JURNAL TEKNIK SIPIL DAN LINGKUNGAN| EISSN:2549-1407
https://jurnal.ipb.ac.id/index.php/jsil

Vol. 10 No. 01 April 2025
DOI: 10.29244/jsil.10.1.203-212

Evaluation of Occupational Safety Performance Using Key Performance Indicators in Manufacturing Industrial Construction

Dimas Ardi Prasetya*, Luvy Dellarosa, and Bayu Rahmat Hidayat

Environmental Engineering and Management Study Program, Vocational School, IPB University, Bogor, 16680 Indonesia,
***corresponding author: dimas_arpras@apps.ipb.ac.id**

Abstract: Occupational Health and Safety (OHS) in work environments is crucial for optimal productivity. Work accidents affect productivity because they can reduce working hours and decrease productivity. The problem faced by a company is the absence of a Key Performance Indicator that explicitly considers the safety aspect. This study aims to determine and calculate the key performance indicator safety of KPIs and implement a correlation between work accidents and productivity. Key Performance Indicator data processing Safety consists of leading indicators for potential future events and lagging indicators for past accident data using the Safe T-Score method to determine the effect of accident rates on work productivity. The Key Performance Indicator calculation results for safety showed good performance, with a total actual value of 94.74%. The results show that the Safe T Score is 2.68 in 2022 and -1.61 in 2023, indicating little change in the occupational health and safety program. The results show a positive relationship between occupational safety and productivity; the fewer the accidents, the higher the productivity.

Submitted : 18 Sep 2024
Revised: 01 Nov 2024
Accepted: 03 Mar 2025

Keywords: ohs; kpi; productivity; safety; work

1. Introduction

Occupational safety, health, and the environment of a company are essential for achieving optimal productivity [6]. Occupational Safety and Health (OHS) is a science and practice that aims to avoid potential accidents and diseases caused by work and the work environment 2. Losses such as injury, disability, death, and damage to property and equipment can be caused by accidents [5]. Occupational Safety and Health (K3) is a key component affecting various operational aspects, including employee welfare and work efficiency.

In the manufacturing industry, the level of Occupational Safety and Health (OHS) has a direct impact on productivity [3]. Work accidents can result in the loss of working hours and decreased productivity [16]. The relationship between Occupational Safety and Health (OHS) and productivity is understood as the higher the accident incidence rate, the lower the productivity, and the lower the accident incidence rate, the higher the productivity [5]. Contributions to good productivity are made by a safe working environment, while the work environment, which can disrupt employee concentration and productivity [11], and Implementing an Occupational Safety and Health (K3) program is not only a legal obligation but also an important strategy to improve operational efficiency and employee welfare.

Implementing an Occupational Safety and Health (OHS) program is very important in a company, especially in manufacturing companies that produce electronic automotive cockpits for motor vehicles. The company implemented the concept of Occupational Safety and Health (OHS) in its work processes or activities. Observations carried out at motor vehicle speedometer manufacturing companies show that work accidents are caused by employee negligence and carelessness almost every year, and they indicate weaknesses in the implemented Occupational Safety and Health (OHS) management system.

Work productivity plays a vital role in a company's overall performance; no Key Performance Indicator (KPI) explicitly considers the company's Occupational Safety and Health (OHS) aspect. The absence of a safety Key Performance Indicator (KPI) makes it difficult for companies to evaluate the impact of an OHS program on employee productivity. KPIs in companies that focus on Occupational Safety and Health (OHS) can more accurately assess and improve occupational safety and health efforts, ultimately contributing to increased productivity.

Therefore, the researcher wanted to conduct research by taking the title " Evaluation of Occupational Safety Performance Using Key Performance Indicators in Manufacturing Industrial Construction" in the manufacturing industry sector.

2. Method

2.1. Material

Conducted research for a company engaged in the manufacturing industry. The data collection technique used in the research was carried out technically: a literature study, namely collecting literature in the form of references related to the topic being carried out, and data collection, namely to obtain secondary data in the form of literature studies related to KPIs and general company data regarding the number of employees and Key Performance Indicators.

2.2. Research Procedures

Primary data included types of work accidents, accident frequency, number of employees working hours, and number of lost working hours over the past three years. Based on the obtained data, data analysis was conducted to determine the correlation between work accidents and work productivity.

a. Determining the level of work accident frequency and Frequency Rate. The frequency rate or Frequency Rate is a measure that shows the number of accident incidents that occur per 1,000,000 human working hours [15] using the following formula:

$$FR = \frac{\text{The number of accidents with lost time injury x 1.000.000}}{\text{human working hours}}$$

b. Severity Rate or severity of work accidents. Calculation of the Severity Rate or severity of work accidents refers to the number of work days lost per 1,000,000 work hours [1], expressed by the following formula:

$$SR = \frac{\text{The number of working days lost x 1.000.000}}{\text{Number of human working hours}}$$

c. Calculate the T-Safety Value (NTS), which aims to compare the level of accident incidents between the past and present in a work unit [15]. The T-Safety Value helps in evaluating the reduction in the accident rate in the unit [22] using the formula:

$$NTS = \frac{FR\,(n) - FR\,(n-1)}{\sqrt{\frac{FR\,(n-1)}{\left(\frac{\text{Working hours in x}}{1.000.000}\right)}}}$$

d. The incidence rate provides information on the percentage of work accidents that occur in the

workplace [5]. The Incident Rate was calculated using the following formula:

$$IR = \frac{\text{The number of accident}}{\text{human working hours}} \text{ x } 100\%$$

e. Productivity measurement can be calculated using the following formula:

$$P = \frac{\text{The number of accident - Number of hours lost by workers.}}{\text{human working hours}}$$

Further data analysis is required to determine the company's safety Key Performance Indicators (KPIs) using the following steps:

a. The process of measuring and creating Key Performance Indicators is divided into two types of measurement indicators, namely lagging indicators and leading indicators. Lagging indicators measure safety performance based on past accident statistics, whereas leading indicators indicate events that may occur in the future.
b. The percentage calculation related to the total cases that had obtained repaired or closed findings was obtained using the following formula:

$$\text{Closing Findings} = \frac{\text{Closed case}}{\text{Total findings}} \text{ x } 100\%$$

c. Determining the lagging indicator pyramid to find out how many near miss cases cannot be reported can be done by calculating the comparison between the lagging indicator pyramid and the Heinrich pyramid using the formula formula:

$$\frac{A_1}{B_1} = \frac{A_2}{B_2}$$

Information:
A = Heinrich's Pyramid Value
B = Lagging indicator pyramid value

d. The design of the KPI formulation uses the actual score of the Key Performance Indicator (KPI), which refers to the exact value or results obtained in measuring performance. The following formula can be used to obtain the actual score value:

$$\text{Score Actual Lagging Indicator} = \text{Score Max} - \frac{\text{Actual accomplised}}{\text{Target}}$$

$$\text{Score Actual Leading Indicator} = \frac{\text{Actual accomplised}}{\text{Target}} \text{ x Score Max}$$

After obtaining the actual score for each aspect, a % Total Value calculation was carried out to obtain the overall result value and determine the success or achievement level based on the Traffic Light System.

$$\%\text{ Total Nilai} = \frac{\text{Jumlah score actual yang dicapai}}{\text{Jumlah Score maksimum}} \text{ x } 100\%$$

A traffic Light System is used to facilitate an understanding of company performance [14]. The traffic-light system determines whether the KPI values require improvement [8]. The Traffic Light System classifies assistance indicators into three color categories: red, yellow, and green.

Table 1 Classification of traffic light systems

Score	Category
> 70%	Good performance and achievement according to company expectations
40% – 69%	Performance is adequate, has not reached target but does not require improvement
< 40%	Low performance, achievement far below target and requires immediate improvement

3. Results and Discussion

3.1. Key Performance Indicators of Manufacturing Companies

The Key Performance Indicator (KPI) is a group of parameters that can be measured, providing information on how much an organization has achieved its strategic goals [10]. The process of measuring and creating Key Performance Indicators is divided into two types of measurement indicators, namely lagging indicators and leading indicators.

Table 2. Lagging indicators

No	Item	Month					
		August	September	Oct	Nov	Dec	Jan
1	Fatality	-	-	-	-	-	-
2	Lost Time Injury (LTI)	-	-	-	-	-	-
3	Medical Treatment Injury (MTI)	-	-	-	-	-	-
4	First Aid Injury (FAI)	-	1	-	-	-	-
5	Near miss	-	-	-	-	-	-
6	Unsafe action	-	-	1	2	-	2
7	Unsafe conditions	3	2	2	8	2	3

The data used in the lagging indicator are from 2023 to 2024, which is six months long. From August 2023 to January 2024, there was one case of first-aid injury in September, with a case of bruising on the middle finger and ring finger of the left hand due to worker negligence when operating the machine. In the unsafe action aspect, five cases occurred in October, November, and January, with the unsafe action condition of not using appropriate PPE when working and playing with a handlift. In terms of unsafe conditions, there were 20 cases from August 2023 to January 2024, with the highest being November, with eight cases. Unsafe conditions often occur, such as hand lift placement in the wrong location and safety sensors not being connected to the machine system.

Leading indicators are measures that indicate events that may occur in the future and are used to improve a company's safety culture. Leading indicators highly correlate with continuous improvement in an organization [23]. The number of accidents in the Lagging Indicator decreases. This shows that safety patrol and safety talk activities, often carried out in the Leading Indicator aspect, have effectively increased employees' awareness and knowledge regarding safety culture, reduced unsafe actions, and reduced near misses. This proves that the leading indicator activity is an effective strategy for improving work safety and reducing the risk of accidents to create zero accidents. Combining leading and lagging indicators can support behavioral changes that can positively impact sustainable work safety levels in the long term [20].

Table 3. Leading indicators

No	Item	Month					
		August	September	Oct	Nov	Dec	Jan
1	HSE Meeting	4	4	4	4	4	4
2	Closing Findings (%)	100	75.4	100	78.5	23.3	90
3	Safety Talk	4	4	4	4	3	3
4	Safety Patrol	19	18	20	22	15	12
5	Board of Directors Patrol	1	1	1	1	1	1
6	Internal Audit	1	-	-	-	1	-
7	Safety Training	-	-	-	1	2	-
8	Medical Check Up Compliance	-	-	-	-	-	1

a. Lagging Indicator Pyramid

According to Heinrich's theory, 88% of accidents are caused by human decisions [13]. Frequent accidents indicate suboptimal safety performance, because employees ignore safety protocols. A behavior that ignores safety indicates declining safety performance [19].

Figure 3. Lagging indicator pyramid

From August 2023 to January 2024, there were zero fatality cases, zero lost time injury and medical treatment injury cases, one first-aid injury case, and 25 safe actions and conditions. There were no (zero) near-miss cases because there were no reports or because they were not reported. To determine the value of unreported near-miss cases, a calculation was performed using Equation 7; the value of unreported near-miss cases was 2.5, or there were two to three near-miss cases. The zero near-miss case factor occurs because workers tend not to report accidents that are considered minor incidents. They are more inclined to report accidents requiring emergency medical attention [17].

b. K3 Key Performance Indicator Assessment

Table 4. Design of key performance indicator formulation

No	Item	Target	Actual	Max Score	Actual Score	Indicator
1	Number of Workers	202		Non-Scoring	Non-Scoring	Absence
2	Number of Working Hours	166,296				Working Hours Data
	Lagging Indicator					
1	Fatality	0	0	Non-Scoring	Non-Scoring	
2	Lost Time Injury	0	0			
3	Medical Treatment	1	0	9.00	9.00	Total Case Numbers
4	First Aid Injury	6	1	8.00	7.83	
5	Near miss	12	3	7.00	6.75	
6	Unsafe Action	60	25	7.00	6.58	Total Case Numbers

No	Item	Target	Actual	Max Score	Actual Score	Indicator
7	Unsafe Conditions	60	25	7.00	6.58	
			Leading Indicator			
1	HSE Meeting	28	28	7.00	7.00	Minutes of Meeting
2	Closing Findings	100%	78%	8.00	6.23	Document Report
3	Safety Talk	24	22	8.00	7.33	Documentation
4	Safety Patrol	132	106	8.00	6.42	Document Report
5	Board of Directors Patrol	6	6	7.00	7.00	Document Report
6	Internal Audit	2	2	8.00	8.00	Inspection Documents
7	Safety Training	2	2	8.00	8.00	List of Attendants
8	Medical Check Up	1	1	8.00	8.00	MCU Report Document
			% Total Score Actual		94.74	

Information:
Lagging Indicator = Actual ≤ Target
Leading Indicator = Actual ≥ Target

Lagging indicators use indicators in the form of total cases with actual conditions ≤ target, while leading indicators use indicators in the form of attendance lists, minutes, reports, and documentation with actual conditions ≥ target.

Table 5. Key performance indicator assessment results

KPI Value Weight	Total Score Actual	% Total Score	Classification
100	94.74	94.74%	Good performance and achievement according to company expectations

After the preparation of the K3 Key Performance Indicator, data were filled in using the last six months' data in the form of leading and lagging indicator data. The calculations using Equations 8, 9, and 10 showed that the results were included in the classification that showed good performance and achievement according to company expectations, which was proven by the total actual value of 94.74% based on the Traffic Light System.

Based on research results from August 2023 to January 2024, there were zero fatality cases, zero lost time injury and medical treatment injury cases, one first-aid injury case, and 25 safe actions and conditions. There were no (zero) near-misss cases because there were no reports orbecause they were not reported. To determine the value of unreported near-misss cases, a calculation was performed using Equation 7; the value of unreported near-misss cases was 2.5, or there were two to three mississ cases. The zero near miss case factor occurs because workers tend not to report accidents that are considered minor incidents. They were more inclined to report accidents that required emergency medical attention. [17].

After the preparation of the K3 Key Performance Indicator, data were filled in using the last six months' data in the form of leading and lagging indicator data. The calculations using Equations 8, 9, and 10 showed that the results were included in the classification that showed good performance and achievement according to company expectations, which was proven by the total actual value of 94.74% based on the Traffic Light System.

3.2. Correlation Between Work Accidents and Work Productivity

Work accidents can be caused by human factors [18], as stated by the International Labor Organization (ILO), who noted that a high number of work accidents were caused by human interaction, type of work, and conditions of the workplace environment [21]. The following are the data on work accidents that occurred and the number of hours lost by employees during 2021–2023:

Table 6. Number of work accidents

Year	Month					Total
	Feb	June	Jul	Sep	Dec	
2021	0	0	0	0	1	1
2022	1	1	2	0	0	4
2023	0	0	0	1	0	1

In 2021-2023, there were six cases of work accidents in the light care (first aid) category. Most work accidents occur in 2022, with four and a total number of hours lost of 1.5 hours.

Table 7. Number of employees lost hours

Year	Lost Days	Number of missing (hours)
2021	0	0.5
2022	0	1.5
2023	0	0.5

Data collected in the field will be analyzed to assess changes in K3 performance using the work accident statistics calculation method.

Table 8. Number of workers and working hours

Year	Number of workers (people)	Total number of employees working hours (hours)
2021	149	306,344
2022	179	347,976
2023	198	380.160

Frequency Rate is an indicator of the level of danger in the workplace. The results of the Frequency Rate calculation (Table 9) show that in 2021 and 2023, the company was classified as having an FR value <5 or low category, and in 2022, it was classified as high with an FR value>10, with a total of four cases of work accidents.

Table 9. Frequency of work accidents

Year	Frequency Rate (FR)
2021	3.26
2022	11.50
2023	2.63

The severity Rate measures the number of work days lost owing to accidents per 1,000,000 human work hours [24]. The Severity Rate results occur because the accident cases that occur are in the mild category and only require first aid treatment, so that employees do not lose work days and can continue working after receiving treatment.

Table 10. Severity of work accidents

Year	Incident Rate
2021	0.67%
2022	2.23%
2023	0.50%

Incident Rate calculations from 2021 to 2023 are included in the low category because they are below the standard, namely IR < 2.7 with the number of workers 50 -249.

Table 11. Incident Rate

Year	Total employees working hours	FR(n-1)	FR (n)
2021	306,344	-	3.26
2022	347,976	3.26	11.50
2023	380.160	11.50	2.63

In the formula for calculating NTS, the FR (n-1) value comes from the previous year, whereas the FR (n) value is the value in the year being measured.

Table 12. Data on T-value Measurement

Year	NTS
2022	2.68
2023	-1.61

The NTS calculation result is between + 2.00 and -2.00, meaning that the work accident control program does not show significant changes between year (x) and year (x-1). An NTS result ≤ -2.00 means that the K3 program has improved in year (x) compared to year (x-1) (Dwijayanti 2018).

Table 13. T Value measurement results Congratulations

Year	Total hours lost (hours)	Number of working hours (hours)	Productivity
2021	0.5	306,344	99.83%
2022	1.5	347,976	99.57%
2023	0.5	380.160	99.87%

The NTS value in 2022 is in the range of ≥ 2.00, with a value of 2.68, indicating a decline in the work accident control program compared with the previous year. In 2023, the NTS value shows a figure of -1.61, which is in the range of + 2.00 to - 2.0, which means that the K3 program in 2023 did not show significant changes, either an increase or a decrease compared to the previous year.

Table 14. Productivity measurement data

Year	Total hours lost (hours)	Number of working hours (hours)	Productivity
2021	0.5	306,344	99.83%
2022	1.5	347,976	99.57%
2023	0.5	380.160	99.87%

The analysis results show a relationship between K3 and productivity from 2021 to 2023 (Table 14), revealing that productivity has a value above 99%. A high productivity percentage value of above 99% indicates that the company has maintained an excellent level of productivity in a safe and healthy working environment. This shows that the K3 programme is effective in preserving worker welfare.

Based on the results of the Incident Rate calculation from 2021 to 2023, it is included in the low category because it is below the standard, namely IR <2.7, with the number of workers 50 -249. Based on the research results, the NTS value in 2022 is in the range of ≥ 2.00, with a value of 2.68, indicating a decline in the work accident control program compared to the previous year. In 2023, the NTS value shows a figure of -1.61, which is in the range of + 2.00 to - 2.0, which means that the K3 program in 2023 did not show significant changes, either an increase or a decrease compared to the previous year.

The level of productivity is a comparison between the results produced and the efforts used [9]. Factors that influence productivity include health, motivation, discipline, work ethics, skills, nutrition, income, social security, education, environment, work climate, industrial relations, production technology, management, and opportunities for achievement [7]. The results of the analysis show a relationship between K3 and productivity from 2021 to 2023 (Table 14), revealing that productivity has a value above 99%. A high productivity percentage value, above 99%, indicates that the company has succeeded in maintaining a very good level of productivity in a safe and healthy working environment. This shows that the K3 programme is effective in maintaining worker welfare.

The productivity percentage value from 2021 to 2022 shows a slight decrease of 0.26%. This small decrease indicated a small increase in the number of work-related accidents. This decrease was relatively small and insignificant, indicating that the company was still successful in maintaining a safe and productive work environment. There is a 0.30% increase in productivity in 2022 and 2023. This increase indicates improvements in the K3 program or additional efforts made by the company to improve occupational safety and health. The smaller the number of lost working hours and the lower the Severity

Rate, the higher is the productivity. Reducing the frequency and severity of accidents will increase employees' work productivity and make workers feel safer in carrying out their duties [15]

4. Conclusion

Safety KPI's in a motor vehicle speedometer company involve two indicators: leading indicators to identify potential future incidents, and lagging indicators to measure safety performance based on past accident data. The KPI K3 evaluation includes the target and actual values and the maximum score for each aspect. Lagging indicators consider all cases below or equal to the target, while leading indicators use Minutes of Meetings (MoM) and report documents that reach or exceed the target. The evaluation showed a good performance, with the total actual value reaching 94.74%. The occupational accident rate increased from 2021 to 2022 from 3.26 to 11.50 but decreased to 2.63 in 2023. There were no accidents resulting in lost workdays between 2021 and 2023. The T-Safety Score (NTS) was 2.68 in 2022 and -1.61 in 2023, indicating little change in the OSH program. Productivity decreased from 99.84% in 2021 to 99.57% in 2022 but increased to 99.87% in 2023. The relationship between occupational safety and productivity shows that the fewer accidents and lost workdays, the higher is the productivity level.

References

[1] Anwar, Syukriah, Ayu. 2019. Occupational Health and Safety analysis based on the fault tree analysis method in the cement packing area at PT. Lafarge Cement Lhokseumawe Indonesia. Journal of Industrial Engineering Systems (JSTI) . 21(1):24–31.

[2] Apriyani, Saputra Y, Turseno A, Hedi Saepudin T. 2022. Occupational safety analysis using the fault tree analysis approach at PT. Indotech Mitra Presisi. InTent Journal . 5(2):1–15.

[3] Ardiansyah Ekoanindiyo F, Yohanes A, Prihastono E, Nur Hayati E. 2021. The approach of fault tree analysis method in occupational health and safety and its influence on productivity. Journal of Industrial Systems Engineering . 7(1):20–25.

[4] Arswendoi Thry R, Prabowo H. 2021. Implementation of occupational health and safety and calculation of work accident statistics to reduce the risk of hazards in the open-pit coal mining area of PT. Daya Bambu Sejahtera, Tebo Regency, Jambi Province. Jurnal Bina Tambang . 6(3):81–90.

[5] Arsya M, Nurwathi. 2023. The approach of fault tree analysis method in work accidents and its influence on work productivity at CV. Raka Jaya Glass. Journal of Industrial and Mechanical Engineering . 4(2):68–76.

[6] Budiharjo PH, Lengkong VPK, Dotulong LOH. 2017. The influence of occupational safety, occupational health, and work environment on employees productivity at PT. Air Manado. Journal of Economic, Management, Business and Accounting Research . 5(3):4145–4154.

[7] Firman Prayogi M, Puspita Sari D, Arvianto A. 2016. Analysis of the causes of furniture product defects using the failure mode and effect analysis (FMEA) and fault tree analysis (FTA) methods (case study at PT. Ebako Nusantara). Industrial Engineering Online Journal . 5(4):1–8.

[8] Gouw R, Rahmawati R, Prima F. 2023. Measuring company performance and determining key performance indicators using the performance prism, ahp, omax, and tls methods in the indosat ooredoo hutchison sales areapontianak. Industrial Engineering and Management System . 7(2):130–140.

[9] Hasibuan YM, Naasution RH, Harahap UN, Pratiwi RA, Hia WK. 2021. Analysis of the implementation of work safety programs in an effort to increase work productivity using the fault tree analysis and hazard and operability study approaches. Jurnal Simetri Rekayasa . 3(2):248–256.

[10] Iglina Lubis P, Kusumanto I. 2018. Employees performance assessment using the key performance indicators (kpi) method (Case study: CV. Bunda Bakery Pekanbaru). Journal of Science, Technology and Industry . 15(2):37–45.

[11] Kusnendar Rafli A, Herwanto D, Hamdani. 2022. Analysis of the application of occupational safety and health (K3) using the fault tree analysis (FTA) method to increase work productivity at PT. Cipta Unggul Karya Abadi. Scientific Journal of Wahana Pendidikan . 8(11):365–378. doi:10.5281/zenodo.6838069.

[12] Megandi, Susanty M. 2023. Digital occupational safety monitoring decision support system. Informatics Journal . 10(1):54–61. doi:10.31294/inf.v10i1.12778.

[13]Nathaniel P, Widyadana A, Sepadyati N. 2021. Designing key performance indicators for the logistics department at PT X. Titra Journal . 9(2):215–222.
[14]Novita E, Marxoni E, Welly. 2021. Performance measurement using performance prism and omax methods. Journal of Industrial and Quality Engineering . 9(1):49–61. doi:10.34010/iqe.v9i1.4307.
[15]Nuryono A, Kurnia H, Tambunan EB, Wiyatno TN. 2023. Analysis of occupational safety and health (K3) performance in the sauce production process using the fault tree analysis method. Scientific Journal of Industrial Engineering . 11(2):141–154.
[16]Prastio F, Ismail. 2022. Fault Tree Analysis Approach to Occupational Safety as an Effort to Increase Work Productivity at PT. XYZ. JTIE Journal . 1(1):61–71.
[17]Putra P, Hamid IM, Rabani SM, Fu'ad A, Denny OR. 2023. Factors Influencing Worker Awareness of Reporting Work Accidents in the Construction Sector. Journal of Student Research . 1(4):207–214. doi:10.55606/jsr.v1i4.
[18]Rahmanto I, Hamdy MI. 2022. Analysis of work accident risk in Karawang using the hazard and operability (hazop) method at PT PJB Services PLTU Tembilahan. Journal of Applied Industrial Technology and Management . 1(2):53–60.
[19]Ramadhia Asmara Dhani, Paskarini I, Silehu S. 2022. Safety motivation as a determinant of safety performance of workers at PT X Sidoarjo. Health Research Journal Suara Forikes . 13(3):823–827. doi:10.33846/sf13347. doi:10.26740/jptt.v12n1.p52-63.
[20]Risma J, Koesyanto H. 2017. Implementation of near miss cards as an effort to reduce the number of work accidents. Journal Of Public Health Research And Development . 1(2):119–130.
[21]Safira Hedaputri D, Indradi R, Putri Illahika A. 2021. The relationship between the level of knowledge of occupational health and safety (K3) and the occurrence of work accidents. Community Medicine and Public Health of Indonesia Journal . 1(3):185–193.
[22]Suherdin, Aditya. 2022. Safety performance analysis using the safe t-score method and traffic light system at PT. X Sidoarjo. Journal of Industrial Hygiene and Occupational Health . 6(2):40. doi:10.21111/jihoh.v6i2.6389.
[23]Viby Indrayana D, Pribadi KS, Marzuki PF, Iridiastadi H. 2023. Analysis of relative importance index on leading and lagging indicators that influence construction safety culture in Indonesia. Journal of Theoretical and Applied Civil Engineering . 30(1):79–88. doi:10.5614/jts.2023.30.1.10.
[24]Yulian Safitri I, Ar A, Megasukma Y. 2021. Analysis of work accidents using statistical methods and risk assessment on IUP 206 & 329 ha limestone. Journal of Research and Community Service . 1(8):392–412.