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Analysis of the Ranking of Work Accident Risk Factors in the Construction Work of the CWI-02 its Surabaya Package Building

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ABSTRACT:
Construction projects involving large-scale educational buildings are highly prone to occupational accidents due to the hazardous nature of the work and inconsistent implementation of safety protocols. This study aims to identify and rank the most critical risk factors contributing to work accidents in the construction of the CWI-02 Package Building at ITS Surabaya. Using a mixed-method approach, primary data were collected through questionnaires, interviews, and field surveys involving 30 respondents, including contractor staff, supervisors, and supervisory personnel. The Risk Breakdown Structure (RBS) method was applied to quantify the probability and impact of each risk factor, enabling a structured risk prioritization. The analysis revealed three major high-risk contributors: labor indiscipline (risk value 0.690), refusal to use personal protective equipment (0.627), and the lack of clear standardization in Occupational Health and Safety (K3) implementation (0.577). These findings emphasize the urgent need for improved workforce discipline, enforcement of safety gear usage, and standardized safety management systems. The study provides actionable insights for project managers and policymakers to enhance construction site safety and mitigate accident risks in critical educational infrastructure projects.

Keywords: *Work Accidents, Occupational Safety and Health Risks, Risk Analysis. Risk Breakdown Structure (RBS) method*

INTRODUCTION

In the current 4.0 era, it is very important for us as part of Indonesian citizens to play an active and passive role in supporting the progress of the country, especially in the field of development (Dayaram et al., 2020; Jaedun et al., 2024). The development covers various sectors, such as building construction, road and bridge infrastructure development, and the

water resources sector (Grigg, 2023; Jain & Singh, 2023; Kantianis et al., 2025). Indonesia, as a developing country with a population of around 275 million people, requires us as workers in the construction sector to help realize the ideals of the nation's predecessors (Hancock, 1998; Musnandar, 2014).

In addition, Indonesia has great potential to reach a golden age by 2045, with an increasingly productive population, commensurate with the needs of a growing society (Pambudi, 2024; Sulistyorini et al., 2024). For this reason, progress in the education sector is very important, which is reflected in the physical construction of educational buildings ranging from elementary schools to universities. In addition, infrastructure development such as roads, bridges, and air infrastructure, including the construction of new airports or the development of existing airports, is also underway. No less important, infrastructure development in the water resources sector is also being intensively carried out in various regions, such as the construction of dams, dams, irrigation canals, and urban drainage.

As we know, construction projects are often associated with work accidents. This happens because the construction sector has a high level of risk, including work accidents. These incidents are often caused by low awareness from the parties involved in the project to prioritize and implement the Occupational Safety and Health (K3) system in accordance with applicable regulations. Occupational safety is a branch of health science that aims to improve the health status of workers, both physical, mental, and social, through preventive efforts against diseases or health disorders caused by occupational and environmental factors, as well as general diseases (Santoso, 2015). Often, the application of the K3 system in construction projects is considered to only add to the cost burden for construction service providers. Many do not realize that the implementation of the K3 system not only serves as a preventive measure against work accidents but also as an investment that can reduce significant losses due to accidents or negative incidents that can occur in construction projects.

Data shows that the construction sector is one of the main contributors to the high number of work accidents (Elsebaei et al., 2022; Lander et al., 2016; Winge et al., 2019). Based on information from the Ministry of Manpower Statistics on the Indonesian Employment Data Portal, in 2023, there will be 370,747 cases of work accidents in Indonesia. Of these, around 93.83% are cases involving wage recipients, 5.37% involve non-wage recipients, and around 0.80% occur in the construction services sector. This is due to the high risk of hazards contained in construction work activities. In addition, according to data from BPJS Ketenagakerjaan, in 2022, there will be 36 million active participants out of a total of 131.06 million workers throughout Indonesia (Aprianto et al., 2023; Kurnianto et al., 2023; Shalihah & Alviah, 2023).

Each stage of work in a construction project always prioritizes the implementation of the Occupational Health and Safety (K3) system, with the main goal of reducing the risk of work accidents and preventing the impact of diseases caused by work in the construction environment.

Therefore, it is important to have regulatory standards in implementing the Occupational Health and Safety (K3) system, often called Construction K3 Risk Management. Based on the thoughts that have been conveyed above, as well as the desire to apply the Occupational Health and Safety (K3) system through K3 Management in every construction project work activity, the researcher is interested in raising the topic of K3 management in building construction projects, especially educational buildings. The object of the research in question is the construction of a lecture building or campus learning center. The availability of adequate and sustainable higher education facilities on campus is essential to support national development. The campuses have produced many generations of excellence in various fields in the country. In addition, higher education at universities is a critical basic need to improve the quality of human resources (HR) and help boost economic growth in a region (Dao, 2024; Przytuła et al., 2024).

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Each stage of work in a construction project always prioritizes the implementation of the Occupational Health and Safety (K3) system, with the main goal of reducing the risk of work accidents and preventing the impact of diseases caused by work in the construction environment. Therefore, it is important to have regulatory standards in the implementation of the Occupational Health and Safety (K3) system, which is often referred to as Construction K3 Risk Management. Based on the thoughts that have been conveyed above, as well as the desire to apply the Occupational Health and Safety (K3) system through K3 Management in every construction project work activity, the researcher is interested in raising the topic of K3 management in building construction projects, especially educational buildings. The object of the research in question is the construction of a lecture building or campus learning center. The availability of adequate and sustainable higher education facilities on campus is essential to support national development. The campuses have produced many generations of excellence in various fields in the country. In addition, higher education at universities is a very important basic need to improve the quality of human resources (HR) and help boost economic growth in a region. This study aims to rank the risk factors that cause work accidents in the CWI-02 Package building construction project at the ITS Surabaya. This research makes theoretical and practical contributions in the field of construction K3 risk management. Theoretically, this study enriches

the literature on the identification and analysis of occupational accident risk factors in construction projects, especially in building construction projects.

Construction projects, particularly those involving large-scale educational buildings like the CWI-02 ITS Surabaya Package, are prone to high occupational hazards. Despite regulations and awareness efforts, the implementation of Occupational Safety and Health (OSH/K3) standards remains inadequate, primarily due to worker negligence, poor discipline, and misconceptions that safety protocols only add to project costs rather than prevent accidents. These gaps significantly increase the risk of work-related accidents, endangering both project outcomes and worker safety.

The urgency of this research stems from national statistics, which show that the construction sector remains one of the top contributors to occupational accidents in Indonesia. According to the Ministry of Manpower's 2023 data, more than 370,000 accidents were recorded, with construction being one of the most affected sectors due to the inherently hazardous nature of the work. The continued rise in infrastructure development, particularly in the education sector, amplifies the need for robust and enforceable safety systems to minimize risks on-site.

Furthermore, educational infrastructure such as the CWI-02 building at ITS Surabaya is critical for national development. These facilities support higher education and directly contribute to improving human capital. Accidents during construction delay project timelines, increase costs, and undermine public confidence in infrastructure safety. This highlights the urgent need for data-driven risk analysis and the prioritization of high-impact safety interventions in such projects.

Saraswati et al. (2020) examined K3 implementation in university construction projects and found that inadequate supervision and unclear task delegation significantly increased accident risk. Their study emphasized the importance of structured safety protocols and training. Similarly, Kurnia Adi & Widodo (2023) evaluated the implementation of K3 in a Jakarta high-rise project, concluding that management awareness and worker behavior were pivotal in mitigating risk exposure.

Cahyono et al. (Cahyono et al., 2022) applied risk management analysis in the Manado-Bitung toll road project and identified failure in personal protective equipment (PPE) usage and poor hazard assessment as major contributors to site incidents. Safitri (2023) also emphasized the need for systematic evaluation of safety programs and standardization across construction sites, especially in public-sector projects managed by major contractors like PT Adhi Karya.

Despite the growing number of studies focusing on general K3 application, few explicitly address the ranking and categorization of specific risk factors using structured methods like the Risk Breakdown Structure (RBS), particularly in the context of academic infrastructure projects.

This creates a knowledge gap in how granular safety factors contribute to overall project risk and the effectiveness of prioritization strategies.

While previous research has broadly discussed the implementation of safety protocols in construction, limited studies have ranked specific risk factors using quantitative tools like the Risk Breakdown Structure (RBS). Moreover, few have focused on campus construction projects in Indonesia, despite their strategic importance. This study fills that gap by applying RBS to assess and rank accident risk factors in the construction of the CWI-02 Package building at the ITS Surabaya.

The novelty of this research lies in its application of the RBS method to quantitatively identify and prioritize accident risk factors in a large-scale educational building project. Unlike earlier studies, this research lists risk sources and provides weighted rankings based on probability and impact, offering a structured framework for safety decision-making in academic construction environments.

This research aims to identify, analyze, and rank the primary risk factors contributing to work accidents in the CWI-02 Package building construction at ITS Surabaya, using the Risk Breakdown Structure (RBS) methodology to support improved safety management practices.

The study provides practical benefits for contractors, project managers, and policy regulators by offering a prioritized list of risk factors that require urgent intervention. It contributes to the enhancement of safety performance in educational building projects, supports safer working environments, and serves as a reference for future K3 risk analysis in similar construction settings.

RESEARCH METHODS

This research was conducted in the CWI-02 Package Building construction project at the ITS Surabaya, using primary and secondary data. Primary data were obtained through questionnaires, interviews, and field surveys with respondents, including contractor staff, workers/supervisors, and Constitutional Court supervisory staff, who met specific experience and educational qualifications. Secondary data includes project technical documents, literature, and references related to risk management. This study uses qualitative and quantitative methods for risk analysis. Risk identification is carried out through a Risk Breakdown Structure (RBS), questionnaires, and interviews to segment risks based on their source. Quantitative analysis is used to rank risks based on the level of potential causes of work accidents. The interviews involved 30 respondents, consisting of 18 contractor staff, 7 workers/supervisors, and 5 Constitutional Court supervisory staff. The questionnaire was divided into three sections: risk identification, frequency of risk factors, and the influence of K3 management on the time of work implementation, using scale-based assessment parameters. The following is a research flow chart.

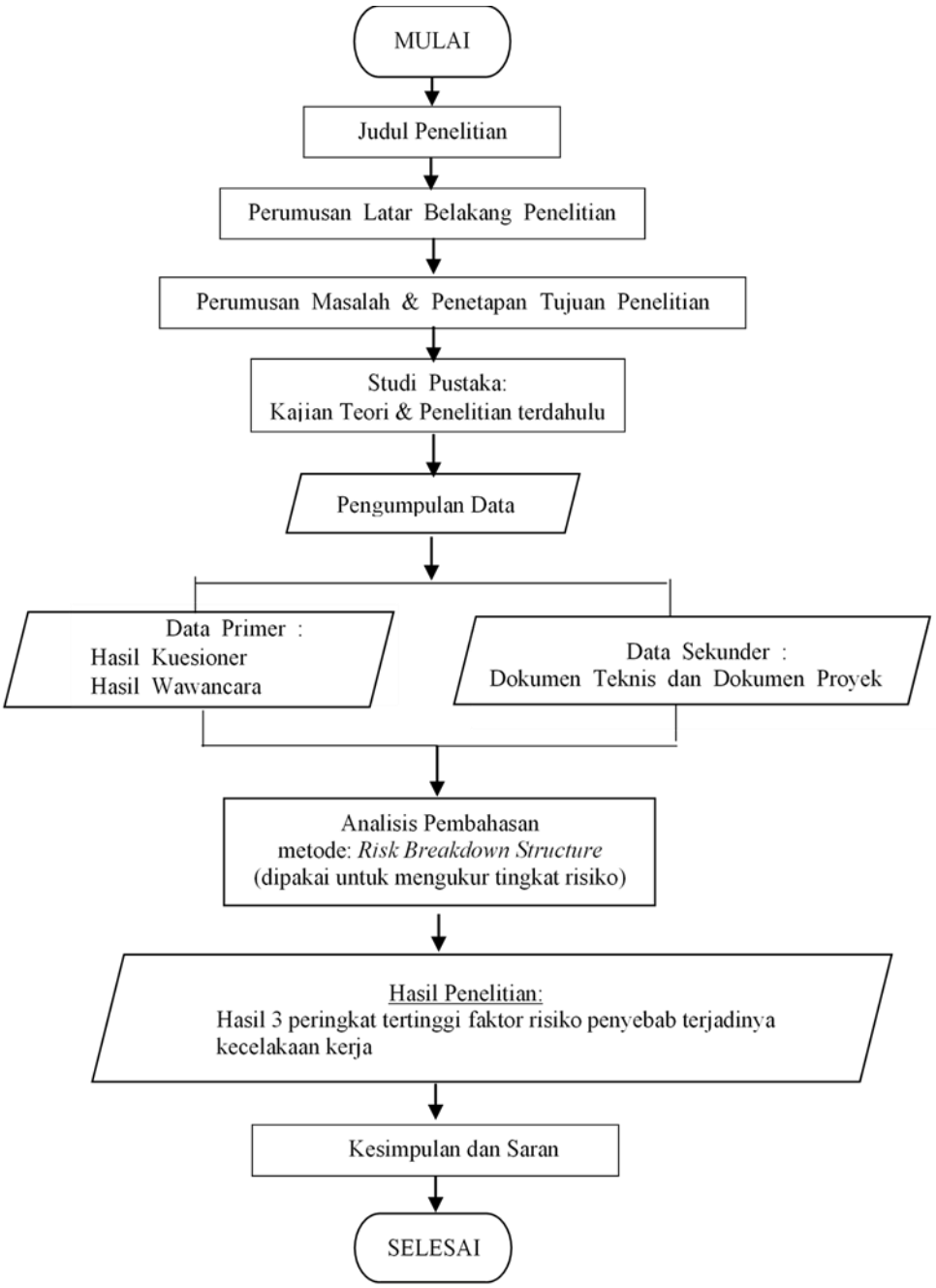

Figure 1. Research Flow Chart
Source: Processed Research, 2024

RESULTS AND DISCUSSION

Information Stage

Research data on the CWI-02 Package building construction project at ITS Surabaya, including:

a. Project Name: Construction of the CWI-02 ITS Package Building
b. Project Address: ITS Campus Jl. Chemical Engineering Kel. Keputih Sukolilo District, Surabaya City, East Java 60111
c. Building Structure: Reinforced Concrete Construction & Steel Construction
d. Planning Consultant: PT. Sigma Rekatama Consulindo
e. Supervisory Consultant/MK: PT. Ciriajasa E.C. - KSO PT. Ciriajasa C.M
f. Contractor: PT. Adhi Karya (Persero), Tbk
g. Number of Buildings: 13 Buildings
h. Building Area: 11.957 m^2 (total)

The total cost required to implement technical work for the construction of the CWI-02 Package building at the ITS Surabaya is Rp. 97,222,888,000,—(ninety-seven billion two hundred and twenty-two million eight hundred and eighty-eight thousand rupiah), including VAT, which is done according to the schedule, which is 540 calendar days.

The information data of the respondents of this study involved a total of 30 people with components derived from the workforce within the CWI-02 Package building construction project at ITS Surabaya. With the characteristics of respondents including:

The data of the workforce respondents studied are as follows:

a. Contractor staff = 18 people
b. Employees/supervisors of the implementing contractor = 7 people
c. Supervisory consultant staff = 5 people

Respondent Profile Data :

Based on gender: Male with a total of 22 people and Female with a total of 8 people. Those who have an education level according to the last diploma are:

a. Vocational education, minimum 5 years of experience = 6 people
b. D3 education, minimum 5 years of experience = 7 people
c. S1 education, minimum 5 years of experience = 17 people

The details of respondents are in the age range of 25-50, which is considered a productive age to carry out the work process in the field.

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documents, literature, and references related to risk management. This study uses qualitative and quantitative methods for risk analysis. Risk identification is carried out through a Risk Breakdown Structure (RBS), questionnaires, and interviews to segment risks based on their source. Quantitative analysis is used to rank risks based on the level of potential causes of work accidents. The interviews involved 30 respondents, consisting of 18 contractor staff, 7 workers/supervisors, and 5 Constitutional Court supervisory staff. The questionnaire was divided into three sections: risk identification, frequency of risk factors, and the influence of K3 management on the time of work implementation, using scale-based assessment parameters. The following is a research flow chart.

Table 1. Assessment of the probability of occurrence of risk factors causing work accidents in the Implementation of the CWI-02 Package Building Construction Project at ITS Surabaya

No	Risk Factors	SK (1)	K (2)	S (3)	B (4)	SB (5)	Probability (a)
1	Extreme weather	8	10	4	6	2	0,393
2	Selection of raw materials that do not comply with standards	18	7	5	0	0	0,213
3	Difficult location of material accumulation	20	8	2	0	0	0,180
4	Rainfall intensity	19	5	6	0	0	0,213
5	**Refusing the recommendation to use personal protective equipment**	**0**	**0**	**2**	**4**	**24**	**0,847**
6	Irregular diet	18	8	4	0	0	0,207
7	Ignoring work rules and occupational safety standards applied at the construction project site	0	0	18	11	1	0,587
8	Unskilled workforce	0	0	20	7	3	0,587
9	Shortage of manpower	0	0	18	10	2	0,593
10	**Labor indiscipline**	**0**	**0**	**0**	**1**	**29**	**0,893**
11	Lack of attention to place in the implementation of K3	0	12	7	10	1	0,500
12	**Not having a good and clear standardization of the implementation of K3**	**0**	**0**	**1**	**3**	**26**	**0,833**
13	There is no evaluation of the system for the implementation of work in implementing K3	19	8	3	0	0	0,193

No	Risk Factors	SK (1)	K (2)	S (3)	B (4)	SB (5)	Probability (a)
14	The division of tasks is unclear in the formation of the organization, so it is not clear in its implementation	0	0	18	9	3	0,600
15	Equipment breakdown	0	0	1	2	27	0,873
16	Inadequate/on-demand availability of equipment	0	10	13	7	0	0,480
17	Equipment productivity	0	12	14	4	0	0,447
18	Lack of operator ability to operate the equipment	0	7	16	7	0	0,500
19	Improper equipment	4	2	10	14	0	0,527
20	Lack of communication	1	5	15	9	0	0,513

Source: Processed Researcher, 2024

According to the results of the questionnaire distribution that has been filled out, of the 30 respondents regarding the probability of risk factors causing work accidents in the Implementation of the CWI-02 Package Building Construction Project at ITS Surabaya, the risk factor "**Labor indiscipline**" is considered to have the greatest probability of occurring, which reaches 0.893. Meanwhile, the risk factor "**Difficult location of material accumulation**" is considered to have the lowest probability of 0.180.

Assessment of the Level of Impact on Risk Factors Causing Work Accidents in Building Projects

Based on the results of the interview questionnaire conducted, the risk stakeholders agreed to determine the magnitude of the possible impact of each aspect/risk factor in providing the risk of work accidents in the building project by giving a value of 0.05 to 0.8 assuming based on table 2 regarding the probability and impact matrix.

The results of the questionnaire assessment of 30 respondents regarding the impact of each risk factor can be explained in Table 2 as follows :

Table 2. Assessment of the impact of risk factors that cause work accidents on the Implementation of the CWI-02 Package Building Construction Project at ITS Surabaya

No	Risk Factors	RS (1)	R (2)	S (3)	B (4)	SB (5)	Impact (b)
1	Extreme weather	8	10	4	6	2	0,207
2	Selection of raw materials that do not comply with standards	15	8	7	0	0	0,098

No	Risk Factors	RS (1)	R (2)	S (3)	B (4)	SB (5)	Impact (b)
3	Difficult location of material accumulation	19	6	5	0	0	0,085
4	Rainfall intensity	20	8	1	1	0	0,080
5	**Refusing the recommendation to use personal protective equipment**	**0**	**0**	**1**	**3**	**26**	**0,740**
6	Irregular diet	18	9	3	0	0	0,080
7	Ignoring work rules and occupational safety standards applied at the construction project site	0	0	18	9	3	0,302
8	Unskilled workforce	0	0	20	8	2	0,293
9	Shortage of manpower	0	0	19	9	2	0,300
10	**Labor indiscipline**	**0**	**0**	**0**	**2**	**28**	**0,773**
11	Lack of attention to place in the implementation of K3	0	6	14	9	1	0,260
12	**Not having a good and clear standardization of the implementation of K3**	**0**	**0**	**2**	**5**	**23**	**0,693**
13	There is no evaluation of the system for the implementation of work in implementing K3	0	2	1	3	24	0,693
14	The division of tasks is unclear in the formation of the organization, so it is not clear in its implementation	0	0	3	6	21	0,660
15	Equipment breakdown	0	10	13	7	0	0,213
16	Inadequate/on-demand availability of equipment	0	11	11	8	0	0,217
17	Equipment productivity	0	6	16	8	0	0,233
18	Lack of operator ability to operate the equipment	0	12	15	3	0	0,180
19	Improper equipment	0	5	17	8	0	0,237
20	Lack of communication	2	2	11	15	0	0,283

Source: Author's Data Processing, 2024

Based on the assessment carried out through questionnaires, of the 30 respondents regarding the impact of the occurrence of these risk factors in the implementation of the CWI-02 Package Building Construction Project at ITS Surabaya, the risk factor "**Labor indiscipline**" is considered to have the greatest risk impact that causes work accidents, which is 0.773. However, on the contrary, the risk factor "**Rainfall intensity**" is considered to have the lowest impact, which is 0.080.

Analisa *Risk Breakdown Structure*

The RBS (Risk Breakdown Structure) analysis was calculated based on data on the probability of occurrence and the impact of the incident assessed by the respondents when they were active in the project work environment every day. The multiplication of probability and impact will result in the importance *level* of risk, which can be explained in table 3 below:

Table 3. RBS (*Risk Breakdown Structure*) Analysis Results

Yes	Risk Factors	Probability (a)	Impact (b)	Risk Importance Level (a x b) = (c)	Category
1	Extreme weather	0,393	0,207	0,081	Moderate
2	Selection of raw materials that do not comply with standards	0,213	0,098	0,020	Low
3	Difficult location of material accumulation	0,180	0,085	0,015	Low
4	Rainfall intensity	0,213	0,080	0,017	Low
5	**Refusing the recommendation to use personal protective equipment**	**0,847**	**0,740**	**0,627**	**Tall**
6	Irregular diet	0,207	0,080	0,017	Low
7	Ignoring work rules and occupational safety standards applied at the construction project site	0,587	0,302	0,177	Tall
8	Unskilled workforce	0,587	0,293	0,172	Tall
9	Shortage of manpower	0,593	0,300	0,178	Tall
10	**Labor indiscipline**	**0,893**	**0,773**	**0,690**	**Tall**

Yes	Risk Factors	Probability (a)	Impact (b)	Risk Importance Level (a x b) = (c)	Category
11	Lack of attention to place in the implementation of K3	0,500	0,260	0,130	Moderate
12	**Not having a good and clear standardization of the implementation of K3**	**0,833**	**0,693**	**0,577**	**Tall**
13	There is no evaluation of the system for the implementation of work in implementing K3	0,193	0,693	0,134	Moderate
14	The division of tasks is unclear in the formation of the organization, so it is not clear in its implementation	0,600	0,660	0,396	Tall
15	Equipment breakdown	0,873	0,213	0,186	Tall
16	Inadequate/on-demand availability of equipment	0,480	0,217	0,104	Moderate
17	Equipment productivity	0,447	0,233	0,104	Moderate
18	Lack of operator ability to operate the equipment	0,500	0,180	0,090	Moderate
19	Improper equipment	0,527	0,237	0,125	Moderate
20	Lack of communication	0,513	0,283	0,145	Moderate

Source: Author's Data Processing, 2024

Based on the results of the RBS (*Risk Breakdown Structure) analysis calculation*, from 30 respondents who had filled out a questionnaire regarding the probability and impact of the occurrence of risk factors causing work accidents in the implementation of the CWI-02 Package Building Construction Project at ITS Surabaya showed that the risk factor "**Labor** indiscipline" has the most significant level of risk importance that can cause work accidents in the implementation of the CWI-02 Package Building Construction Project at ITS Surabaya, which reaches **0.690**. Meanwhile, the risk importance factor "**Difficulty in the location of material stacking"** is considered to have the lowest risk level, which is **0.015**.

From the analysis of the discussion of 20 (twenty) risk factors that have been obtained, 3 (three) risk factor rankings with the "**High" risk level category are taken**, namely:

1. Labor indiscipline (**0.690**)
2. Reject the recommendation to use personal protective equipment (**0.627**).

Not having a good and clear standardization of the implementation of K3 (**0,577**).

CONCLUSION

Based on the results of the analysis, this study identified three main factors causing work accidents in the construction project of the CWI-02 Package Building at ITS Surabaya, namely labor indiscipline (93.33%), rejection of the recommendation to use personal protective equipment (90.00%), and the absence of good and clear standardization of the implementation of K3 (86.67%). Analysis using the Risk Breakdown Structure (RBS) method showed that the top three highest risk rankings were labor indiscipline with a risk importance value of 0.690, followed by refusal to use personal protective equipment (0.627), and lack of adequate standardization of K3 implementation (0.577). These findings highlight the importance of improving workforce discipline, adherence to personal protective equipment, and implementing clear K3 standards to reduce the risk of work accidents.

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