Quest Journals
Journal of Architecture and Civil Engineering
Volume 7 ~ Issue 8 (2022) pp: 07-22
ISSN(Online) : 2321-8193
www.questjournals.org

Research Paper

The Analysis of Risk Management to Occupational Health Aspect During Covid-19 Pandemic Time In Double Track Railway Projects AT KM 43+800 MOJOKERTO-SEPANJANG to 49+500 SURABYA-SOLO ROUTE

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ABSTRACT : *Whole world currently experiencing Covid-19 pandemic, with no exception of Indonesia. One of the sectors affected is the construction work. There are many changes must be made to prevent the Covid-19 transmission in the work area, including prevention of Covid-19 at project site for the construction of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route.*
The study uses a Failure mode and Effect Analysis or known as FMEA method in analyzing risks due to Covid-19 pandemic. From the FMEA results, the risks and mitigation priorities will be obtained which then be analyzed further by employing the Analytical Hierarchy Process (AHP) method to take the final decision.
The results of research analysis by FMEA methods are stated as: 1) in K3 system activities, highest variable is below standard equipment for virus transmission prevention in accordance to SOP (with RPN percentage of 60 %), 2) in employees and worker management activities, the highest variable is the undetected virus transmission activity (with RPN percentage of 75%), 3) as the last activity of this study is found in the work method with the highest variable of no physical distancing between workers and the over shift working hours (both activities have the same RPN percentage of 27 %). From the calculation result above, the highest risks lies on the undetected virus Covid-19 transmission which has RPN value of 75 %.
KEYWORDS: *Risk Management, Covid-19 Failure Mode and Effect Analysis, Analytical Hierarchy Process, Double Track Railway, Southern Java.*

R**eceived 07 August, 2022; **R**evised 20 August, 2022; **A**ccepted 22 August, 2022 © The author(s) 2022. **P**ublished with open access at **www.questjurnals.org

I. INTRODUCTION

Indonesian government programs during Joko Widodo presidential era brought up vision and mission of evenly distributed infrastructure development throughout Republic of Indonesia territories, an activity that known better as *Nawa Cita.* Infrastructure sector has become one from many developments focus during Joko Widodo–Jusuf Kalla administration era. An intention to increase infrastructure connectivity will stimulate economic growth in various region of Indonesia. President Jokowi emphasizes the infrastructure development program becomes the part of embodying justice for all citizens of Indonesia [6].

There are five work targets in the second period of Joko Widodo-Makruf Amin presidential era which one of the targets is a continuation of infrastructure development program by the Indonesia government. According to Joko Widodo, infrastructure will connect any production area to the distribution area, facilitates access to any tourism attraction/tourist areas, boosts many available new jobs, and accelerates the added value of people' economy.

The spreading of Covid-19 throughout the world as a very dangerous virus for society affected many aspects of life. One of the sectors affected by the pandemic is a construction work sector. As a result, many new changes must be made to prevent Covid-19 virus transmission in the work area, by referring to regulation from Minister of Public Works No.05/PRT/M/2014 about The Guidelines for The Occupational Health and Safety Management System (SMK3) for Construction in Public Work Sector as stated in chapter 1 article 1 regarding the Construction Occupational Safety and Health, hereinafter referred as K3. The scope of construction work in this study covering the construction of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route, where this project also prone to high risk of contracting Covid-19. Therefore, it requires a risk management related with preventing the spreads of Covid 19 and also management in handling work during Covid-19 pandemic time because many workers from different regions of Indonesia are interacting with each other's (whether with staffs or local residents in the region). According to Maelissa, et.al [9], during pandemic time, the service providers should implement the health protocols for preventing Covid-19 in strict manners within the project sites, asides implementing other implementation strategies in the project.

The discussion related to risk management on occupational health aspect during Covid-19 pandemic time for double track railways are scarce/very limited, therefore the researchers postulate research problems as: 1). How to identify the dominant risk during the Covid-19 pandemic in the construction project of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route by applying the FMEA method? 2). How to determine the dominant risk priority during the Covid-19 pandemic in the construction project Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route? 3). How is the mitigation of occupational health and safety (K3) at the most dominant risk in the construction of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route during the current Covid-19 pandemic?

II. LITERATURE REVIEW

2.1. Risk Management in Construction Project

Risk management is a management process to the risk were started from identifying hazards, assessing risk levels and controlling the risks [12]. Meanwhile, definition from AS/NZS 4360 [3] said the Risk management is an iterative process consisting of well-defined steps which, taken in sequence, support better decision-making by contributing a greater insight into risks and their impacts.

A risk management, in general, defined as processes of identifying, measuring and ascertaining risks also developing strategies for managing these strategies. Within these areas, the risk management will involve processes, methods and techniques that able to help the project managers maximize the probability and consequences of positive events and minimize the probability and consequences of negative events [5][17]. Benefits from risk management provided to companies can be classified into 5 (five) main points as stated below:

1. Risk management may be able to prevent the company from failure in completing work tasks.
2. Risk management directly supports increased profits.
3. Risk management can provide indirectly profits.
4. Elicit inner peace of mind for managers due to existence of protection against pure risks and becomes a non-material asset for the company.

2.2. The Risk Identification

Rahayu in Labombang [8] stated the risk, in general, can be identified through various perspectives which depend on the needs for handling:

1. Pure risk and speculative risk; Is a method to analyze causes of a problem or conditions as well as able to identify and organize possible causes of an effect and then separate the root causes. The stages of fishbone diagram are as stated below: One example of pure risk is work accidents happen on a project. Thus, pure risk also called as static risk. Whereas the speculative risk is known as a dynamic risk. An example of speculative risk to an insurance company, if the guaranteed risk occurs, the insurance company will suffer a loss because it has to bear the sum insured for the value of the work loss, however, when the guaranteed risk does not occur, the company will make profits.
2. Risk to objects and people; Where risk to objects is type of risk that afflicts objects such as a burning house, while risk to human is type of risk that afflicts human such as old rage risk, death risk, etc.
3. Fundamental risk and particular risk; It is a risk likely to happen in most members of society which cannot be blamed on one individual or several people as the cause, the examples are natural disaster or war. Meanwhile the particular risk is a risk originates from independent events where the its nature is not always catastrophic but it can be controlled or in general it can be insured.

According to Darmawi [5] risk identification is a systematic and sustainable analysis process to find risks (potential losses) that challenge the company. Based on its function, risk identification includes planning, assessment (identification and analysis), handling, and risk monitoring. Risk assessment is the initial and the most important stage in the risk management program because it affects the entire program in risk management. Risk identification serves to identify areas and technical processes that have potential risks for further analysis.

2.3. Risk Analysis

According to Godfrey in Zuhdi, et.al. [19], risk analysis that carried out in systematic way able to help identify, assess and rank the risk comprehensively, with focus on the main risks, and able to explain the limitations, weaknesses and functions of each individual or entities involved in the risk management. In addition, Thompson and Perry in Zuhdi, et.al. [19] stated when results show high probability with a high impact, it will produce a high level of risk, and vice versa (when the probability is low then the risk level is also low), where the next step will be followed by giving a treatment (handling) to the dominant risk which known as risk management.

Australian and New Zealand Standard [3] established 4 (four) steps procedures in a risk management as stated below:

1. Determine the context; determine the internal or the external boundaries which will be considered and discussed in the risk management.
2. Risk identification; which applied to determine the relevant risk variables
3. Target of the risk identification; the development from risk sources and events that impacted on the identified goals and target context.
4. Risk analysis; which includes consideration to the risk sources, its consequences and the likelihood of the risk emergence. The risk will be analyzed by combining probability (frequency probability) and consequence (impact or effect) values. The likelihood and consequences of each risk will determine the risk level.

2.4. Risk Evaluation

The purpose of risk evaluation is assisting the decision-making process that aligned with the result of the analysis. The risk evaluation process will determine which risk that requires treatment and the way (how) to prioritize those risks. It will be conducted by grouping/classifying the possibilities and consequences into a risk matrix. Then, after identifying the possible value also the consequences that exist, then these values can be plotted into a risk matrix to find out how high the risk impact [19]. For the risk matrix will be explained in table 1 below:

Table 1. The risk matrix

	Impact (*Consequences*)				
Probability (Likelihood)	(1) Insignificant/ Very small	(2) Small	(3) Average	(4) Big	(5) Damaging/ Very Big
(A) Very Often	H	H	E	E	E
(B) Often	M	H	E	E	E
(C) Average	L	M	E	E	E
(D) Seldom/rare	L	L	M	H	E
(E) Very rare	L	L	M	H	H

Source: AS/NZS 4360:1999 Risk Management [3]

Where:

E : *Extreme risk*, no tolerance, needs an immediate care.
H : *High risk*, unwanted, only acceptable when there was existed a risk reduction, unable to execute, needs special attention from management division.
M : *Moderate risk*, accept with further agreement and require a clear responsibility from the management division.
L : *Low risk*, accepted with agreement by the management division and able to be handled with the routine procedures.

2.5. Risk Occupational Safety and Health Protocol (*Kesehatan dan Keselamatan* Kerja-K3)

According to Ervianto in Putra et.al. [13], the Occupational Safety and Health has become problem that caught attention of many organizations at present time, because it conveys problem in many aspects such as humanity, economic costs and benefit, legal aspects, accountability and the image from the organization itself. These aspects have the same important level although there are changes in behavior (in here and there) both within the environment itself or in the other factors came from external elements of the industry. The Occupational Safety and Health is the most important factor when achieving project objectives. A maximum result in cost performance, quality and time performance will be meaningless if the work safety level is neglected. The indicator of low work safety level can be present in a high rate of work accidents; workers die or having permanent disability or any damaged project installation, aside from heavy/large material losses [13].

According to Wiyasa [18], the Occupational Safety and Health (K3) has a legal basis which must be obeyed by all parties; workers, employers or the other related parties, under reference of several regulations below.

1. Law no. 1/1970 on work safety.
2. Article 23, Law no. 18/1999 on construction services.
3. Article 86, Law no. 13/ 2003 on manpower or labor, and Article 87 on requirement of every organization for implementing the Occupational Safety and Health or OHS Management System.
4. Minister of Public Works No.09/PRT/M/2008 on Guidelines for Occupational Health and Safety Management System (SMK3) to Construction in the Public Works Sector.
5. Indonesia Government Regulation No. 50/2012 on the Occupational Health and Safety Management System (SMK3).

2.6. Failure Mode and Effect Analysis (FMEA)

FMEA method is conducted to analyze any potential of failures in the system also analyze identified potentials which will be classified according to the magnitude of the potential failure and its effect on the process.

The FMEA method is used to examine the failure causal which occurs during the production process, evaluate the priority risks that cause work accidents, and help in taking action to avoid problems identified as work accident hazard. The FMEA method combines knowledge and human experience into the process [10].

1. Identify the potential failure of a product or process.
2. Evaluate the failure of a product or process and its impact.
3. Assist the engineer to take corrective action or preventive action.
4. Eliminate or reduce the possibility of failure.

According to Alijoyo et.al. [2] definition of FMEA is a technique used to improve the reliability and security of a process by identifying potential failures (or so called as failure modes) in the process. Every failure mode will be assessed by three parameters: severity (S), probability of occurrence (O), and probability of detection failure (detectability-D). The three parameters were then combined to determine critically significance (FMECA) of each failure mode. Combination of the three parameters is known as the Risk Priority Number (RPN). In mathematic way, relationship between parameters and the RPN can be formulated as follow:

$$\mathbf{RPN = S \times O \times D}$$

Description:

S : Severity rating scale (Severity level)
O : Occurrence rating scale (Level of probability of occurrence)
D : Detectability rating scale value (Detection level)

Severity is used to calculate the seriousness impact caused by the failure occurrence based on the S parameter criteria which have been compiled prior to it. The applied scale to measure the severity of a risk is put in range between 1 – 10. The seriousness of the impact caused by the failure then able to be explained below in table 2.

Table 2. Rating severity

Effect	Severity Criteria	Ranking
Hazardous without warning	May endanger machine or assembly operator. Very high severity ranking when a potential failure mode affects safe operation and/or involves noncompliance with regulation. Failure will occur without warning.	10
Hazardous warning	May endanger machine or assembly operator. Very high severity ranking when a potential failure mode affects safe operation and/or involves noncompliance with regulation. Failure will occur with warning.	9
Very High	Major disruption to production line. 100% of product may have to be scrapped. Item inoperable, loss of primary function. Customer very dissatisfied.	8
High	Minor disruption to production line. A portion of product may have to be sorted and scrapped. Item operable, but at reduced level. Customer dissatisfied.	7
Moderate	Minor disruption to production line. A portion of product may have to be scrapped (no sorting). Item operable, but some comfort items inoperable. Customer experiences discomfort.	6
Low	Minor disruption to production line. 100% of product may have to be reworked. Item operable, but some comfort items operable at reduced level of performance. Customer experiences some dissatisfaction.	5
Very Low	Minor disruption to production line. Product may have to be sorted and a portion reworked. Minor adjustments do not conform. Detect noticed by customer.	4
Minor	Minor disruption to production line. Product may have to be reworked online, but out of station. Minor adjustments do not conform. Defect noticed by average customer.	3
Very Minor	Minor disruption to production line. Product may have to be reworked online, but out of station. Minor adjustments do not conform. Defect noticed by discriminating customer.	2
None	No Effect	1

Source: Borror, C. M. [4]

0 parameter criterion used to measure how often a failure may occur. Probability 0 failure then measured by applying a scale from 0 – 10, starting from scale 1 which represent condition of almost no possible failure to scale 10 which represents condition of almost unavoidable chance of failure. The measurement about how often the possibility of failure might occur can be observed in table 3 below.

Table 3. Rating occurrence

Probability of failure	Possible failure rates	Ranking
Very high: Failure almost inevitable	> 1 in 2	10
	1 in 3	9
High: Repeated failures	1 in 8	8
	1 in 20	7
Moderate: Occasional failures	1 in 80	6
	1 in 400	5
	1 in 2000	4
Low: Relatively few failures	1 in 15.000	3
	1 in 150.000	2
Remote: Failure is unlikely	< 1 in 1.500.000	1

Source: Borror, C. M. [4]

The detection scale used for determining the likelihood to able detecting failure in the scope of failure in handling Covid-19 transmission in the current project area is given a scale from 1 to 10. How likely the scale to detect failure can be explained in the table 4 below.

Table 4. Rating detection

Effect	Detection Criteria	Ranking
Absolutely impossible	No known controls to detect failure mode.	10
Very remote	Very remote likelihood current controls will detect failure mode.	9
Remote	Remote likelihood current controls will detect failure mode.	8
Very low	Very low likelihood current controls will detect failure mode.	7
Low	Low likelihood current controls will detect failure mode.	6
Moderate	Moderate likelihood current controls will detect failure mode.	5
Moderately high	Moderately high likelihood current controls will detect failure mode.	4
High	High likelihood current controls will detect failure mode.	3
Very high	Very High likelihood current controls will detect failure mode.	2
Almost certain	Current controls will almost certainly detect a failure mode. Reliable detection controls are known with similar processes.	1

Source: Borror, C. M. [4]

The Severity Index Analysis is an impact level caused by each risk factor which causes project work to halt/fail [7]. To obtain the result from the severity index calculation, a formula shown in the following equation can be applied [1].

$$SI = \frac{\sum_{i=}^{4} aixi}{4\sum_{i=0}^{4} Xi} \times 100\%$$

Formula description:

ai : Rating constant
xi : Respondent probability
i : 0,1,2,3,4,5,…., n

x0,x1,x2,x3,x4 are responses of respondent probability
a0=0, *a1*=1, *a2*=2, *a3*=3, *a4*=4
x0 = 'very low' respondent probability, thus, *a0* = 0
x1 = 'low' respondent probability, thus, *a1*= 1
x2 = 'quite high' respondent probability, thus *a2*= 2
x3 = 'high' respondent probability, thus *a3*= 3
x4 = 'very high' respondent probability, thus *a4*= 4

To determine the probability of impact, the researchers applying the following classification scale table.

Table 5. The severity index rating scale to probability

Scale	Probability Category	Severity Index (%)
1	Very low	≤ 20
2	Low	20 – 40
3	Average/Moderate	40 – 60
4	High	60 – 80
5	Very High	80 – 100

Source: Borror, C. M. [4]

2.7. Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a method for solving a complex unstructured situation into several components by hierarchical arrangement, to give subjective value to the relative importance for each variable, and to determine variable that has the highest priority in order to influence the outcome from the situation. Whereas the decision-making process is basically a process to choose the best alternative which take form of structuring problems, determining alternatives, determining possible values for aleatory variables, setting values, requirements for time preferences and specification of risks. No matter the widening range of the alternative ranges that can be set or how detailed the assessment of the possible values, such limitation that surrounds these situations is the basis of comparison in a single criterion format [11].

According to Supriadi [16], the Analytical Hierarchy Process is selected to be the problem-solving method (compared to other methods) for the following reasoning:

1. It has a hierarchical structure, as a consequence of the selected criteria into the deepest sub-criteria.
2. Taking validity into account up to the inconsistency tolerance limit as the criteria and alternatives chosen by the decision maker.
3. Considering the durability of the output from the decision-making sensitivity analysis.

Supriadi, et.al. [16] further stated, alike another analytical method, the AHP also has advantages and disadvantages in its analysis system. Points of advantages from this analysis are:

- Unity; AHP detaches broad, unstructured problems into a flexible and easy-to-understand model.
- Complexity; AHP solves complex problems through a system approach and deductive integration.
- Interdependence; AHP can be used on system elements which are independent and do not require a linear relationship.
- Hierarchy Structuring; AHP represents natural way of thinking that has a tendency to group system elements into different level where each level will contain similar elements.
- Measurement; AHP provides measurement scales and methods for obtaining priorities.
- Consistency; AHP considers logical consistency in the assessment used to determine priorities.
- Synthesis; AHP leads to an overall estimate of how desirable each alternative is.
- Trade Off; AHP considers the relative priority of the factors in the system so that people are able to choose the best alternative based on their goals.
- Judgement and Consensus; AHP does not require a consensus, yet it combines the results from different assessments.
- Process Repetition; AHP is able to make people refining/filtering the definition of a problem and develop their judgment also their own understanding through an iterative process.

Whereas for the AHP method weaknesses are stated as follow:

- The dependence from AHP method on its main input. The main input for this method lies in the expert’s perception, thus, it involving the expert subjectivity a lot and makes the model becomes meaningless if the expert gave an erroneous (wrong) assessment.
- The AHP method is only a mathematical method without involving any statistical testing, so there is no confidence level/limit of any correctness of model that able to be formed.

III. RESEARCH METHOD

3.1. The Sampling Method

The selected method in this study was a purposive sampling technique, by gathering samples from population that determined by the researcher (Subjective) [15]. As sample of this research was the expert staffs from the service providers who work on Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route.

3.2. The Data Type

The researchers use primary data and secondary data in this study:

1. Primary data in this study were obtained by several ways:
    - The primary data which obtained by spreading questionnaires and conducting direct interview with institutions and stakeholders of the construction of double track railways Southern Java. For collecting and observe the potential risks also to know the risk management applied in the project area during the Covid-19 pandemic, the variable used in determining the questionnaire was the OHS management system consisted of OHS management procedures during the Covid-19 pandemic. Other variable applied in this study was the management of employees and workers, where this variable contains the priority of compliance with the implementation or preventing the Covid-19 transmission. Finally, as the last variable was the work method, which was the variable that analyze how the project activities were managed during the Covid-19 pandemic time.
    - The primary data which obtained by observing activities and interactions of employees and workers at the project site during the Covid-19 pandemic time.
    - The primary data obtained by a documentation method; observing and taking pictures of the object studied during the Covid-19 pandemic time.

2. Secondary data utilized in this study was *Bill of Quantity* (BOQ) data for K3 management from PT. Wijaya Karya as the service provider.

3.3. The Research Stages

The research steps for this study are:

1. Conduct a process study, by identifying the failure mode from the studied object through survey at the project area, distributing questionnaire, and making direct interview with relevant resource individuals who have expertise in the project and understanding the Covid-19 pandemic situation.
2. Conduct The Risk Analysis by Employing FMEA Method
   - Determine the severity level. It is an estimation of the severity as the consequences if failure occurs in the form of scores of the factors that play significant role in determining the severity in the case process of Covid-19 situation [14].
   - Determine the level of occurrence. This is used to assess how often the possibility of failure able to occur.
   - Determine the level of detection. For detecting, measuring criteria and controlling the failure mode by considering all control aspects and other indicators attached to the analyzed process [2].
   - The result values from severity, occurrence, and detection can be calculated by using the Severity Index (SI).
   - Using the formula from Borror [4] to determine the RPN value.
3. Determine the risk mitigation alternatives according to the calculation results of risk priorities and the result of interview with resource individuals and references from previous researches.
4. Collecting data about alternative risk mitigation through questionnaire.
5. Conducting data analysis by AHP method with stages as explained below:
   - Develop an AHP hierarchy by starting with determining goals and continues with criteria classification and the desired risk mitigation alternatives.
   - Calculating the geometric mean since AHP only requires one input, meanwhile in this study contained of several respondents.
   - Carry out weighting to each criterion and the risk mitigation alternatives by creating a pairwise comparison matrix that describes the relative contribution to objectives or to each of the above criteria. Comparison was made on the basis of assessment of respondents who have been selected to measure the level of the importance of an element when compared to other elements.
   - Perform the pairwise comparison between criteria to obtain a relative value. Then on each criterion, each risk mitigation alternative will be compared to each other to get the relative value between the risk mitigation alternative on one related criterion.
   - Calculate the eigen vector of each pairwise comparison matrix and test its consistency. When it is not consistent (by consistency value > 0.1) then data collection needs to be repeated.
   - Calculate the final value from each risk mitigation alternative by adding up the weight of the risk mitigation alternative by the weight of each criterion.

The AHP stages are repeated on each criterion, risk mitigation, also to criteria by applying Microsoft Excel application. The explanation below is the AHP hierarchy structure employed in this study:

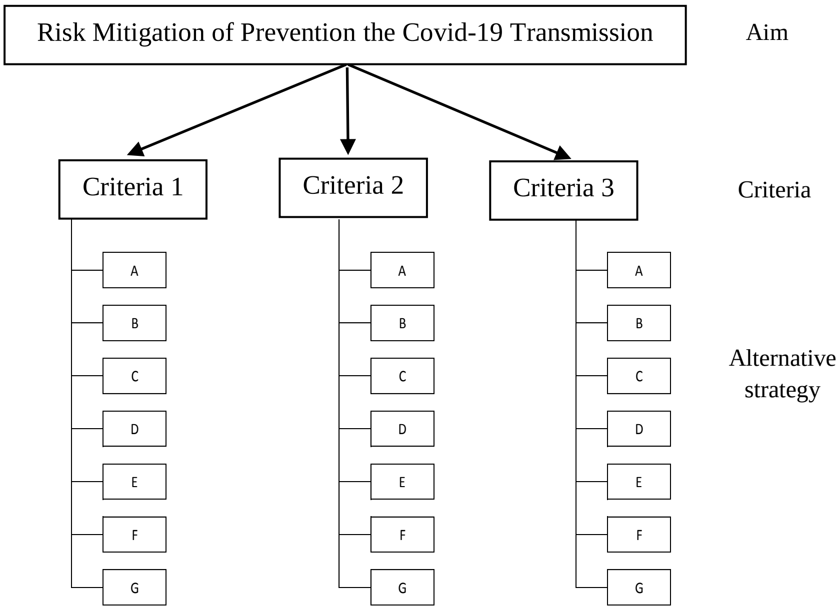

Figure 1: The structure of AHP hierarchy

IV. RESULT AND DISCUSSION

4.1. The Calculation of Risk Priority Number (RPN)

The FMEA approach to identify the impact of the Covid-19 pandemic on the project environment was applying a Risk Priority Number, where it is the result of the multiplication of severity, occurrence and detectability scale values. This study focuses on activities that have the potential to be a source of Covid-19 transmission in the construction project of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route. The value of the Risk Priority Number will help to identify risks which have potentialities in causing Covid-19 transmission.

The results from scale of severity, occurrence, and detectability events are presented in table and calculation of severity index in the severity analysis is using the formula of Al Hammad, et.al [1] as an example below:

$$SI = \frac{\sum_{i=}^{4} aixi}{4\sum_{i=0}^{4} Xi} \times 100\%$$

$$SI = \frac{\sum_{i=}^{4}(0x0) + (1x0) + (2x1) + (3x0) + (4x4)}{4\sum_{i=0}^{4}(5)} \times 100\%$$

$$SI = 90\ \%$$

From the result calculation by the severity index formula, undetected Covid-19 became the risk that has highest value failure mode with an index of 90 %. This result is included in category of very high probability scale values with a scale value of 5. Whereas values reached S1=90 % are stated as follow: 1) The type of K3 system activity is *failure mode*, less standard equipment for preventing virus transmission, thus it has *effect* not detecting virus infection, with severity scale 3=1, 5=4 (include in very high category/S1=90%). 2) The type of management activities of employees and workers is *failure mode* where the Covid-19 virus undetected, then the *effect* of staff and workers transmitting virus to others, with severity scale 3=1, 5=4 (include in very high category/S1=90%) as listed in table 6 below.

Table 6. Failure mode and effect analysis (severity)

No.	Type of Activity	*Failure Mode*	*Effect*	*Severity scale*					S1%	Category	*Scale*
				1	**2**	**3**	**4**	**5**			
1.	**The Occupational Safety Health System**										
		Lack of standards in the appropriate tools for preventing the Covid-19 spreading	Not detected infected with the virus			1		4	90	Very High	5
2.	**The Management of Employees and Workers**										
		Not detected infected with the Covid-19 virus	Staff and workers transmit the virus to others			1		4	90	Very High	5

Source: The calculation result, 2022

After the calculation through severity index (SI) has been obtained (presented in the table 6), then continued with Risk Priority Number (RPN) calculation with following formula from Alijoyo, et.al. [2]:

RPN = S x O x D

Description:

S : Severity rating scale (Severity level)
O : Occurrence rating scale (Level of probability of occurrence)
D : Detectability rating scale value (Detection level)

Table 7. The result calculation of Risk Priority Number (RPN)

No.	Type of Activity	Failure Mode	Severity Scale	Occurrence Scale	Detection Scale	RPN (SxOxD)
2.	**Management of Employees and Workers**					
		No detection of get infected by Covid-19 virus	5	5	3	75

Source: The calculation result, 2022

The result from RPN calculation will be used to show risk categories level and the most critical threat of loss caused by Covid-19 transmission. By finding the highest RPN value, it will be able to identify the highest source of Covid-19 transmission in scope of construction work of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route. The result of these calculations showed no workers or staff have been detected / contracted by Covid-19 viruses and became the first rank with RPN scale value of 75 % thus it requires an improvement and mitigation priorities to prevent the Covid-19 transmission within the project area.

4.2. Mitigation in Prevention of Covid-19 Transmission at Project Site by Applying AHP Method

In establishing or conforming the mitigation of Covid-19 transmission prevention, in particular for the highest causal of transmission due to undetected workers or employees who have contracted with Covid-19 virus, interview was conducted to sources (individuals) who have an important role in decision making within the scope of construction project of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route. From the result of the interview, there are several criteria's for determining alternative mitigations for the prevention of Covid-19 virus which then arrange in a hierarchical system as stated below:

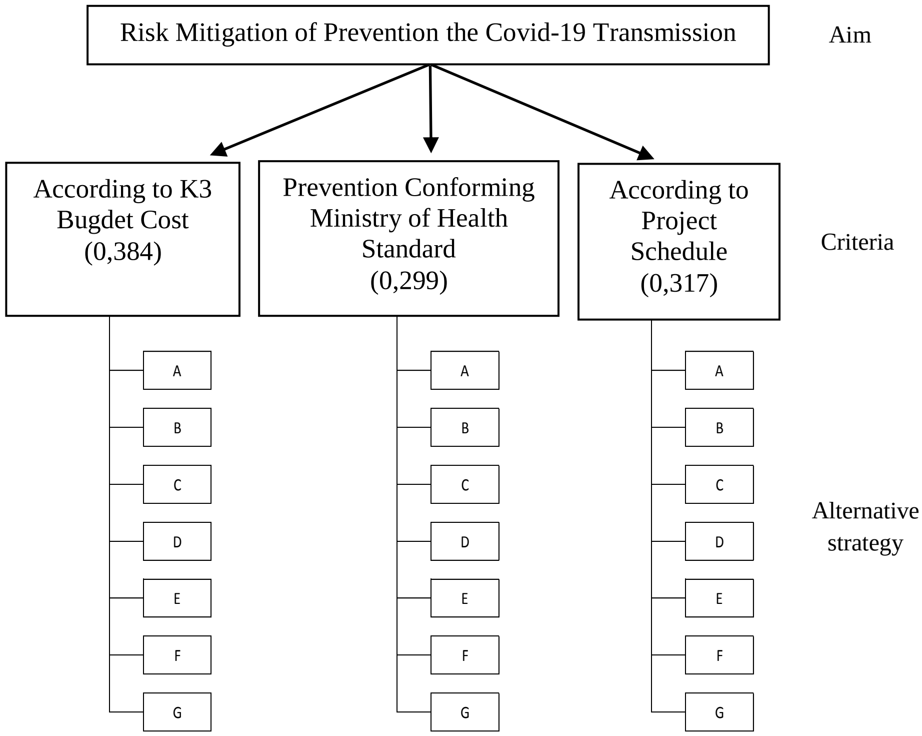

Figure 2: The structure of AHP hierarchy

Mitigation Descriptions
A : Availability of medical examination tools for the employees and workers on work area
B : Location of Swab test (PCR and Antigen Swab) is close and fast to reach
C : Creating a collaboration work for handling employees and workers who are suspected positive Covid-19 with the local hospital or health centers
D : A routine socialization of Covid-19 symptoms to the employees and workers
E : Availability of medical personnel at the project site
F : Installation of Covid-19 educational media at the project site
G : Establish a Covid-19 prevention task force

Table 8. Consistency ratio

No	Aim, Criteria Level 1	Consistency Ratio Value (CR)
1	Risk mitigation of preventing the Covid-19 transmission	0,0312
2	In accordance to K3 budget cost	0,0724
3	Prevention conforms the standards issued by Indonesia Minister of Health	0,0606
4	According to the project schedule	0,0699

Source: The calculation result, 2022

Based upon the calculation presented in table 8 about the value of the consistency ratio (CR), all the applied criteria's have met the standard and the data are valid to be used for decision making. It indicated by the calculation result from the value of the consistency ratio 0.1 or 10 %. The table showed a value of 0.0724 for the criteria according to the K3 budget, a value of 0.0606 for the prevention criteria according to the standards of the Indonesia Ministry of Health (*Kemenkes*) and a value of 0.0699 for the criteria according to the project schedule. Meanwhile for the purpose of mitigating risk of preventing the Covid-19 transmission, the consistency ratio value was 0.0312.

4.3. Priority Analysis of Criteria Assessment

From the calculation result by the Analytical Hierarchy Process (AHP) method, weight value of each criterion variable can be obtained and be used for preventing the Covid-19 transmission in the scope of construction project of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route as presented in table 9 below:

Table 9. Variable weight

No	Criteria	Weight
1	In accordance to K3 budget cost	0,384
2	Prevention conforms the standards issued by Indonesia Minister of Health	0,299
3	According to the project schedule	0,317

Source: The calculation result, 2022

From the calculation presented in table 9, weight of each variable was able to obtain and it is visible that the highest weight in the variable conforms to K3 cost budget by weighted value of 0.384. The highest weight has a higher importance, therefore will be prioritized in mitigating the risk of preventing Covid-19 transmission in the project area. This criterion also intended to make no cost overrun inside K3 cost budgets by following the control hierarchy (by considering the direct cost of safety and indirect cost of safety). Therefore, it requires an alternative mitigation which appropriate to the cost when the mitigation process is carried out to prevent the Covid-19 transmission in the work area.

The second highest criterion is in accordance with the project schedule, by a weighted value of 0.317. Due to an influential of time factor, the prevention act which about to carried out will inevitably lead to cost overrun in the project operational costs and potentially will result in prevention of Covid-19 transmission must be held quickly and precisely. Furthermore, the conducted prevention tends to experience difficulties along the establishment of time limit in working hours which limited workers productivity when the Covid-19 pandemic hit Indonesia.

The lowest criterion in this study was the prevention of Covid-19 transmission according to the Indonesia Ministry of Health standards. This criterion obliges service providers to do preventive activity in each type of work conducted in the project area by conforming the safety procedures of Covid-19 prevention issued by the Ministry of Health of Republic of Indonesia. It intended to minimize the risk of Covid-19 airborne transmission (transmitted through the air). The management division from the service providers must be very thorough in applicating every Covid-19 prevention procedure in order to provide an optimal and efficient results despite it will require cost, concentration and big role that must be spent for Covid-19 prevention according to the regulation issued by the Indonesia Ministry of Health.

4.4. Priority Analysis of Criteria Assessment

The results from assessment and weighting of these mitigation alternatives are employed to prevent risk factors based on the highest RPN value of all work activities in the construction project of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route which will be presented in table 10 below:

Table 10. Weights of alternative mitigation criterion variable according to K3 budget

Mitigation	Weight	Rank
Close location of swab test (PCR and Antigen) and fast to reach	0,159	1
Availability of medical health devices for employees and workers	0,148	2
Presence/availability of medical personnel at project site	0,146	3
Creating task force for Covid-19 prevention	0,146	4
Installation of educational media for Covid-19 pandemic at the project site	0,145	5
A routine socialization of Covid-19 symptoms to the employees and workers	0,129	6
Collaboration in handling employees and workers who are suspect of Covid-19 with the local hospital and health centers	0,127	7

Source: The calculation result, 2022

From the calculation of mitigation alternative questionnaire, as the first mitigation alternative for criteria in accordance to K3 budget is the location of Swab test (both PCR and Antigen test) which found to be close and fast to reach by a weight value of 0.159, whereas according to experts and respondents, the mitigation alternative is very efficient for preventing the Covid-19 virus transmission. Due to the near location of Swab test makes people fast in getting the test results and it able to speed up the prevention of virus transmission among workers or employees (whether for those with or without symptomatic positive Covid-19 status). In terms of the cost incurred, the cost for this mitigation is not too expensive when the location of Swab test is built very close to the project location because the transportation cost can be minimized.

The second alternative mitigation is the availability of medical examination tools for employees or workers with a weight value of 0.418. This mitigation is sufficient to prevent the Covid-19 transmission among employees and workers. As the medical check-up instruments available at the project site, initial health condition from employees and workers can be identified thus it will prevent the Covid-19 virus transmission around the project site. In terms of cost incurred, it can reduce operational costs for checking each employee and workers when someone shows symptoms of contracting Covid-19 virus or other work-related diseases.

The third alternative mitigation is the availability of medical personnel at the project site with a weight value of 0.146. This mitigation is used to anticipate presence of workers or employees who infected by Covid-19 with mild/moderate symptoms, so they can be handled immediately and quarantined from other workers. The medical assessment and first treatment for Covid-19 patients are urgently needed to anticipate virus transmission on a wider scale. With the presence of medical officers at the project site, it is expected that access to health services during Covid-19 pandemic time will get closer and be easier.

The fourth alternative mitigation based on criteria according to the K3 budget is to form the Covid-19 prevention task force with a weight value of 0.416. Establishing prevention task force at the project site will be very beneficial for service providers because the prevention can be managed by the provider itself. Creating task force able to help prevent the Covid-19 spreading at the project site become in focus and easy to direct.

The fifth alternative mitigation based on criteria according to K3 budget is the installation of educational media for Covid-19 information at the project site with a weight value of 0.145. The educational media installation serves purpose as a means of warning and advises regarding the prevention of Covid-19 spreading in the project area. Example of educational media are signboard and posters on project site which obviously affordable in the K3 implementation budget of the related project.

The sixth alternative mitigation is a routine socialization of Covid-19 symptoms to employees and workers with a weight value of 0.129. The mitigation alternative can be held every day (daily), weekly, or during monthly coordination meetings, so employees and workers indirectly always remember how important to prevent the Covid-19 virus transmission.

The seventh alternative mitigation for criterion variable according to K3 budget is to make a collaboration activities in handling employees and workers suspected of Covid-19 with the local hospitals and health centers by a weight value of 0.127. Under this collaboration, it requires funds to accommodate mobility, equipment, medicines from hospital or health centers to the project site also payment for hospital operational bills for the preventive measures and monitoring the employees and workers.

Table 11. Weights of alternative mitigation criterion variable according to ministry of health standards

Mitigation	Weight	Rank
Collaboration in handling employees and workers who are suspect of Covid-19 with the local hospital and health centers	0,188	1
Availability of medical health devices for employees and workers	0,162	2
Creating task force for Covid-19 prevention	0,157	3
Close location of swab test (PCR and Antigen) and fast to reach	0,130	4
A routine socialization of Covid-19 symptoms to the employees and workers	0,129	5
Installation of educational media for Covid-19 pandemic at the project site	0,129	6
Presence/availability of medical personnel at project site	0,105	7

Source: The calculation result, 2022

From the result calculation of further mitigation alternatives, table 11 explains the variable of prevention criteria according to standards established by Ministry of Health and getting mitigation that reached the highest value weight is variable of creating collaboration in handling employees and workers (who are suspected Covid-19) with local hospitals and health centers with a weight value of 0.188. This alternative mitigation has the highest weight value because according to some respondents, to make a collaboration work with hospital/health center is a preventive mitigation that easy to implement because the preventive mitigation can have direct directions from the local hospital or health centers.

The second alternative for mitigation is the availability of medical examination tools for employees and workers with a weight value of 0.162. The medical devices during Covid-19 pandemic are urgently needed as an early detection equipment for employees and workers once they enter the project area. With a complete inspection equipment, it is expected for those who get infected by Covid-19 can be identified immediately and isolated from other workers and employees. A mandatory inspection equipment that must be available in the project area is a body temperature measuring device (Thermogun), an oxygen measuring device (pulse oximeter), and a blood pressure measuring device (sphygmomanometer).

The third alternative for mitigation with weight value of 0.157 for calculation of prevention criteria according to standards from Indonesia Ministry of Health belongs to the alternative mitigation to create a Covid-19 prevention task force, with the formation of the task force will be able to control activities and mobility of employees and workers to oblige the directions when in the project area, as well as to become a prevention facilitator according to the standards released by Ministry of Republic Indonesia, as well as a means for implementing instructions from Minister of Public Work and Public Housing No:02/IN/M/2020 regarding the protocol of preventing the Corona Virus Disease 2019 (Covid-19) spreading in the area of construction services implementation.

The fourth alternative for mitigation with weight value of 0.130 is the location of Swab test (PCR and Antigen swab) which located in close and fast area to reach. It is closely related to standardized examinations to establish a Covid-19 diagnosis according to the Covid-19 management guidelines which published by the Ministry of Health and internationally has reached an agreement upon by WHO.

The fifth alternative for mitigation for the prevention criteria variable according to Ministry of Health standards in project scope is the routine socialization of Covid-19 symptoms to employees and workers by weight value of 0.129. By conducting socialization in routine way, workers and employees will pay attention to each other's health conditions, both for themselves and for other workers and employees as well.

The sixth alternative for mitigation with a weight value of 0.129 is the installation of Covid-19 educational media at the project site. The installation of educational media, both in digital or physical media is very necessary as a means of knowledge and information about Covid-19 for project workers and employees.

The seventh alternative for mitigation, for the variable prevention criteria according to Ministry of Health standards with a weight value of 0.105 is the availability of medical personnel at the project site. The presence of medical officers under instruction of Minister of Public works and Public Housing No:02/IN/M/2020 regarding the protocol for preventing the Covid-19 spreading in the implementation of construction services, will help maximize early detection and treatment for workers and employees who get infected by Covid-19. However, in practice, bringing medical personnel to the project site are not easy when considering needs of medical personnel in health facilities during pandemic time are also very high. Therefore, despite the regulation states the Covid-19 task force and medical officers are obliged to provide information and handle those who are infected, this duty was difficult to implement in the work area.

Table 12. Weights of alternative mitigation criterion variable according to project schedule

Mitigation	Weight	Rank
Presence/availability of medical personnel at project site	0,181	1
Close location of swab test (PCR and Antigen) and fast to reach	0,174	2
Creating task force for Covid-19 prevention	0,155	3
A routine socialization of Covid-19 symptoms to the employees and workers	0,138	4
Availability of medical health devices for employees and workers	0,120	5
Collaboration in handling employees and workers who are suspect of Covid-19 with the local hospital and health centers	0,129	6
Installation of educational media for Covid-19 pandemic at the project site	0,086	7

Source: The calculation result, 2022

The result of data processing of respondent's questionnaire for the prevention criteria variable according to the project schedule with the highest weight value of 0.181 is the alternative to the mitigation of the availability of medical officers at the project site. With the medical personnel presence on site, it is expected to accelerate mitigation in health protocol application. The experience and knowledge of existing medical officers can maximize the facilities and infrastructure for preventing the Covid-19 spreading at the project site. Although the funding allocation for bringing medical personnel to the project site is quite large, this action becomes very supportive to the project activities completion in a timely manner.

The second mitigation alternative is the swab test location (PCR and antigen swab) is close and fast with a weight value of 0.174. The availability of nearby swab test location certainly speeds up diagnosis of workers or employees who contracted with Covid-19. If the infected people can be identified fast, they can immediately quarantine and separated from the other workers or employees so the work project can be continued as it should. It is aligned with findings in this study that the risk with the highest RPN value is the undetected Covid-19 transmission on the project site. When access to inspection becomes easy and near, then the risk able to be mitigated.

The third mitigation alternative in this criterion is forming a Covid-19 task force with a weight value of 0.155. The task force is expected to be able to work synergistically with management division in tacking Covid-19 on the project site. With the presence of Covid-19 task force, any workload related to prevention cab be distributed equally to each member of the task force so the management division, workers and employees can focus on completing projects according to the predetermined schedule.

The fourth mitigation alternative is the routine socialization of Covid-19 symptoms to all employees and workers. This mitigation alternative has a weight value of 0.138. A routine socialization of Covid-19 symptoms through safety morning talks and coordination meetings can increase the knowledge and sensitivity of workers and employees towards colleagues who show signs and symptoms of Covid-19. This alternative is expected to reduce Covid-19 transmission and shorten the management time in making decision whether the workers or employees needs to be quarantined or not.

The fifth mitigation alternative is the availability of medical examination tools for employees and workers. Health check tools such as body temperature measuring devices (Thermogun), oxygen measuring device (pulse oximeters), and blood pressure measuring device (sphygmomanometers) are vital health devices that must be available at the project site during the Covid-19 pandemic time. These medical devices can be used for conducting initial screening of all employees and workers who enter the project area every day. If an employee or worker is found showing signs and symptoms to Covid-19, the individual can be quarantined first so the ongoing projects continue to run smoothly according to the predetermined schedule.

The sixth mitigation alternative with a weight value of 0.219 is to make collaboration in handling employees and workers suspected of Covid-19 with local hospitals and health centers. With the collaboration, it is expected that it can accelerate the handling of workers and employees who have been infected with Covid-19 by providing a place for self-quarantine both in hospitals and health centers which had been reaching agreements to cooperate with service provider, so as not infect other workers and employees, then the worker productivity does not decrease and they able to complete the project on time.

The seventh mitigation alternative with the lowest weight value of 0.086 for prevention variable according to the project schedule is the installation of Covid-19 educational media at the project site. Installation of educational media such as banners, signboards, and posters are a risk mitigation tool for knowledge about the dangers of Covid-19 spreading to project workers and employees. The educational media indirectly took important role in term of giving knowledge about actions that must be taken as mitigation efforts also informing the flow of handling workers and employees who have been infected with Covid-19 virus.

V. CONCLUSION

1. The identification of the dominant risk in the double track railway construction project found 3 (three) dominant activities which consisting of 25 (twenty-five) risk variables. (a) The highest variable K3 system activity is found in the lack of standard equipment for preventing Covid-19 transmission in accordance with SOP, by a weight value in RPN scale of 60 % (b) In employees and workers management activities, the highest variable is undetected Covid-19 transmission with a weight value in RPN scale of 75% (c) In the work method, the highest variable is no physical distancing between workers and working in over shifts with both activities gained a weight value in RPN scale of 27%.

2. From the weighted value of RPN, it is visible that biggest risk of Covid-19 transmission in the scope of construction project of Southern Java Double Track Railway at KM 43+800 to 49+500 Mojokerto-Sepanjang, Surabaya-Solo route is undetected Covid-19 transmission with the RPN value of 75 %.

3. From the highest risk variable, an alternative to the mitigation of Covid-19 transmission is obtained by making calculation with Analytical Hierarchy Process (AHP) method, then, in this study found 3 (three) criteria with 7 (seven) risk mitigations. These three criteria are conforming the K3 budget costs, whereas the prevention activity is according to the standard issued by The Indonesia Ministry of Health, and the prevention activity is in accordance to the project schedule. From calculation for each criterion, it found that the mitigation alternative with the highest weight value was the near location of the Swab test (PCR

and antigen swab) and the collaboration act for handling employees and workers with suspected Covid-19 with the local hospitals, health centers, and medical staff at the project site.

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