ANALYSIS OF ACCIDENT DATA AT PT X FOR THE 2018-2022 PERIOD USING THE HFACS-MINING INDUSTRY FRAMEWORK METHOD

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ABSTRACT

The mining industry is acknowledged for its high-risk nature, where human factors stand out as the primary culprits behind significant accidents. PT X, a company operating in copper, gold, and silver concentrate sectors under Mining Industry Indonesia, reported 322 accidents between 2018 and 2022. This study aims to scrutinize these incidents at PT X using the Human Factor Analysis and Classification System-Mining Industry (HFACS-MI) framework. The methodology involved qualitative data collection from 322 accident cases at PT X during the specified period, recorded as recordable injuries in the incident management system database. These accidents were categorized using the HFACS-MI framework, with descriptive statistics applied for analysis. Findings revealed that 84% of accidents involved contractor workers, while 16% involved permanent PT X employees. Analysis using the HFACS-MI framework highlighted contributions to accidents from different levels, including external factors (44%), organizational influences (68%), unsafe leadership (90%), preconditions for unsafe acts (99%), and actual unsafe acts (99.7%). In conclusion, these results emphasize the necessity of minimizing human errors in mining operations to counteract the prevailing accident trend. The HFACS-MI framework proves to be a valuable instrument for comprehensive accident analysis, especially regarding human factors in the mining industry.

Keywords : HFACS-MI; Mining Industry; Accident; Recordable Injury

ABSTRAK

Industri pertambangan diakui memiliki sifat berisiko tinggi, di mana faktor manusia menjadi penyebab utama di balik kecelakaan yang signifikan. PT X, sebuah perusahaan yang beroperasi di sektor konsentrat tembaga, emas, dan perak di bawah naungan Industri Pertambangan Indonesia, melaporkan 322 kecelakaan antara tahun 2018 dan 2022. Penelitian ini bertujuan untuk mengkaji insiden-insiden ini di PT X menggunakan kerangka Analisis dan Klasifikasi Faktor Manusia-Industri Pertambangan (HFACS-MI). Metodologi melibatkan pengumpulan data kualitatif dari 322 kasus kecelakaan di PT X selama periode yang ditentukan, yang tercatat sebagai cedera yang dapat dicatat dalam database sistem manajemen insiden. Kecelakaan-kecelakaan ini dikategorikan menggunakan kerangka HFACS-MI, dengan statistik deskriptif diterapkan untuk analisis. Temuan menunjukkan bahwa 84% kecelakaan melibatkan pekerja kontraktor, sementara 16% melibatkan karyawan tetap PT X. Analisis menggunakan kerangka HFACS-MI menyoroti kontribusi terhadap kecelakaan dari berbagai tingkatan, termasuk faktor eksternal (44%), pengaruh organisasi (68%), kepemimpinan yang tidak aman (90%), kondisi awal untuk tindakan tidak aman (99%), dan tindakan tidak aman sebenarnya (99,7%). Kesimpulannya, hasil ini menekankan pentingnya meminimalkan kesalahan manusia dalam operasi pertambangan untuk

Submitted : 04/02/2023 |Accepted : 05/03/2024 |Published : 10/05/2024
P-ISSN; 2541-5255 E-ISSN: 2621-5306 |

menanggulangi tren kecelakaan yang ada. Kerangka HFACS-MI terbukti menjadi instrumen berharga untuk analisis kecelakaan yang komprehensif, terutama mengenai faktor manusia dalam industri pertambangan.

Kata kunci : HFACS-MI; Industri Pertambangan; Kecelakaan; Cedera yang Dapat Dicatat

INTRODUCTION

PT X operates within the exploration, extraction, text editing and advertising domains of copper, gold, and silver concentrates. It is a subsidiary mining owned by the state conglomerate, "Mining Industry Indonesia (MIND ID)". The ownership structure comprises a 51% stake held by the central government through MIND ID, with the remaining 49% owned by PT X. Situated in the Tembagapura Plateau region of Mimika, Central Papua, PT X operates at elevations ranging from 2,800 to 3,500 meters above sea level and employs over 30,000 personnel (Ministry of Energy and Mineral Resources, 2024).

The activities that are carried out in the mining sector, described by high degrees of hazards plus risks, can lead to employment mishaps, affecting both the safety of individuals and the general company effectiveness. According to NIOSH data, there has been an increase in mining sector accidents, rising from 3,193 incidents in 2020 to 3,421 in 2021. Data from the Social Security Administrator for Employment (BPJS Ketenagakerjaan) indicates a rising trend in work-related accidents and diseases from 2019 to 2021, amounting to 210,789 cases in 2019, 221,740 cases in 2020 (an increase of 5.1%), and 234,370 cases in 2021 (an increase of 5.7%). Furthermore, the number of deaths arising from work-related accidents and illnesses has stayed elevated, with 4,007 worker fatalities in 2019, declining to 3,410 in 2020, then escalating to 6,552 in 2021, according to the "Ministry of Manpower of the Republic of Indonesia" (2022) (Manpower, 2022). According to the "Directorate General of Minerals and Coal, Ministry of Energy and Mineral Resources of the Republic of Indonesia (2024)", there were 62 fatalities, 97 severe accidents, and 219 minor accidents documented. These figures represent There was a rise compared to the preceding year, with mineral and coal mining documenting 11 worker fatalities, 75 severe accidents, and 36 minor accidents, indicating a notable decrease in the safety performance of the mining sector that warrants urgent attention .

Submitted : 04/02/2023 |Accepted : 05/03/2024 |Published : 10/05/2024
P-ISSN; 2541-5255 E-ISSN: 2621-5306 |

During the timeframe from 2018 to 2022, PT X's Incident Management System recorded a total of 322 injury-related accidents, categorized into recordable injuries such as those requiring medical treatment, restricted duty, lost time, or resulting in fatalities. Cases where only initial first aid was administered were not classified as recordable injuries, following the "MSHA 30 CFR Guideline". Examination incident statistics indicates that 60% of these occasions were attributed to conduct elements.

"The Swiss Cheese Model", proposed by Reason, illustrates accidents within an organization resulting from a flawed defense system. Unsafe actions reflect failures in the active defense system, directly contributing to incidents and accidents. Additionally, latent conditions within the organizational defense system, which may not be immediately apparent, can accumulate over time, fostering hazardous behavioral patterns (Joe-Asare, Amegbey, & Stemn, 2020). Hence, accident investigations should be conducted comprehensively, extending beyond individual actions to include organizational factors.

"The Human Factor Analysis and Classification System (HFACS)" is an advanced exploratory and analytic framework built upon the principles of the "Swiss Cheese Model" concept. It is utilized throughout various Vocational sectors, incorporating mining. Specifically tailored for the mining sector, "HFACS in Mining Industry (HFACS-MI)" delineates the defense system has five tiers. breakdowns contributing to Crash susceptibility: administrator behavior or dangerous acts, preconditions for dangerous acts, dangerous management, Systematic factors, and outside variables (Joe-Asare, Stemn, & Amegbey, 2021).

Currently, PT X has adopted the Loss Causation Model for incident investigations, a model that has evolved from Bird's conceptualization of Heinrich's domino effect theory. The investigations into incidents employ the Procedure for Analyzing Causes. This study utilized "the HFACS-MI" technique and analytical strategy, conducting a comprehensive analysis of risk variables for misfortunes, including both overt and covert breakdowns (Joe-Asare et al., 2020).

The objective of this study is to examine the person elements associated with misfortunes at PT X between 2018 and 2022, focusing on the components or levels outlined in the HFACS-MI method. These accidents fall under the recordable injury category, which includes cases requiring disability, time off, and medical care, or

Submitted : 04/02/2023 |Accepted : 05/03/2024 |Published : 10/05/2024
P-ISSN; 2541-5255 E-ISSN: 2621-5306 |

resulting in fatalities. “The HFACS-MI” method was deliberately designed also implemented for the mines, making it highly applicable in the study context.

RESEARCH METHOD

Method is a method of work that can be used to obtain something. While the research method can be interpreted as a work procedure in the research process, both in searching for data or disclosing existing phenomena (Zulkarnaen, W., et al., 2020:229). In this study, the HFACS-MI framework depicted in Figure 1 is employed for accident analysis within the mining sector. This model delineates 21 classes across five tiers of the nation's mining operational risky behavior protection mechanism, preconditions concerning risky acts, risky management, impacts on the company, and outside variables (Creswell, 2018).

The study took place within the operational vicinity of PT X in “Mimika Regency, Central Papua, during October 2023”. A study that is both explanatory and examinative approach was utilized to assess the relative assignment of accident-collaborative factors within each analyzed aspect, following the “HFACS-MI method”. The next step was to use a cross-sectional methodology that included collecting data at the same time and measurement of variables. Research data were gathered in the course of a mixed literature review also interviews.

The study population consisted of crashes information encompassed within reports on accidents examined recorded at PT X between 2018 and 2022. The investigation employed a group evaluation method to select injury records pertaining to accidents, which included cases categorized as requiring healthcare therapy, limited responsibility, time squandered and lives lost within the the specified period, amounting to 322 samples. Selecting samples of recordable injuries was based on the acknowledgment of their substantial impact on worker well-being, as well as their significant implications for an organization's operational and monetary considerations.

Based on the study findings comprised two main sources: primary data collected from the source itself and secondary data collected, processed, and recorded. Information about accidents was derived from six important sources, including supervisors and superintendents, who were interviewed to provide primary data. From 2018 through 2022, secondary data consisted of accident investigation reports and accident recording records.

This study entailed a thorough review of the contents within accident investigation reports. Data analysis employed a univariate analysis approach, where each processed data variable was individually examined to gain insight into its characteristics. The findings were presented through descriptive statistics for both the independent and dependent variables, as well as frequency distribution, proportion size, and percentage.

Ethical assessment procedures were conducted for this study, and approval for implementation was obtained with "registration number: Ket- 639/UN2.F10. D11/PPM.00.02/2023".

RESULT AND DISCUSSION

Table 1 illustrates the categorization on a registrable injuries in incidents involving PT X's mining operations, comprising 322 cases. Through analysis by means of the "HFACS-MI model", it becomes evident each of the examined levels played a role in such mishaps' occurrence. It is possible for elements from different layers to play a role in the same accident more than once, as accidents often have multifactorial causes. A comprehensive analysis regarding the factors contributing to incidents involving PT X's mines is provided is shown in Table 1 attached.

Unsafe Acts

According to an examination of PT X's workplace accidents (refer to Figure 2), it is evident that risky behavior consistently become the leading cause of accidents between 2018 and 2022. Out of 63 accidents that were registered in 2018, 62 were due to dangerous acts, making up 98% of all accidents. All seventy-five accidents that occurred in 2019 were caused by dangerous behaviors. Similarly, throughout 2020 and 2021, risky behaviors played a role to 100% of the accidents, with 61 cases every year. Out of 62 cases in 2022, all of them were due to dangerous acts. Out of all the incidents, 321 (99.7 percent) involved dangerous conduct out of the total 322 cases recorded from 2018 to 2022.

Within the "HFACS-MI" system, risky behavior are categorized as the first level, or last layer, which is further divided into two distinct components: errors and violations. At PT X, errors emerged as a more significant contributing factor to accidents compared to violations. In 2018, there were 62 errors recorded, surpassing the total of 39 violations. Similarly, in 2019, there were 75 errors compared to 50 violations. In 2020,

errors contributed to 61 cases, while there were 41 violations. The trend continued in 2021, with 61 errors and 47 violations, and in 2022, with 62 errors and 42 violations. Overall, from 2018 to 2022, mistakes were the cause of 99.7% of cases, totaling 321 incidents, while infractions played a part to 68%, made up 219 of the 322 instances that were documented.

Precondition for Unsafe Acts

From look at the events that happened at PT X (Figure 3), it is evident that Having the right conditions before doing something dangerous becomes a major cause, helping out significantly to numerous Mishaps from 2018 to 2022. In 2018, conditions for dangerous acts were met a crucial position, accounting for 97% or 61 cases out of the 63 reported Mishaps. Similarly, All seventy-five incidents in 2019 involved preconditions for dangerous behaviors. All sixty-one of the documented incidents in 2020 and 2021 involved preconditions for risky conduct. Of the 62 occasions documented in 2022, 98%, or 61 out of 62, were related to preconditions for risky conduct. Overall, in the comprehensive review of mishaps from 2018 to 2022, precondition for unsafe acts emerged as the predominant factor, accounting on 319 (322 total) instances, accounting for 99.1 percent.

Prerequisites for risky behavior belong to the HFACS-MI model are positioned as the subsequent level, designated as Level 2. This tier goes on, subdivided divided into three separate parts: environmental elements, operator conditions, as well as personnel elements. In 2018, environmental elements contributed to 55 cases, operator conditions made up 61 cases, as well as personnel elements were responsible for in the HFACS-MI system, there are 57 examples.. Similarly, in 2019, environmental factors comprised 74 cases, operator conditions accounted for 75 cases, and personnel factors totaled 68 cases according to the HFACS-MI framework. In 2020, experiences identified within the HFACS-MI framework showed environmental factors at 60 instances, operator conditions at 57 instances, considering personnel-related aspects at 59 instances. In 2021, noted incidents the HFACS-MI system showed that 59 instances of environmental elements, 55 instances of operator conditions, and 54 instances of personnel factors. Moving to 2022, instances inside the structure of HFACS-MI included 56 instances of environmental elements, 40 instances of operator conditions, and 55 instances of personnel factors. Through a thorough examination of the incidents

Submitted : 04/02/2023 |Accepted : 05/03/2024 |Published : 10/05/2024
P-ISSN; 2541-5255 E-ISSN: 2621-5306 |

from 2018 to 2022, the environment was responsible for 94.4%, corresponding to 304 cases; operator conditions Human considerations represented 91%, or 293 out of 322 situations, and represented 89.4%, or 288 occurrences.

Unsafe Leadership

Based on the findings based on PT X's examination of workplace incidents (refer to Figure 4), it is evident that unsafe leadership significantly contributes to a considerable number of accidents from 2018 to 2022. Positioned as the third level (Level 3) within the "HFACS-MI framework", unfit governance plays a crucial participation in accident causality at PT X. 2018, unfit governance contributed significantly, accounting for 95% or 60 out 63 recorded crashes in all. In an identical vein, in 2019, unfit governance remained a crucial element, representing 97% or 73 out of 75 total number of occurrences identified. 2020 saw unreliable governance continued to have a noteworthy impact, contributing to 97% or 59 cases out of the total 61 reported incidents. The influence of unsafe leadership peaked in 2021, representing 100% of 61 cases. The impact of dangerous leadership persisted in 2022, causing 48 out of 62 recorded events, or 77% of the total. All things considered, when looking at the total number of mishaps from 2018 to 2022, dangerous governance had a significant impact, making up 93.5%, or 301, of the 322 occurrences that were documented.

Organizational Influences

According to the analysis results of PT X's work-related mishaps (refer to Figure 5), from 2018 to 2022, corporate effects clearly became apparent as a major causative component that considerably affects mishaps. Positioned as the fourth tier (Level 4) within the "HFACS-MI framework", organizational influences play a crucial part in the cause of the crash at PT X. Of the 63 recorded mishaps in 2018, organizational influences accounted for 51 occurrences, or 81% of the overall. This influence continued in 2019, where administrative variables accounted for 75%, constituting 56 of the 75 instances identified in total. In 2020, the pattern continued, with managerial variables accounting for 70%, or 43 occasions, of the 61 occasions that were recorded. Administrative effects continued to have an impact in 2021, accounting for 41 cases, or 67% of the 61 cases that were recorded overall. Administrative effects were still very much in play in 2022, accounting for 24 occasions, or 44%, of the 62 occurrences that were documented. Organizational factors played a substantial role in the aggregate

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P-ISSN; 2541-5255 E-ISSN: 2621-5306 |

analysis of accidents from 2018 to 2022, accounting for 218 occurrences (or 67.7%) out of the 322 total incidents documented.

External Factors

Discussion

The "HFACS-MI framework's" assessment of human variables in relation to occupational accidents at PT X from 2018 to 2022 revealed a prevalence of accidents involving contractors, accounting for 84%, whereas accidents featuring PT X constant employees constituted 16%. External factors, particularly social obligations, were found to be 44% related to incidents where local workers were engaged by contractors in accordance with Law Number 3 of 2020's mining restrictions. This study discovered a strong relationship between regulatory parameters and safety culture (Ye et al., 2018). This monitoring highlights the vulnerability of vendors to mishaps, emphasizing their crucial function as the mining sector's main operating staff. This susceptibility is exacerbated by their insufficient expertise and familiarity with the mining industry (Nwankwo, Arewa, Theophilus, & Esenowo, 2022). Contractors often come from diverse educational backgrounds and past experiences, leading to their unfamiliarity with the working situation. Moreover, discrepancies in safety protocols and practices between contractors and the companies that hire them are widespread (Griffiths, Sovacool, Kim, Bazilian, & Uratani, 2021). This reveals notable deficiencies in the organizational procedures and technology utilized for carrying out these activities. IIn actuality, the study of human factors investigates the interactions between people (contractors), equipment (technology), and procedures (processes) (Nwankwo et al., 2022).

Law Number 3 of 2020 states that national rules are a contributing element to weaknesses in organizations affecting organizational environment, procedure security society, and the administration of resources. The implementation of a recruitment strategy to replace departing personnel as a result of work stoppages, layoffs, and voluntary separation schemes serves as evidence of this. To cover 53% of the incidents, the corporation hired almost 9,000 people from contractor firms and local communities to fill these positions. Insufficient organizational protocols and an unsatisfactory organizational culture can lead to insufficient oversight and an inability to address recognized issues, mostly because of a lack of commitment on the part of managers.

This study reveals that organizational atmosphere leads to 52% of accidents, whereas organizational processes account for 47% of accidents. According to Nwankwo's perspective (Nwankwo et al., 2022), inadequate organizational policies and practices have a significant impact on accidents that happen in the mining, oil, and gas industries. A few things that can lead to deficiencies in crew resource management are poor supervision, ignoring problem solving, and breaking supervisory procedures. This is consistent with the findings of (Jiang, Han, Zhou, & Huang, 2020), which suggest that insufficient handling of resources affects supervision inadequacy and specifically impacts unreasonable personnel placement, inadequate systems for selecting personnel qualifications, and the low quality of safety personnel. Collectively, these factors contribute to 53% of accidents.

Inadequate leadership, accounting for 90% of contributions, failure to rectify acknowledged issues at 91%, inappropriate Scheduled operations at 54% and infractions by management at 64%, appeared as notable factors contributing to mishapsin the examined scenario. The standard of management plays a crucial role in shaping the organizational climate and can significantly impact the organization's overall performance. Organizations fostering conducive environments motivate both potential and existing employees to strive for their utmost performance. Key components of safety leadership encompass safety coaching, demonstrating concern for safety, and overseeing safety measures. Safety coaching articulates the vision and objectives of a security project define its legitimacy, impact safety ideals, and clarify the outcomes of work completed (Ariscasari & Syaaf, 2018). The company's training policy, which does not include any provisions for training contractor personnel, supports this. It is commonly known that workers for contractors, especially those who live nearby, do not have enough safety information and expertise. This shortcoming presents a possible danger element that could lead to mishaps. As highlighted by Ziwei (Fa, Li, Liu, Qiu, & Zhai, 2021) in his study, unsafe supervisory practices and unsafe preconditions that fail to offer guidance or intervene in unsafe behaviors, inadequate identification and resolution of hidden risks, irrational work arrangements during preshift meetings, failure of leaders to enforce pertinent regulations, approval of supervisors for unqualified personnel to operate, and insufficient hazard identification can collectively lead to employees experiencing unsafe mental conditions, such as insufficient awareness of

self-protection and collective safety or a diminished sense of responsibility.

Environmental problems related to technology and physical aspects accounted for 94% of the causes of the accidents at PT X. Eighty-four percent of mishaps are caused by the harsh environmental conditions in which PT X works. These settings are characterized by high-risk elements such as inclement weather, extreme temperatures at work, slick and steep terrain, and insufficient lighting, especially in mining tunnel locations. This is consistent with the findings of Nwankwo's investigation (Nwankwo et al., 2022), they highlight how the work environment's intrinsic risk factors significantly raise the chance and severity of accidents.

People who are tired are less inclined to operate at their best, and exhaustion has been found to be a major factor in a large number of incidents, wounds, and fatalities. According to the UK's Health and Safety Executive (Health and Safety Executive United Kingdom, 2020) weariness is a contributing factor in 20% of serious traffic accidents and can be expensive. The significant 90% contribution of the operators' condition to all reported incidents in this investigation supports this claim.

The study's findings demonstrated that, at 99.7% of all mishaps, risky behavior was a major contributing factor. Many factors could impact these risky behaviors; skill-based errors account for 98% of the errors, decision-making errors account for 99%, and perceptual errors account for 90%. Errors and violations are two categories for unsafe worker activities. While infractions entail deliberate behavior that disobeys or violates laws, ordinances, and/or established practices, errors are unintended actions (Wiegmann, Wood, Solomon, & Shappell, 2021). Errors based on skill can be caused by a number of things, such as insufficient personal preparation, poor crew resource management, physical or mental impairments, and issues with employees' mental health. One suggested strategy is to raise employees' perceptions of risk by carefully choosing qualified people who have the necessary education, experience, expertise, and understanding for a given assignment. Empirical evidence suggests that inadequate staff resource management contributes to decision-making errors, whereas factors such as personal preparation, crew resource management, physical or mental limits, and degraded mental states of workers result in skill-based errors. Inadequate physiological conditions, less-than-ideal psychological states, and mental or physical impairments can also cause misconceptions (Nwankwo et al., 2022). Regular exercises and revision

Submitted : 04/02/2023 |Accepted : 05/03/2024 |Published : 10/05/2024
P-ISSN; 2541-5255 E-ISSN: 2621-5306 |

sessions are essential to guaranteeing that employees make the right judgments in situations of emergencies (Wang et al., 2021).

Routine violations commonly result from various underlying factors, such as inadequate personal readiness, ineffective management of crew resources, physical or mental limitations of workers, compromised mental states of workers, and unsafe physical environments. According to (Nwankwo et al., 2022), a lack of operational discipline may result in repeated infractions, especially when poor safety cultures exist inside the company. The results of the research showed that 67% of all reported accidents were caused by regular violations.

CONCLUSIONS

Through the application of the "HFACS-MI framework", it is evident that each layer or level plays a role in accidents, with external factors contributing 44%, organizational influences 68%, unsafe leadership 90%, dangerous activities 99.7% and risky behaviors 99% as prerequisites. This study also reveals significant impacts from administrative and external impacts on the protection operation of the enterprise. It is critical that the business handle this issue by creating thorough mitigation and mitigation strategies targeted at decreasing vulnerabilities at every level and mitigating cause factors, given the significant contributions of dangerous behaviors and risky prerequisites.In order to create a safe work culture and environment, solidify organizational procedures, put in place efficient risk management and control mechanisms, and provide sufficient monitoring, company dedication is essential. This commitment begins with mindful choice, evaluation, and oversight of constructors, along with the implementation of a method for hiring staff members based on their competencies. Furthermore, comprehensive measures such as intensive training and regular refresher courses, improvement of safety communication strategies, and enforcement of disciplinary actions for safety violations can further enhance the establishment of a robust safety culture within the organization. Additionally, contractors, government agencies, and other stakeholders might greatly benefit from outreach and educational programs that attempt to improve the knowledge and abilities of potential employees in this industry. The application of the HFACS-MI framework in this work provides significant benefits since it is an effective research instrument. This

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P-ISSN; 2541-5255 E-ISSN: 2621-5306 |

framework's comprehensiveness makes it possible to analyze mining sector incidents including human aspects in great detail.

APPRECIATION

The author expresses sincere gratitude to the following people: their family; the PT X Mining Safety Division team for helping with the research data; classmates from the 2022 Master's program in Occupational Health and Safety; and the larger Graduate Program in Occupational Health and Safety community at the Faculty of Public Health, Universitas Indonesia.

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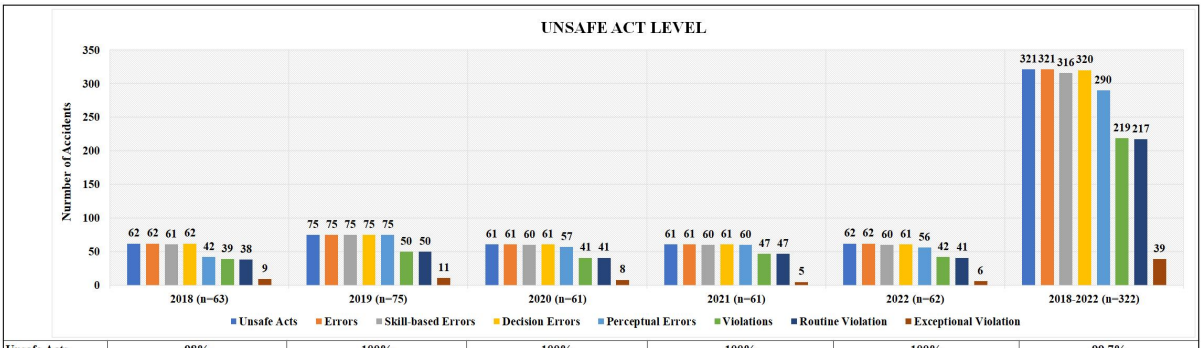
GAMBAR, GRAFIK DAN TABEL

Table 1. Results of HFACS-MI analysis of work-related accidents at PT X for the 2018-2022 period

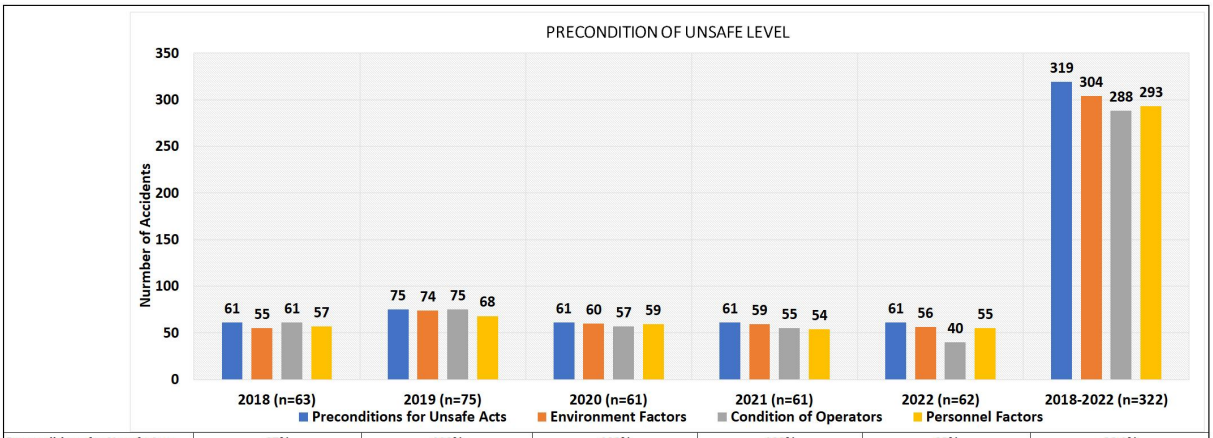
Category	Causation Factor Using the HFACS-MI at PT X Accident in 2018 - 2022											
	2018		2019		2020		2021		2022		2018-2022	
	(N=63)		(N=75)		(N=61)		(N=61)		(N=62)		(N=322)	
	∑	%	∑	%	∑	%	∑	%	∑	%	∑	%
External Factor	33	52 %	35	47%	30	49%	25	41%	18	29%	141	43.8 %
Regulatory Factor	33	52 %	35	47%	30	49%	25	41%	18	29%	141	43.8 %
Other Factors	33	52 %	35	47%	30	49%	25	41%	18	29%	141	43.8 %
Organizational Influences	51	81 %	56	75%	43	70%	41	67%	27	44%	218	67.7 %
Resource Management	40	63 %	44	59%	33	54%	32	52%	21	34%	170	52.8 %
Organizational Process	40	63 %	37	49%	38	62%	24	39%	12	19%	151	46.9 %
Organizational Climate	44	70 %	43	57%	31	51%	29	48%	22	35%	169	52.5 %
Unsafe Leadership	60	95 %	73	97%	59	97%	61	100 %	48	77%	301	93.5 %
Inadequate Leadership	59	94 %	72	96%	59	97%	55	90%	46	74%	291	90.4 %
Planned Inappropriate Operations	13	21 %	16	21%	14	23%	11	18%	0	0%	54	16.8 %
Failure to Correct Known Problem	57	90 %	72	96%	59	97%	60	98%	45	73%	293	91.0 %
Leadership Violation	52	83 %	59	79%	45	74%	28	46%	22	35%	206	64.0 %
Precondition for Unsafe Acts	61	97 %	75	100 %	61	100 %	61	100 %	61	98%	319	99.1 %
Environmental Factor	55	87 %	74	99%	60	98%	59	97%	56	90%	304	94.4 %
Physical Environment	46	73 %	71	95%	47	77%	53	87%	48	77%	265	82.3 %
Technical Environment	37	59 %	47	63%	45	74%	41	67%	33	53%	203	63.0 %

Condition of Operator	61	97 %	75	100 %	57	93%	55	90%	40	65%	288	89.4 %
Adverse Mental State	61	97 %	70	93%	54	89%	55	90%	37	60%	277	86.0 %
Adverse Physiological State	49	78 %	61	81%	29	48%	14	23%	11	18%	164	50.9 %
Physical/Mental Limitation	47	75 %	30	40%	12	20%	3	5%	1	2%	93	28.9 %
Personnel Factor	57	90 %	68	91%	59	97%	54	89%	55	89%	293	91.0 %
Coordination & Communication	57	90 %	68	91%	59	97%	54	89%	55	89%	293	91.0 %
Fitness for Duty	2	3%	2	3%	0	0%	0	0%	0	0%	4	1.2%
Unsafe Acts	62	98 %	75	100 %	61	100 %	61	100 %	62	100 %	321	99.7 %
Error	62	98 %	75	100 %	61	100 %	61	100 %	62	100 %	321	99.7 %
Skill-based Error	61	97 %	75	100 %	60	98%	60	98%	60	97%	316	98.1 %
Decision Error	62	98 %	75	100 %	61	100 %	61	100 %	61	98%	320	99.4 %
Perceptual Error	42	67 %	75	100 %	57	93%	60	98%	56	90%	290	90.1 %
Violation	39	62 %	50	67%	41	67%	47	77%	42	68%	219	68.0 %
Routine Violation	38	60 %	50	67%	41	67%	47	77%	41	66%	217	67.4 %
Exceptional Violation	9	14 %	11	15%	8	13%	5	8%	6	10%	39	12.1 %



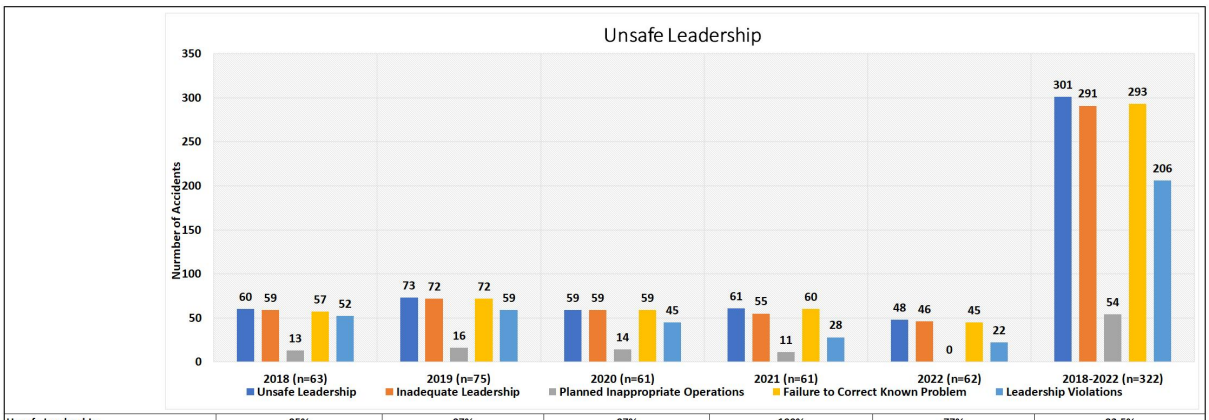
Unsafe Acts	98%	100%	100%	100%	100%	99.7%
Errors	98%	100%	100%	100%	100%	99.7%
Skill-based Errors	97%	100%	98%	98%	97%	98.1%
Decision Errors	98%	100%	100%	100%	98%	99.4%
Perceptual Errors	67%	100%	93%	98%	90%	90.1%
Violations	62%	67%	67%	77%	68%	68.0%
Routine Violation	60%	67%	67%	77%	66%	67.4%
Exceptional Violati	14%	15%	13%	8%	10%	12.1%

Figure 2. HFACS-MI Analysis Results for Unsafe Act level of PT X work-related accidents for the 2018-2022 period



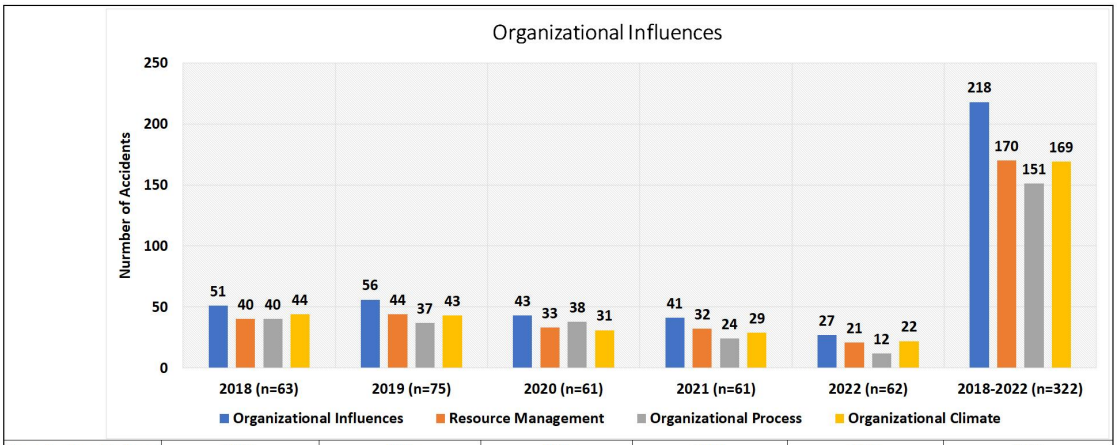
Preconditions for Unsafe Acts	97%	100%	100%	100%	98%	99.1%
Environment Factors	87%	99%	98%	97%	90%	94.4%
Condition of Operators	97%	100%	93%	90%	65%	89.4%
Personnel Factors	90%	91%	97%	89%	89%	91.0%

Figure 3. Results of HFACS-MI analysis of level of precondition for unsafe acts at PT X work-related accidents for the 2018-2022 period



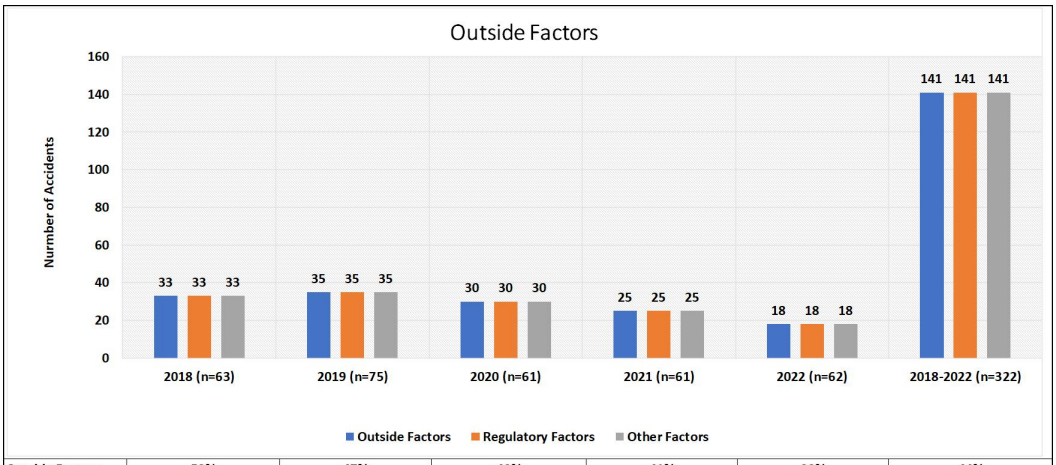
Unsafe Leadership	95%	97%	97%	100%	77%	93.5%
Inadequate Leadership	94%	96%	97%	90%	74%	90.4%
Planned Inappropriate Operations	21%	21%	23%	18%	0%	16.8%
Failure to Correct Known Problem	90%	96%	97%	98%	73%	91.0%
Leadership Violations	83%	79%	74%	46%	35%	64.0%

Figure 4. Results of the HFACS-MI analysis of unsafe leadership level at PT X work-related accidents for the 2018-2022 period



Organizational Influenc	81%	75%	70%	67%	44%	68%
Resource Management	63%	59%	54%	52%	34%	53%
Organizational Process	63%	49%	62%	39%	19%	47%
Organizational Climate	70%	57%	51%	48%	35%	52%

Figure 5. Results of HFACS-MI analysis of organizational influence level at PT X work-related accidents for the 2018-2022 period



Outside Factors	52%	47%	49%	41%	29%	44%
Regulatory Factors	52%	47%	49%	41%	29%	45%
Other Factors	52%	47%	49%	41%	29%	44%

Figure 6. Results of HFACS-MI level outside factors analysis of PT X work-related accidents for the 2018-2022 period

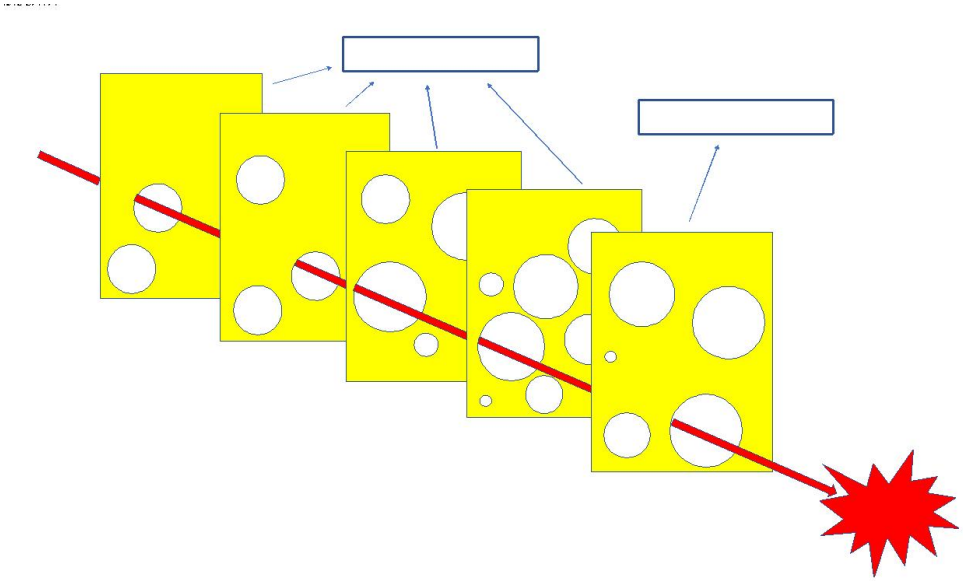


Figure 7. Results of the 2018-2022 PT X accident analysis using the HFACS-MI framework”