Journal Of Economics, Technology, And Business (JETBIS)
Volume 2, Number 8 August 2023
p-ISSN 2964-903X; e-ISSN 2962-9330

RISK AND COST ANALYSIS STUDY OCCUPATIONAL HEALTH AND SAFETY (K3) ON PASSENGER TERMINAL BUILDING WORKS NEW MENTAWAI AIRPORT DEVELOPMENT PROJECT

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KEYWORDS:
AHP, cost, OSH, risk, terminal building

ABSTRACT

This study aims to conduct an in-depth analysis of the risks and costs associated with Occupational Health and Safety (K3) aspects in the context of the construction of a Passenger Terminal in the Mentawai New Airport Development Project. The project has important significance in connecting Mentawai with a better air transport network but requires special attention to K3 factors to ensure a safe and healthy working environment for construction workers. This research method involves the identification, evaluation, and mitigation stages of K3 risks that can arise during various stages of development. Data was collected through field surveys, direct observations, interviews with related parties, and documentation studies related to K3 regulations and work accident costs. Risk analysis is carried out by applying a probabilistic approach to measure the potential for unsafe events and their impact. Next, the impact of workplace accidents on project costs is evaluated, including medical costs, damages, and potential project delays. This research method involves the identification, evaluation, and mitigation stages of K3 risks that can arise during various stages of development. Data was collected through field surveys, direct observations, interviews with related parties, and documentation studies related to K3 regulations and work accident costs. Risk analysis is carried out by applying a probabilistic approach to measure the potential for unsafe events and their impact. Next, the impact of workplace accidents on project costs is evaluated, including medical costs, damages, and potential project delays. These findings will provide valuable insights for project decision makers, K3 managers, and other relevant parties in planning and implementing development projects by considering K3 aspects holistically. By understanding the risks involved and their financial impact, effective steps can be taken to improve worker safety and health, while optimizing the use of financial resources in the project.

INTRODUCTION

The development of the air transport subsector has a significant impact on national economic conditions, considering its role in the distribution of goods and services and the movement of people. The government must ensure the availability of infrastructure as a public good to encourage equity and accelerate development as well as meet the needs of the community to achieve affordability and open access to disadvantaged, border, and disaster-prone areas. The achievement of the vision and mission of the Directorate General of Civil Aviation is expected to be realistic and accommodate the demands of infrastructure provision through the construction and maintenance/rehabilitation of sustainable air transportation facilities and infrastructure as well as strengthening regulations,

institutions, and human resources to improve aviation safety and security and air transportation services.

As is known that construction work is a combination of various disciplines, both in terms of construction engineering and non-technical aspects, and includes elements of human resources. Factors that positively influence and are significant to the success of the project with its end goal are quality, cost, time, HSE environmental health and safety, and stakeholder satisfaction (Marleno et al., 2018). The implementation of this construction work must meet the provisions on engineering, occupational safety and health (K3), labor protection, and local environmental management to ensure the orderly realization of construction work, with occupational safety and health (K3) costs from the smallest is for road construction projects, then bridge construction projects, drainage construction projects and the largest for building construction projects (Marleno et al., 2019). The percentage of K3 costs ranges from 1.94% (Jatrawan et al., 2021), to 2.01% to 3.70% of the contract value (Calvin & Johan, 2020), with the correlation criteria of the relationship between building work and work accidents being strong, sufficient, weak, or uncorrelated (Latief et al., 2017). Cost component of K3.

The incidence of occupational accidents and occupational diseases, especially at airports, does not only occur on a national (Faqih & Prabowo, 2023), (Dharma et al., 2021) or international scale. On a national scale, there is a trend of increasing cases until 2022. Risk management (Sharma et al., 2011), (Akbar et al., 2022) is needed, which is the essence of SMK3 (Ramli, 2019) for risk management to prevent work accidents or adverse events.

To minimize and eliminate the incidence of work accidents and occupational diseases in the passenger terminal building work on the New Mentawai Airport Development project to achieve zero accidents in its implementation in line with the realization of zero accidents (there must not be the slightest mistake) in the aviation world which holds the motto "The sky is very vast but there's no room for error" for the sake of creating health, Aviation security and safety, then this study aims to identify K3 risk factors, determine the highest K3 risk factors using the Analysis Hierarchy Process (AHP) method and then prepare a Construction Safety Plan (RKK) and its K3 costs (Aprizaldi & Saputro, 2022).

At the core of the definition of risk is uncertainty. Risk can also be associated with possible events or circumstances that threaten the achievement of organizational goals and objectives. According to Vaughan (1978), some definitions of risk are risk is the opening of the possibility of loss, risk is the possibility of loss, and risk is uncertainty. Risk management is all the process of activities carried out solely to minimize and even prevent the occurrence of company risks. Construction safety risk management contains at least job descriptions, hazard identification, and determination of construction safety risk levels in construction work (RAKYAT, 2021).

Research related to K3 risk factors (hazards and risks) has also been conducted (Waris et al., 2019)–(Sulistyaningsih, 2022). Some of these studies used questionnaire and interview methods to determine K3 risk factors. A sample is needed to represent the study population. The number of samples taken using the Slovin formula is as follows:

$$n = \frac{N}{1 + N.e^2} \qquad \ldots(1)$$

Information:
n = Number of samples
N = Population
e = error rate of 10% (0.1) or 5% (0.05)

The AHP method is a decision-making method that arranges complex problems in a hierarchy consisting of several levels containing objectives, several considerations and/or evaluation criteria, and several alternative solutions. AHP assessment can be done using Saaty weighting (Sulistyaningsih, 2022) shown in the table below:

Table 1
Relative Importance Assessment using the Saaty Scale

Scale	Information
1	Both elements are equally important
3	One element is slightly more important than the other
5	One element is essential compared to the other
7	One element is more important than the other
9	One element is more important
2,4,6,8	Values compromise between two adjacent considerations

with AHP stages (Fauzi et al., 2022) namely defining the problem and determining the desired solution, Arranging the hierarchy (Fauzi et al., 2022) of the problem faced (Figure 1), Determining the priority of elements, Assessing criteria/variables and alternatives, calculating the consistency of ratios (equations 2 and 3), Checking the consistency of the hierarchy (CR≤10%), Calculations to determine the goals, and finally knowing the value of the risk.

a. Consistency Index (CI) with the formula:

$$CI = ((\lambda maks - n) / n-1) \quad \text{....2}$$

Where n = number of elements

b. Consistency Ratio (CR) with the formula :

$$CR = CI / IR \quad \text{....3}$$

Ket: CR = Consistency Ratio
CI = Consistency Index
IR = Index Random

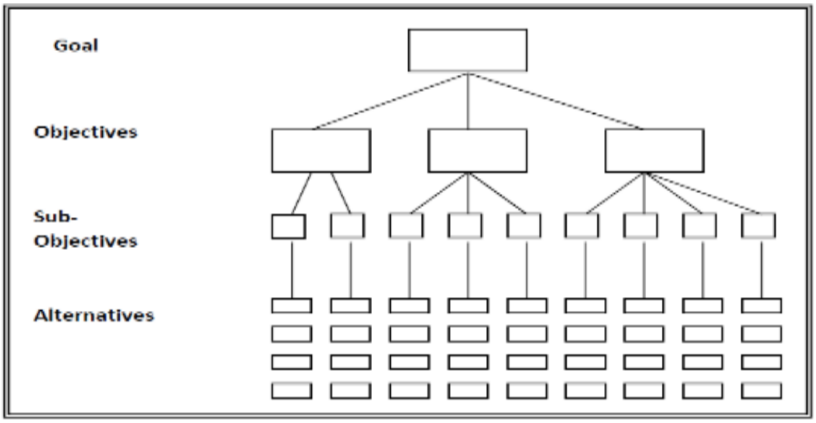

Figure 1
AHP hierarchy

Software to assist with AHP analysis includes *PHP and MySQL, Expert Choice, Super Decisions, Ms. Excel, Priorty Estimation Tool (PriEsT), and SpiceLogic Analytic Hierarchy Process*. In this study, AHP analysis used the *Expert Choice application tool*.

Construction Safety Plan (RKK) Implementation is prepared as documented information that at least contains leadership and participation of workers in construction safety, construction safety planning, construction safety support, construction safety operations, and construction performance evaluation. The document also conveys the need for K3 costs needed.

This study aims to conduct an in-depth analysis of the risks and costs associated with Occupational Health and Safety (K3) aspects in the context of the construction of a Passenger Terminal in the Mentawai New Airport Development Project.

And It is expected that this research will contribute to the determination of policies related to K3 budget priority posts for the construction of airport passenger terminals in particular as well as the construction of other facilities (land side and air side, airport environment) that pay attention to occupational health and safety for the Ministry of Transportation, especially the Directorate General of Civil Aviation.

RESEARCH METHODS

The flow chart of this study is illustrated as follows:

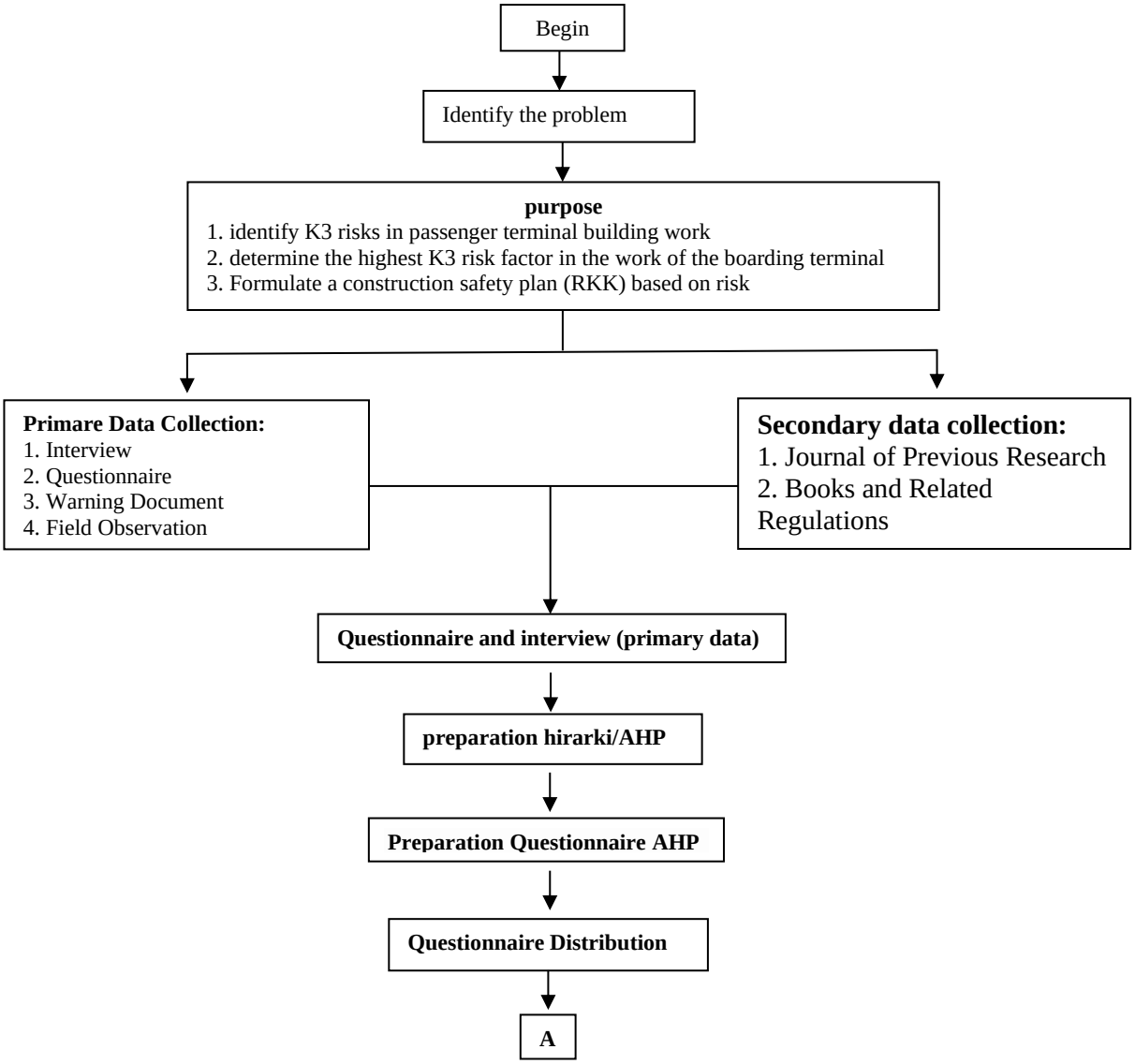

Figure 1
Research Flow

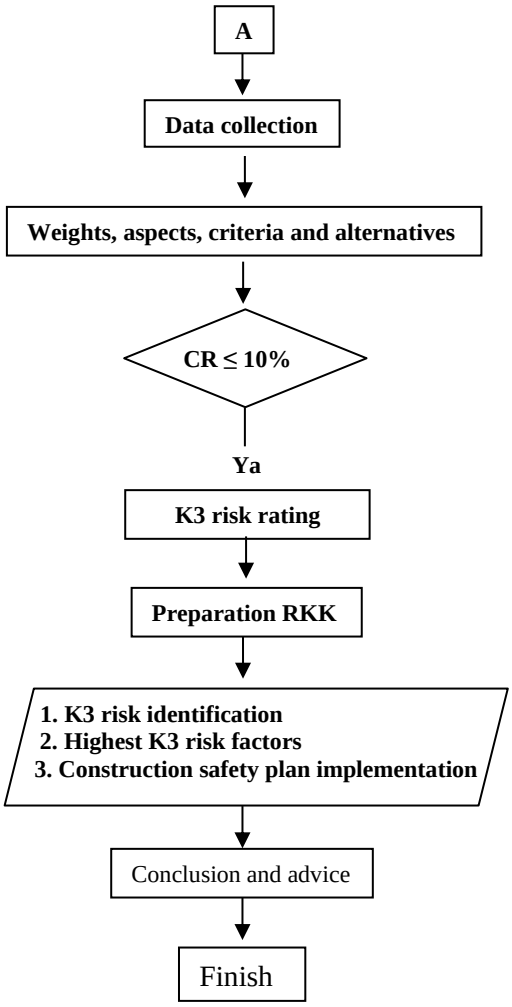

Figure 2
Research Flow Chart (advanced)

This study used descriptive techniques that identified risks qualitatively by quantifying data based on previous research and questionnaires. In the quantification process, primary data is needed, namely questionnaires containing several risk factor questions. Based on questionnaires and interview guidelines prepared. This questionnaire will be answered by several selected respondents using *the purposive sampling* method. Risk Factors identified or missed will be given variable names for each risk factor The risk factor data is rearranged in the form of a hierarchical scheme that will be processed using the AHP method of passenger terminal building work, and continued by conducting an AHP analysis to determine the highest risk factor. The research method is carried out through questionnaire surveys and interviews with respondents who play a role in implementing K3, and supervising work activities, as well as experts and competent in their fields.

The stages of this research begin with the identification of problems followed by the collection of primary data and secondary data. Primary data consists of interviews, questionnaires, bid documents, and field observations. While secondary data is obtained from previous research journals and related books or regulations.

The text of the interview and questionnaire as a preliminary study are prepared to identify

risk factors-risk factors as well as the highest risk factors based on respondents' experiences. The respondents selected to be interviewed *are Project Managers, Safety Officers,* or those who represent parties who play a role in implementing K3 policies/implementation, K3 experts who are competent in planning, implementing, and evaluating the implementation of SMK3, and service users, namely the technical team from representatives of Rokot airport, Sipora. Questionnaires are also distributed to K3 experts, as parties who are competent in planning, implementing, and evaluating the implementation of SMK3, cannot be directly interviewed. service users, in this case, the technical team from representatives of Rokot airport, Sipora, or parties from the Directorate General of Civil Aviation responsible for the project, *Inspectors* or Medical Officers, or who represent competent project workers.

Primary and secondary data were collected and classified and preliminary study data were carried out whose results were then arranged in the AHP hierarchy of the study. The hierarchical structure of this study consists of goals or objectives, namely the highest K3 risk factors, criteria based on the work done (structural work, architectural work, electrical work, mechanical work), sub-criteria are K3 risk aspects in terms of management aspects, work aspects, environmental aspects, and equipment aspects, while the alternative is the breakdown of risk factors from management aspects, worker aspects, environmental aspects, and equipment aspects.

The AHP hierarchy is structured as the basis for creating the AHP questionnaire. The AHP questionnaire is then distributed to respondents with special characteristics and conditions, namely to K3 implementers, K3 experts, and service users. The results of the questionnaire are included in *the Expert Choice* application to calculate the weight of aspects, criteria, and alternatives provided that the consistency of the ratio is less than equal to 10% (CR≤10% or CR≤0.1). If the ratio consistently exceeds what is required, it must be refilled the questionnaire by respondents whose CR value is less than 10%. After obtaining consistent results, the weight of each criterion, sub-criteria, and alternatives is obtained. The weights were then ranked to determine the highest risk factor for K3 in this study.

The preparation of the Construction Safety Plan (RKK) is prepared based on the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 10 of 2021 concerning Construction Safety Management System Guidelines, which consists of Worker Leadership and Participation in Construction Safety, Construction Safety Planning, construction safety support, Construction Safety Operations, and Construction Safety Performance Evaluation. In the RKK, K3 fees were obtained which were prepared based on the Circular Letter of the Minister of Public Works and Public Housing Number 11 / SE / M / 2019 concerning Technical Guidelines for the Cost of Implementing a Construction Safety Management System.

RESULTS AND DISCUSSION

The respondent rate for this study was 97% which was included in the very good category of more than 70% (Waris et al., 2019), with the number of interviewees being 11 respondents, and questionnaires in the preliminary study for primary data amounting to 50 respondents. Based on the Slovin formula, it is known that the population (N) in this study is 69 people, with an error rate (e) of 5%, then the minimum sample number is 58 people. With 61 respondents in this study, the sample number of respondents in this study has met the minimum requirements.

Demographic Characteristics of Respondents

Data of respondents who filled out the AHP questionnaire were presented based on the origin of the respondent's organization/institution, educational background, work experience, and academic qualifications of respondents. shown in the following figure:

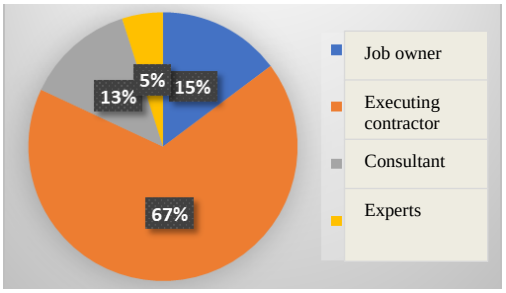

Figure 3
Origin of Respondent Organization/Institution

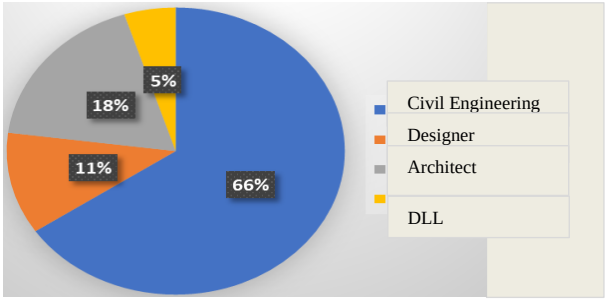

Figure 4
Respondent's Educational Background

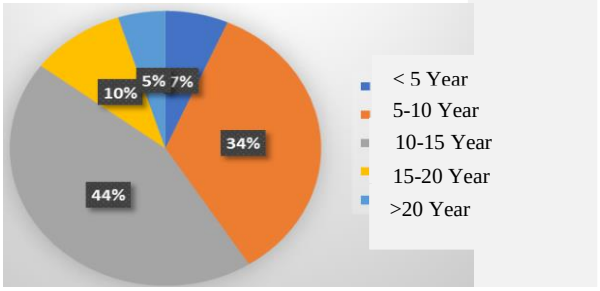

Figure 5
Respondent's Work Experience

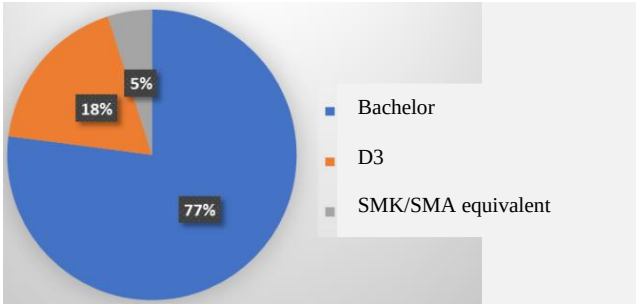

Figure 6
Respondent's Academic Qualifications

K3 Risk Factor Assessment with AHP

Based on the results of the recapitulation of primary data and secondary data, the risk factors used in this AHP analysis, for the work of the Passenger Terminal Building in the New Mentawai Airport Development project, are shown in Figure 7 Based on the figure, the input of all elements including objectives, criteria and alternatives is then carried out in the hierarchical structure in the *Expert Choice* application, then enter the importance comparison value for each pair of elements which includes the criterion element against the goal, the sub-criterion element against the criterion, and the comparison of each alternative to the goal. After the synthesis calculation is carried out, the priority order of the alternatives is obtained.

Table 2
Recapitulation of Weighted Criteria and Alternative Risk Factors K3

Criterion	Criterion Weights	Alternative	Alternate Weights	Total Weight	Rank
Structural Work	0,643	Worker Aspect	0,622	0,3999	1
Structural Work	0,643	Equipment Aspect	0,243	0,1562	2
Mechanical Work	0,22	Worker Aspect	0,552	0,1214	3
Mechanical Work	0,22	Equipment Aspect	0,303	0,0667	4
Structural Work	0,643	Environmental Aspects	0,09	0,0579	5
Electrical Works	0,093	Worker Aspect	0,583	0,0542	6
Structural Work	0,643	Management Aspects	0,044	0,0283	7
Architectural Work	0,044	Worker Aspect	0,581	0,0256	8
Electrical Works	0,093	Equipment Aspect	0,253	0,0235	9
Mechanical Work	0,22	Environmental Aspects	0,097	0,0213	10
Architectural Work	0,044	Equipment Aspect	0,273	0,0120	11
Electrical Works	0,093	Environmental Aspects	0,118	0,0110	12
Mechanical Work	0,22	Management Aspects	0,048	0,0106	13
Architectural Work	0,044	Environmental Aspects	0,099	0,0044	14
Electrical Works	0,093	Management Aspects	0,046	0,0043	15

Criterion	Criterion Weights	Alternative	Alternate Weights	Total Weight	Rank
Architectural Work	0,044	Management Aspects	0,048	0,0021	16

Based on the results of the analysis in the table above, it is known that Structural Work is the criterion that causes the highest risk factor K3. Mechanical work, mechanical work, and architectural work followed sequentially from highest to lowest risk factors.

Table 3
Recapitulation of Alternative Weights and Sub-Alternative Risk Factors K3

Alternatives	Alternate Weights	Sub Alternatives	Alternate Sub Weights	Total Weight	Rank
Worker Aspect	0,622	Worker *Burnout* Conditions	0,474	0,2948	1
Worker Aspect	0,622	Working at Heights	0,304	0,1891	2
Equipment Aspect	0,243	Material and Equipment Maintenance	0,447	0,1086	3
Worker Aspect	0,622	SOP Compliance level is lacking	0,124	0,0771	4
Equipment Aspect	0,243	Non-conformity of Use of Construction Equipment	0,242	0,0588	5

Table 3
Recapitulation of Alternative Weights and Sub-Alternative Risk Factors K3 (continued)

Alternative	Alternate Weights	Sub Alternatives	Alternate Sub Weights	Total Weight	Rank
Environmental Aspects	0,09	Noise	0,448	0,0403	6
Worker Aspect	0,622	Inadequate Human Resources Capacity	0,063	0,0392	7
Equipment Aspect	0,243	Improper Transport Methods	0,151	0,0367	8
Environmental Aspects	0,09	Skin Problems (Irritation, Contact with Chemicals)	0,273	0,0246	9
Worker Aspect	0,622	Mismatch of Manpower Needs	0,035	0,0218	10
Equipment Aspect	0,243	Security and Safety Facilities in the Field Less Guaranteed	0,087	0,0211	11
Management Aspects	0,044	Design Changes	0,366	0,0161	12
Environmental Aspects	0,09	Unpredictable Circumstances	0,129	0,0116	13
Equipment Aspect	0,243	New Technology	0,045	0,0109	14
Management Aspects	0,044	Lack of Standardization of Occupational Health	0,241	0,0106	15
Environmental	0,09	Bad Description	0,081	0,0073	16

Alternative	Alternate Weights	Sub Alternatives	Alternate Sub Weights	Total Weight	Rank
Aspects					
Management Aspects	0,044	Lack of Guaranteed Job Security	0,163	0,0072	17
Equipment Aspect	0,243	Data Supports Laboratory Testing of Site and Material Conditions	0,028	0,0068	18
Management Aspects	0,044	The implementation Method is not by Project Conditions	0,105	0,0046	19
Environmental Aspects	0,09	Increase in Domestic Waste	0,041	0,0037	20
Management Aspects	0,044	Design Specifications and Materials Do Not Match	0,067	0,0029	21
Environmental Aspects	0,09	Difficult Site Location Conditions	0,028	0,0025	22
Management Aspects	0,044	Technical Miscalculation	0,031	0,0014	23
Management Aspects	0,044	Poor Management	0,026	0,0011	24

Construction Safety Plan

The Construction Safety Plan (RKK) for the Implementation of Passenger Terminal Building Work for the New Mentawai Airport Construction Project is prepared based on the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 10 of 2021, with the following explanation:

a. Leadership and Worker Participation in Construction Safety, carried out with leadership concern for internal and external issues manifested in policies related to aspects of occupational safety and health, quality and security consisting of management system policies, safety policies, occupational health and environment, drug and alcohol prevention and abuse policies, driving safety policies and HIV/AIDS prevention and control policies. Another manifestation is by compiling an SMKK management organization consisting of a Project Manager, Site Operational Manager, *Site Administration Manager*, *HSE Officer*, *an HSE Inspector*, and workers. Construction safety commitment and labor participation are implemented to prevent work accidents, occupational diseases, and environmental pollution to achieve the target of zero accidents, without occupational diseases and no environmental damage. Leaders also ensure the implementation of supervision, training, accountability, resources, and support which are then outlined in the Construction Safety Support Element and Construction Safety Performance Evaluation Element
b. Construction Safety Planning, carried out by preparing IBRP tables (Hazard Identification, Risk Assessment, Control, and Opportunities), followed by the preparation of Engineering, Management, and Manpower Action Plans, General and Special Targets and Programs, and Fulfillment of Construction Safety Standards and Laws and Regulations that become a reference during construction activities ranging from Laws and Regulations, Government Regulations to

appropriate AMDAL/UKL-UPL documents with the scope of work carried out (You et al., 2022).

c. Construction Safety Support, consisting of resources (equipment, materials, and costs), labor competence, caring, communication management, and documented information. The cost of K3 compiled in this study based on Circular Number 11 / SE / M / 2019 is IDR 698,250,000.00. Competency needs and the implementation of personnel training are analyzed monitored and reviewed by the *Site Administration Manager* in the project periodically. In construction safety support, concern for K3L can be increased by starting from implementing K3 because of routine supervision, then increasing to the needs of each individual, and finally implementing K3L because of care and necessity. All leaders are committed to implementing K3L in the project environment, to provide *role models* to workers. Contractors carry out various kinds of *preventive* and *promotive activities*, namely carrying out socialization of procedures to increase *awareness*. Implementation of *Reward and Punishment* programs and training related to K3 aspects to improve competence. K3L communication (HSE) for the work in this study consisted of *HSE Induction, Daily Toolbox Talk, Weekly Toolbox* Meeting, hazard source report, K3L information board (HSE), K3L Meeting (HSE), and K3L campaign (HSE)
d. Construction Safety Operations, carried out in the framework of hazard control at the work site which is realized in the planning and implementation of RKK, control of construction safety operations, readiness and response to emergency conditions, and investigation of construction accidents
e. Construction Safety Performance Evaluation, realized by monitoring or inspecting the level of compliance with laws and regulations through the determination of inspection methods, criteria, and procedures related to SMKK. K3L Performance Report is conducted every month. *The cut-off* date for Project K3L Performance Report on the last date of each month. The report submitted is by the FM-LKHSE form and is completed with supporting documents Appendix. In addition, HSE also makes a Project K3L Performance Evaluation Report which will be presented every 3 (three) months. Other manifestations in the form of evaluation (methods of evaluating compliance and taking action), management review (planning and establishing procedures and reports), and improvement of construction safety performance.

CONCLUSION

Based on the risk factors from the preliminary study results, 24 risk factors were identified, which were classified based on aspects of management, equipment, workers, and environment. Where each of these aspects is known to be the highest risk factor in passenger terminal building work in the Mentawai Baru Air Bandan construction project. Based on the AHP analysis in this study, the risk factor *for burnout conditions of workers who are part of the worker aspect and carried out in structural work is the highest.*

The Construction Safety Plan is prepared by the Regulation of the Minister of Public Works and Public Housing of the Republic of Indonesia Number 10 of 2021 concerning Construction Safety Management System Guidelines so that the K3 cost of the risk analysis results is IDR 698,250,000.00 (Numbered: six hundred Ninety-eight million two hundred and fifty thousand rupiah).

It is recommended in further research to be more detailed and specific related to other risk

factors that affect the implementation of construction projects, especially other buildings that include land-side facilities at airports, so that parties involved in the implementation of terminal building construction at airports, especially leaders and management, pay more attention to these 24 risk factors, especially *burnout* conditions workers on structural work, so it is expected that the work can run on time and by the set budget.

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