 days with a total of 6 incidents.
2. By using the Human Factor And Classification System (HFACS) method to analyze the 6 accidents, the results were obtained that at level 1, the biggest causes of accidents were in the sub-level decision error, skill-based error, perceptual error and routine violation. At level 2, the biggest cause of accidents is in the sub-level technological environment and personal readiness. Meanwhile, at level 3 and level 4, Failed to

correct problems and supervisory violations have the largest percentage at level 3 and resource management at level 4.

3. To find the root of the problem, the Fault Tree Analysis or FTA method was used, the following results were obtained:
   a. Level 1 : 16 basic cause pada sub level perceptual error, 15 basic cause pada sub level decision error dan 13 basic cause pada sub level routine violation.
   b. Level 2 : 41 basic cause pada sub level technological environment, 12 basic cause pada sub level personal readiness.
   c. Level 3 : 9 basic cause pada sub level failed to correct problem, 9 basic cause pada sub level supervision violation.
   d. Level 4 : 5 basic cause pada sub level resource management
4. Based on the Fault Tree Analysis method, the most applicable improvement recommendations are obtained as follows:
   a. Providing guidance to foremen and workers in accordance with the Company's obligations in Article 9 of Law No. 1 of 1970
   b. Conduct health checks for workers before admission in accordance with the provisions of Article 8 of Law No. 1 of 1970
   c. Entering the budget for the implementation of K3 in the Company in the preparation of the budget in accordance with the provisions of Government Regulation No. 50 of 2012 concerning SMK3
   d. Conducting inspections and tests on lift aircraft in accordance with the Company's obligations in Permenaker Number 08 of 2020 concerning Lift Aircraft and Transport Aircraft
   e. Adding personnel responsible for K3, such as operators, conductors, technicians, fire role officers, P3K officers, general K3 experts.
   f. Involve operators, contractors and technicians in related training in order to obtain a K3 license in accordance with the Regulation of the Minister of Manpower Number 08 of 2020 concerning Lift Aircraft and Transport Aircraft

RECOMMENDATIONS

Based on the research that has been carried out, the suggestions proposed for the next research are:

1. To ensure the feasibility of the equipment, an analysis must be carried out on each equipment that is critical and has a high potential for accidents by using the Reliability Centered Maintenance method with Failure Mode and Effect Analysis (FMEA)
2. Conduct research on the impact of policies on recruiting workers by prioritizing work experience in the previous milling period with the rate of accidents that occur.

FURTHER STUDY

Given their own inexperience and limitations, it is not shocking that the researcher discovered a few grammatical, writing, and presentational style problems when producing this paper. To ensure the work is flawless, the

researcher thus anticipates perceptive criticism and recommendations from numerous sources.

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