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ANALYSIS OF OCCUPATIONAL SAFETY AND HEALTH (K3) RISK IN THE CONSTRUCTION OF SAMPANG SOUTH RING ROAD (JLS) USING HAZID HIRA AND HAZOP METHODS

Hazin Mukti[1], **Fairus Zabadi**[2]

[1,2]Civil Engineering, University of Madura, Pamekasan, 69371, Indonesia

e-mail: hazinmukti@unira.ac.id

ABSTRACT

Occupational Health and Safety (K3) is all engineering activities to support construction work in realizing the fulfillment of security, safety, health, and sustainability standards that ensure construction engineering safety, workforce safety and health, public safety, and environmental safety. This research was conducted to determine the risks of work accidents, identify technical implementation risk factors, and determine responses to the most dominant risks. The method used is HIRA, HAZID, and HAZOP. In HIRA, 4 dominant risk variables may occur during the construction of the South Ring Road (JLS) Sampang, namely: (X4.4), (X5.3), (X6.1), and (X6.2). To determine whether or not the variable data used to use the HAZID method is to use a preliminary questionnaire which is distributed before the main questionnaire. the correlation value of each variable is obtained or it is called the r count, then the r count can be compared with r table. To determine the risk response and recommendations that may occur using the HAZOP method is to use literature studies from previous journals as well as occupational safety and health standards. Thus, 19 recommendations for controlling the 4 dominant risks that may occur in the South Ring Road (JLS) Sampang project are obtained.

Keywords: *Occupational Safety and Health (K3), HAZID Method, HIRA Method, and HAZOP Method*

1. Introduction

Infrastructure development is an important aspect that influences economic growth and social activities. This is because infrastructure has a major impact on national development and people's welfare such as transportation, sanitation and energy. Infrastructure development or construction is included in activities that have a high level of risk. The construction of the South Ring Road (JLS) for Sampang was built with a length of 6.4 km, starting at Jalan Makboel and ending at Jalan Pangongsean, Torjun Sampang District. The construction of the South Ring Road (JLS) in Sampang has carried out land clearing and construction work under the bridge as well as road paving. The work will be completed within one year through several project phases that have been planned, starting on 16 December 2021 and ending on 21 December 2022. The construction of the South Ring Road (JLS) for Sampang is to reduce the road load that enters the heart of the city.

Based on the Regulation of the Minister of Public Works Number: 05/PRT/M/2014 in Chapter 1 Article 1 Construction Occupational Health and Safety Management System in the Public Works Sector, hereinafter abbreviated to SMK3 Construction in the Public Works Sector, is part of the organizational management system for carrying out construction work in the context of controlling K3 risks on every construction work in the Public Works sector. Occupational Safety and Health (K3) are all engineering activities to support construction work in realizing the fulfillment of

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security, safety, health, and sustainability standards that guarantee construction engineering safety, workforce safety and health, public safety, and environmental safety (PUPR Ministerial Decree No. 10 of the Year 2021). Therefore, every project must have structured, collective, and proactive management to minimize the occurrence of work accidents, so that the project can achieve success without risks that could disrupt the smooth running of a construction project.

The increasing construction of road-supporting facilities, will, of course, have an impact on the work process. Therefore, it is necessary to identify risks and impacts that could occur in construction work. In this research, the Sampang South Ring Road (JLS) Project was chosen because it was categorized as a project with high risk. Given the problems of work accident risks, implementation of technical risk factors, and responses to the most dominant risks, risk analysis is needed to prevent work accidents that might occur on the project., risk analysis is needed to prevent work accidents that might occur on the project.

Analysis of aspects of work accidents in this research uses the HIRA (Hazard Identification and Risk Assessment), HAZOP (Hazard Analysis and Operational Study), and HAZID (Hazard Identification) methods. The HIRA method is used to provide an assessment of risks and the level of possibility of occurrence, HAZID is used to provide identification of risks that may occur, while HAZOP is used to analyze deviations, causes, and impacts, and provide proposed corrective actions.

2. Material and Methods

This research will focus on the identification and analysis of risks to the project. What this research wants to achieve is the identification of risks that may occur and risk analysis using the Hazard Identification and Risk Assessment (HIRA), Hazard Identification (HAZID), and Hazard Operability (HAZOP) methods. This research starts at Jalan Makboel and ends at Jalan Pangongsean, Torjun Sampang District. The object of this research is the Development of the South Ring Road (JLS) of Sampang.

2.1. Data Collection Techniques

The data in this study were obtained by distributing questionnaires to several respondents consisting of workers and project employees. The data needed in this study are as follows:

1. Primary Data
   In this study, primary data was obtained from the results of distributing questionnaires to several workers and employees on the project. The primary data in this study is in the form of a questionnaire
2. Secondary Data
   The secondary data used in this study came from previous reference studies and data obtained from the HSE (Health, Safety, and Environmental) division. Secondary data needed in this study are:
   a. Planning Drawings
   b. Job Safety Analysis
   c. Respondent Profile

2.2. Population and Sample

Population is a generalized area consisting of objects and subjects that have certain qualities and characteristics. Based on the definition of population, the population in this study are all workers and staff of PT. AKL-DPK-KSO (PT. Asri Karya Lestari-Dua Putri Kedaton-Cooperation Operations) totaling 105 people who are carrying out the Sampang South Ring Road (JLS) construction project. So that the sample size taken can be representative, it is calculated using the Slovin formula.

The Slovin formula is a formula or formula for calculating the minimum sample size when the behavior of a population is not known with certainty. Where n is the minimum number of samples, the value of N is the population and the value of e is the error margin. The minimum sample size can be determined based on the level of error or margin of error. With a 95% degree of confidence,

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the researcher determines the minimum sample limit that can meet the 5% margin of error by entering the margin of error into the Slovin formula.

2.3. Data Analysis

Data analysis is the activity of grouping data based on variables and types of respondents, tabulating data based on variables from all respondents, presenting data for each variable studied, and carrying out calculations to test the hypotheses that have been proposed. Data processing and analysis in this research were carried out using the SPSS version 25 program. The data will be presented in tabular form to make it easier to understand.

1. Validity Test

Shows the degree of accuracy between the data that occurs on the object and the data collected by the researcher. This validity test is carried out to measure whether the data obtained after the research is valid data or not, using the measuring instrument used (questionnaire).

For the testing of the variables used in this research to be truly legal or valid, a statistical aid program was used. The validation process will use Bivariate Pearson correlation (Pearson Moment Product). This analysis is calculated by correlating each item score with the total score obtained.

$$r = \frac{n(\sum XY) - (\sum X \sum Y)}{\sqrt{n\sum x^2 - (\sum x)^2 (n\sum Y^2 - (\sum Y)^2)}} \quad (1)$$

With:

r = Correlation Coefficient
X = Question Score
Y = Total Score
N = Number of Samples

2. Reliability Test

Reliability is a tool for measuring a questionnaire which is an indicator of a variable or construct. A questionnaire is said to be reliable or reliable if a person's answers to statements are consistent or stable over time.

Reliability Test is used to measure the consistency of measurement results from the questionnaire in repeated use. Respondent's answers to questions are said to be reliable if each question is answered consistently or if the answers cannot be random.

Reliability testing in this research uses statistical support programs. Testing the reliability of the instrument uses the Alpha Cronbach formula because this research instrument is in the form of a questionnaire and a multilevel scale.

$$r = \left[\frac{k}{(k-1)}\right]\left[1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right] \quad 2)$$

With:

r = Reliability Value
$\sum \sigma b^2$ = Total Score Variance for Each Question Item
Σt^2 = Total Variance
K = Number of Question Items

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2.4. Research Flow Diagram

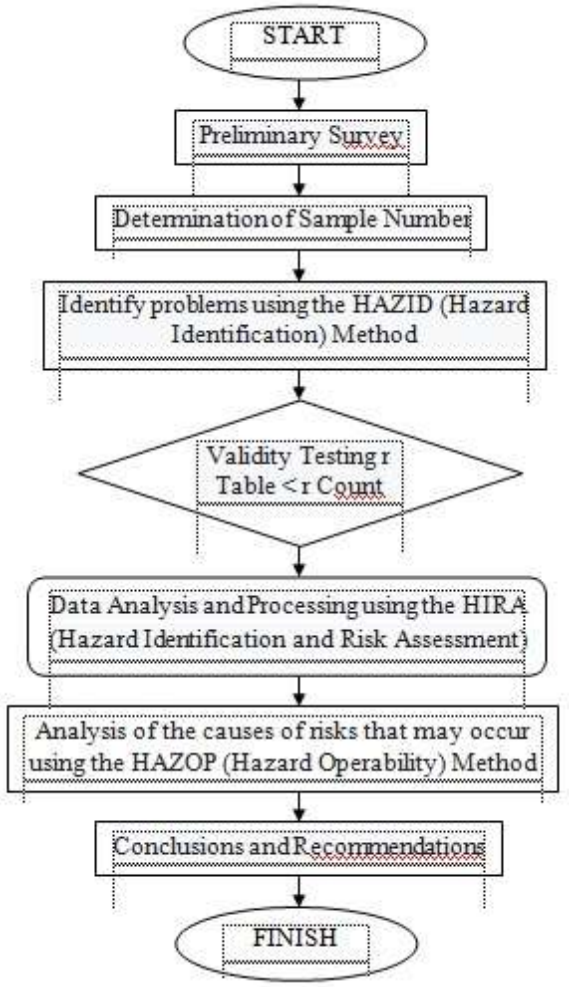

Figure 1. Research Flowchart

3. Result and Discussion

3.1. Risk

A risk is an event that has the potential to affect the project negatively as a result of uncertainty. Risk is associated with the possibility or probability of events occurring beyond those expected. Future events cannot be known with certainty [3]. This event or an output from an activity or event can be in the form of good conditions or bad conditions. If what happens is a good condition then it is an opportunity, but if something bad happens then it is a risk [9].

Risk is the uncertainty of outcome as a result of a decision or current situation. Risk is a quantity measure or empirical measure that can measure the possible value of an event with its fluctuations. Risk has supporting data (knowledge) regarding possible events [5].

Based on the understanding of risk from several theories and experts, it is necessary to use methods to assess and measure uncertainty regarding events that may hurt the achievement of organizational goals [1].

3.2. Risk Management

Risk management is an organized approach to finding potential risks to reduce the occurrence of unexpected things. Risk management must be carried out as early as possible, supported by this

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information. The process is a preventive action where the real condition of the business can become clear before it is too late and bigger failures can be avoided [7].

In the real world, dynamic changes always occur, so there is always uncertainty. Risk arises because of uncertainty, and risk will have unfavorable consequences. If this risk befalls a project, the project could experience significant losses. In some situations, these risks can result in the abandonment of the project. Therefore risk is important to manage. Risk management aims to manage risks so that the project can survive, or perhaps optimize risks [6].

Risk management is a structured and systematic process of identifying, measuring, mapping, and developing alternative risk management, the implementation of this risk management helps companies identify risks from the start and helps make decisions to overcome these risks [7].

In this way, through risk management, the appropriate method will be known to avoid/reduce the magnitude of losses suffered due to risk. Directly, good risk management can avoid as much as possible the costs that must be incurred due to the occurrence of a detrimental event and support increased business profits [6].

3.3. Risk Identification

Risk identification is a step to recognize or answer the questions of what risks can occur, and how and why they can occur. The purpose of risk identification is to collect as many sources of danger and risky activities as possible that could disrupt the organization's goals, objectives, and achievements [3].

Several things that must be done in identifying hazards include:

1. Compile a comprehensive risk list of events that could impact each element of the activity.
2. Recording the factors that influence existing risks in detail to describe the processes that occur.
3. Develop a scenario for the process of events that will give rise to risks based on information describing the results of problem/hazard identification.

These things can provide an overview of the consequences and probability of existing risks. Consequences and probability are variables that are needed in determining the level or level of risk.

3.4. Occupational Safety and Health Management (K3)

Occupational health and safety management is part of the overall management system which includes organizational structure, planning, responsibilities, execution or implementation, procedures, processes and resources needed in its development and implementation, study of achievement and maintenance of health policies and work safety to control risks related to work activities, use of tools, creating a safe and comfortable, productive and efficient workplace [12].

Occupational Safety and Health or what is usually called K3 above, are all general definitions that are often used rather than other definitions [16]. The word safety comes from the English word 'safety' which is always associated or associated with being free or safe from an accident. From the word safety itself, free from accidents. Meanwhile, the verb is taken from English, namely 'work', which means activities carried out by someone who gets results [10].

From the choice of syllables above, it can be concluded that occupational safety is a science that studies methods that can ensure that workers are free from accidents when they are carrying out a project or job. The characteristics of work safety have the potential to cause disruption or defects during the process and equipment damage [15]. Occupational Health can also be explained like occupational safety which was explained previously. Health is taken from English which means means not only freedom from accidents or disease, but healthy here means being healthy physically, mentally, and socially healthy [13]. Occupational Health is a part of K3 which aims to ensure that a person is always safe, healthy, and has strong competitiveness in this way, work can run smoothly and no accidents occur while doing work or workers get sick which makes them unproductive. Occupational accidents are minimized by occupational safety efforts, while occupational health can be maintained and improved by occupational health [11].

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3.5. Work Accidents

A work accident is an undesirable and unexpected event that can cause human and property casualties. Work accidents are work-related events that can cause injury or illness (depending on the severity), death, or events that can cause death [14].

A work accident is an event or incident that is unexpected or unexpected and results in loss of time, costs, or property as well as loss of life in the work process.

Thus, work accidents contain the following elements:

a. It was not initially expected, because behind the accident there was no element of intent or planning
b. It is not desired or expected, because every accident will always be accompanied by physical and mental losses
c. It always causes loss and damage, which will at least cause work process disruption.

3.6. HIRA (Hazard Identification and Risk Assessment)

Hira (Hazard Identification and Risk Assessment) is a method or technique for identifying potential work hazards by defining the characteristics of hazards that may occur and evaluating risks based on risk assessments using a risk assessment matrix [8].

There are three important elements in risk assessment, namely the level of frequency, the level of exposure (Severity/Consequences), and probability (Probability).

Table 1. Classification of Possible Hazard Levels

LIKEHOOD (L)	DESCRIPTION	LEVELS
Almost Certain	This can happen at any time	5
Likely	Often	4
Possible	May happen occasionally	3
Unlikely	Seldom	2
Rare	Rarely, very rarely happens	1

Table 2. Hazard Severity Classification

SEVERITY (S)	DESCRIPTION	LEVELS
Catastrophic	Fatal > 1 person, very large losses and very wide impact, cessation of all activities	5
Maior	Serious injury > 1 person, major losses, production disruption	4
Moderate	Moderate injury, requires medical treatment, large financial losses	3
Minor	Minor injury, moderate financial loss	2
Insignifacnt	No injuries occurred, little financial loss	1

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Table 3. Risk Rating

	Severity (S)				
Likehood (L)	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

Information :
Red = Tall
Yellow = Currently
Green = Low

Table 4. Risk Control Classification

RISK	DESCRIPTION	ACTION
13-25	HIGH	High risks require immediate action to control the hazards included in the control hierarchy. Actions taken should be documented in the risk assessment form including completion date.
5-12	MEDIUM	Moderate risks require a planned approach to controlling the hazard and implementing temporary measures if necessary. Actions taken should be documented in the risk assessment form including completion date.
1-4	LOW	Risks identified as low may be considered acceptable and subsequent reductions may not be necessary. However, if risks can be resolved quickly and efficiently control measures must be implemented and recorded.

3.7. HAZID (Hazard Identification)

HAZID is a hazard identification technique that is similar to using analysis and opinion expression techniques, but this method is designed to be used at a much earlier stage in risk identification in a project. When carrying out the HAZID methodology several terms need to be understood, namely [2]:

a. Hazards Is a potential source of harm. Deviations from design and operational objectives may result in the emergence of potential hazards, besides that hazards can have several types of harm.
b. Harm Is physical injury or damage to a person's health or damage to property or the environment. Harm is a consequence of hazard and harm has various forms such as user safety, employee safety, regulatory risk, environmental risk and so on.
c. Risk It is a combination of the possibilities for a hazard to occur and the consequences of that hazard.

The HAZID method is a systematic analysis to identify risks that will occur critically so that the potential dangers that exist and the consequences that arise as a whole can be known. There are parameters in the HAZID method to take into account the effects of hazards and the frequency of hazards [4].

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Table 5. Parameters for Calculating Hazardous Effects in HAZID

PARAMETER	MINOR	MAJOR	SEVERE
Human Resources	No accidents	Accidents are not fatal	Fatal accident
Asset	Losses are lower than US$ 100,000	Losses between US$ 100,000 to 1,000,000	Losses of more than US$ 1,000,000
Environment	No environmental damage	Minor damage to the environment	Huge damage to the environment

Table 6. Hazard Frequency Parameters in HAZID

	MOST	LIKELY	UNLIKELY
Hazard Frequency	More than 10 times in 10 years	Between 1 to 10 times in 10 years	Less than 1 time in 10 years

3.8. HAZOP (Hazard Operability)

A hazard is a physical condition that has the potential to cause harm, or accidents to humans and/or damage to equipment, the environment, or buildings. Operability Studies are several parts of operational conditions that already exist and are designed but can give rise to a series of incidents that can be detrimental to the company [4].

The purpose of using the HAZOP method is to systematically review a process in a system to determine whether process deviations can lead to undesirable events or accidents. Systematically identify every possible deviation from predetermined operating conditions, look for various causal factors that allow deviant conditions to arise, determine adverse consequences as a result of deviations and provide recommendations or actions that can be taken to reduce the impact of potential risks that have been identified [2].

In the HAZOP method, some terms are often used to simplify its implementation, including:

1. Process is taking place or where is the location where the process is taking place.
2. Source of danger (hazards) found in the field.
3. Deviation (Deviation) What things have the potential to cause risks
4. Cause a big possibility that will cause deviation.
5. The consequences of deviations that must be accepted by the system.
6. Actions are divided into 2 groups, namely actions that reduce or eliminate consequences (consequences). As for what is decided first, this is not always possible, especially when dealing with equipment damage. However, initially, it is always attempted to eliminate the causes and only where necessary reduce the consequences.
7. Severity This is the level of severity that is expected to occur.
8. Likelihood It is a possible consequence of the existing security system.
9. Risk is the risk value obtained from a combination of possibilities
10. Likelihood and severity The HAZOP process is based on the principle that a group approach to hazard analysis will identify more problems than individuals working separately and then combining the results.

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Table 7. Terms in HAZOP Implementation

VOCABULARY	EXPLANATION
METHOD	The part of the process that is determined as the object of analysis
DESIGN INTEND	Functions, systems, parameters and quantities have been determined so that the process runs smoothly
GUIDE WORD	Words used to help direct the discussion when reviewing a process parameter/when identifying risks
PARAMETER	Reference/measure of the process under review
DEVIATION	Deviation
CAUSE	Reasons put forward as to why deviations may occur
CONSEQUENCE	The consequences that result if deviations occur
SAFEGUARD	Instruments for control purposes
HAZARD CATEGORY	Risk value/weight
RECOMMENDATION	Operation procedure

4. Conclusions

This study used HIRA, HAZID, and HAZOP methods. In HIRA, 4 dominant risk variables may occur during the construction of the South Ring Road (JLS) Sampang, namely: (X4.4), (X5.3), (X6.1), and (X6.2). To determine whether or not the data variables used using the HAZID method are valid, use a preliminary questionnaire which is distributed first before the main questionnaire. The respondents' answers were then processed using the help of SPSS version 25, after that the correlation value for each variable was obtained or called r calculation, and then the calculated r could be compared with the r table, where the results of the r table were determined by the number of respondents, namely 30 respondents. , then if the correlation value or calculated r is greater than the table r value then the variable can be declared valid, but if the calculated r is smaller than table r then the variable is declared invalid, so the invalid variable will not be included in the questionnaire main.

To determine risk responses and recommendations that may occur in the implementation of the Sampang South Ring Road (JLS) construction project using the HAZOP method, use literature studies from previous journals and also occupational safety and health standards. So, 19 control recommendations were obtained for 4 dominant risks that might occur on the Sampang South Ring Road (JLS) project which include: checking work methods, personal protective equipment (PPE), work protective equipment (APK) and equipment to be used. Conduct briefings and directions on work to follow predetermined work SOPs. Provide direct supervision and provide warnings if violations of work SOPs occur.

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