RISK MANAGEMENT OF OSH IN BALOI PERMAI COMMUNITY HEALTH CENTRE CONSTRUCTION PROJECT WITH THE HIRA (HAZARD IDENTIFICATION AND RISK ASSESSMENT) APPROACH

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AUTHENTICITY STATEMENT

In the name of Allah, I hereby certify that this research is based on my own work except for citations and summaries in which of those is explicit knowledge. If in the future, this statement is proved not right and violates the legal regulation of papers and intellectual property rights, I agree Universitas Islam Indonesia revoke my bachelor certificate.

Yogyakarta, June 2021

Moch Agung Ferdana

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DEDICATION PAGE

Alhamdulillahirabbil'alamin

I dedicate this undergraduate thesis to my parents, because of their support, I can go this far.

As well as Mr. Winda Nur Cahyo as the supervisor who has been willing to spend his time and provide meaningful guidance in the process of preparing this Undergraduate Thesis.

May Allah always provide sustenance and protection to all of us.

MOTTO

[55] Ar-Rahman: 13

فَبِأَيِّ آلَاءِ رَبِّكُمَا تُكَذِّبَانِ

So which of the favours of your Lord would you deny?

"Happiness Equals Reality Minus Expectations"

Tom Magliozzi

"I must be able to speak more than two languages."

Moch Agung Perdana

知らぬが仏

Shiranu ga hotoke

Ignorance is a Bliss

PREFACE

Assalamu'alaikum Warrahmatullahi Wabarakatuh,

Alhamdu lillahi rabbil 'alamin, all praise and gratitude for the presence of Allah SWT, who has bestowed His grace and guidance, so that the researcher can complete this undergraduate thesis with the title "**RISK MANAGEMENT OF OSH IN BALOI PERMAI COMMUNITY HEALTH CENTRE CONSTRUCTION PROJECT WITH THE HIRA (HAZARD IDENTIFICATION AND RISK ASSESSMENT) APPROACH**". In completing this Undergraduate Thesis, the researcher realized that it could not be separated from many parties' help. That is why researchers want to deliver the special thanks to:

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Yogyakarta, June 2021

Moch Agung Perdana

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INTRODUCTION

1.1. Background

Work accidents are defined as unexpected, unplanned, and incidental events that occur in the workplace and can result in injury, illness, and even death. This incident can cause harm to humans, goods, and the environment. Because of this, work accidents are things that need to be watched out for in a company. In Indonesia in 2019, there were 77,295 cases of work accidents recorded (BPJS, 2019).

The construction services sector is one of the many business fields classified as highly accident-prone. Factors that cause work accidents in a construction project, among others, are the behaviour factors of construction workers who tend to disregard the provisions of work safety standards, inaccurate selection of work methods, changes in workplaces, equipment used, and the lack of discipline of workers in complying with the provisions concerning OSH which regulates the use of personal protective equipment (Ervianto, 2005). From the factors that cause work accidents, it is shown that work accidents are generally caused by human error, both in terms of the competence of construction implementers and understanding the importance of implementing OSH, this is also supported by there are still many construction workers who do not heed provisions such as not wearing a safety helmet, proper footwear (boot), belts, safety glasses, and so on while working.

To protect workers from work accidents, it is necessary to promote Occupational Safety and Health. Deaths in construction projects in developing countries are three times

higher than in developed countries due to weak law enforcement (King & Hudson, 1985). A high degree of safety and health in the workplace is a worker's right that the Company must fulfil in addition to other normative rights. Companies should be aware and understand that workers are not a resource that is continuously being used but as social beings that must be maintained and considered being exposed by many factors and risks of hazard that existed at the workplace.

The implementation of Occupational Safety and Health (OSH) in Indonesia, especially in the implementation of construction projects, specifically for construction workers, still needs to be improved since OSH implementation in this field is considered as less optimal, apart from being caused by human error as mentioned above. The implementation of OSH is also influenced by the availability of tools and the application of the principle of OSH tools appropriateness for construction workers.

One way to reduce the impact of work accidents' risk is to use the Hazard Identification and Risk Assessment (HIRA) method, which is a method that analyzes and identifies risks based on existing work activities. By applying the Hazard Identification and Risk Assessment method, it is hoped that efforts can be made to prevent and reduce the occurrence of work accidents in the company, to avoid and manage these risks in an appropriate manner.

Based on the explanation, the researcher wants to conduct a research entitled "RISK MANAGEMENT OF OSH IN BALOI PERMAI COMMUNITY HEALTH CENTRE CONSTRUCTION PROJECT WITH THE HIRA (HAZARD IDENTIFICATION AND RISK ASSESSMENT) APPROACH", in which this research was taken place at the Baloi Permai Community Health Center, Batam.

1.2. Problem Formulation

Based on the background above, problems that arise can be identified. The formulation of the problem to be discussed in this research are:

1. What is the highest risk identified at the Community Health Centre that related to construction project?

2. What is the strategy to mitigate the risk?

1.3. Objective

The objectives of this study are:

1. To determine the highest risk in the project using the HIRA method.
2. To identify the risk mitigation strategy.

1.4. Problem Limitation

To avoid the spread of the topic in this study, it is necessary to set boundaries to make it more targeted. Therefore, the limitations in this study are:

1. This research was only conducted in the construction project of Baloi Permai Community Health Centre, Batam.
2. The Risk Management method used in this study is Hazard Identification and Risk Assessment (HIRA).
3. The project period is set from July 6th 2020 – December 18th 2020.

1.5. Research Advantages

The advantages obtained from this research are:

1. The research results can be useful as input for the company/contractor to improve the Occupational Safety and Health system in future projects to minimize the probability of work accidents that may occur.
2. As a reference for future researchers, especially those related to Occupational Safety and Health (OSH) in construction projects using the Hazard Identification and Risk Assessment (HIRA) method.

1.6. Systematic Writing

This undergraduate thesis adopts the writing systematics under the format below:

CHAPTER I INTRODUCTION

This chapter contains a preliminary description of research activities, a background of the problem, formulation of the problem, the objectives to be achieved, also the advantages of research and systematic writing.

CHAPTER II THEORETICAL REVIEW

This chapter explores the theories of reference books, journals and the findings of previous research on the problem of research used as a reference for problem-solving.

CHAPTER III RESEARCH METHODOLOGY

This chapter contains the research object to be studied, the methods used in the study, also the research framework, and its description.

CHAPTER IV DATA COLLECTION AND PROCESSING

This chapter contains the data obtained during the research and how to analyze it. Data processing includes an analysis of the results. This chapter also provides a reference for the discussion of the results to be written in Chapter V.

CHAPTER V DISCUSSION

This chapter contains a discussion on the results of data processing that has been obtained, the suitability of the research objectives to make the recommendation.

CHAPTER VI CONCLUSIONS AND RECOMMENDATIONS

This chapter contains the conclusions of the analysis and any recommendations or suggestions based on the results identified during the research.

REFERENCES

APPENDIX

CHAPTER II

LITERATURE REVIEW

2.1. Inductive Study

The first research was conducted by Restuputri & Sari (2015) entitled "Analisis Kecelakan Kerja dengan Menggunakan Metode Hazard and Operability Study (HAZOP) ". The workers at the production area in PT Mayatama Sentosa is treated as subjects while the Production Area in PT Mayatama Manunggala Sentosa is employed as research objects. Using the Hazard and Operability Study (HAZOP) method, the researchers found the potential threat and hazards posed by the glass-making process area. It is necessary to have standard operating procedures for occupational safety and health.

The second research was conducted by Wardhana (2015) entitled “Analisis Risiko Keselamatan dan Kesehatan Kerja (K3) dengan Metode Hazard Analysis”. by using Hazard Identification and Risk Assessment (HIRA), Hazard Analysis and Operability Study (HAZOP) on the Marvell City Surabaya Building Construction Project. The results identified the risk of work accidents that can occur in the Marvell City Apartment project. There are fifty-eight risks classified based on resources, including work method risks, human risks, financial risks, and material risks.

The third research was conducted by Smallwood with the title of “Optimising the Element of a Construction Health and Safety (H&S) Programme and Audit System” performed in 2015. The research was conducted at Master Builders Africa (MBSA) with workers as subjects. By using the Hazard Identification and Risk Assessment (HIRA) method and Likert Scale. The results obtained from eleven aspects of the H&S Program

then were submitted to respondents to achieve optimal health. The highest-ranking includes hazard identification and risk assessment, and risk management.

Fourth research was conducted by Mechhoud et al. in 2016 entitled "A New Tool for Risk Analysis and Assessment in Petrochemical Plant" by employing the Hazard and Operability Study (HAZOP), Failure Mode, Effect and Criticality Analysis (FMEA) method,and the interaction between workers and machines as subjects. The analysis produces various operating parameter deviations from each system in the Company. The possibility in which this deviation may occur is considered as the impact and preventive action can be identified. The result is risk minimization and system improvement.

Fifth research was conducted by Zhi-qiang & Ya-mei entitled "Research on Risk Assessment Technology of the Major Hazard in Harbour Engineering". Using Preliminary Hazard Analysis (PHA), Hazard and Operability Study (HAZOP) on the BeiGangchi construction project at Beijing Port. The analysis proposes a procedure for assessing the main hazards in port engineering as well as a standard for assessing the consequences and likelihood of accidents. In addition, a further method emerged with the classification method of the risk level of the main hazards in the field of ashtray techniques.

The Sixth research was conducted by Sholihah (2018), with the title of "Implementasi Sistem Manajemen Keselamatan dan Kesehatan Kerja (SMK3) pada Konstruksi Jalan Sebagai Upaya Pencegahan Kecelakaan Kerja". This research aims to determine the Occupational Safety and Health Management System implementation in the Access Road Development Project to the Trisakti-Liang Anggang Port. In this project, there is a mismatch in understanding of occupational safety and health (OSH) knowledge, with the existence of workers who unaware of the impact of unsafe acts, workers who work unsafe despite of their knowledge on how to work safely, and workers who are aware of themselves. The workers are considered as competent enough yet the direction and guidance are still required. After conducting an assessment on the implementation of the Occupational Safety and Health Management System for the Access Road Development Project towards Trisakti-Liang Anggang Port, the results were obtained for 88.295%. Meanwhile, for the assessment of the completeness of K3 facilities, the result was calculated as 81.2%.

2.2. Deductive Study

2.2.1. Risk

The concept of risk is used as an expected value, probability distribution, uncertainty, and event (Aven & Renn, 2019). Risk can also be interpreted as a combination of probability and severity of damage or loss (Ridley, 2008).

Some definitions of risk are defined as follows (Darmawi, 2004):

1. Risk is a risk is chance of loss, which is used to indicate a situation where there is an openness to loss or a possible loss.
2. Risk of the possibility of loss, which is the probability of an event between zero and one.
3. Risk is uncertainty, meaning that risk is related to uncertainty.

Risks can be distinguished in the opinion of several experts. Among them are (Charette, 1989):

1. Known Risk

   Is a risk that can be disclosed after careful evaluation of the project plan, business and technical environment in which the project is being developed, as well as other reliable sources of information such as unrealistic delivery dates, lack of documented requirements, lack of scope and developer environment. the bad one.
2. Forecasted Risk

   They are extrapolated from previous project experience, e.g., staff turnover, poor communication with customers, and reduced staff effort when ongoing maintenance requests are served.
3. Unknown Risk

   These risks can occur but are very difficult to identify in advance.

2.2.2. Risk Management

Risk management is all stages of work related to risk, including assessing, planning, handling, and monitoring accidents (Kerzner, 2001). Risk management is a part that cannot be eliminated absolutely from previously planned project work.

Several steps of risk management are:

1. The first step before carrying out OSH risk identification, the OSH supervisor/expert must be able to plan scenarios in the field and predict the impact of the work that will be carried out afterward, such as the process of installing a foundation.
2. After carrying out and creating implementation scenarios on the job, then identifying hazards based on the use of materials, the masons' and coolies' abilities, work methods, work tools, and the planned work environment. In carrying out hazard identification, it is important to know the scenario's hazard factors and it is crucial to have collaborative discussions with workers who usually do the work.
3. The OSH risk level is described as the size of the chance of an accident occurring multiplied by the level of impact or consequence.
4. After identifying the general level of risk based on the steps above, control is carried out on the OSH risk that may occur.
5. It is essential to communicate to the parties involved at each stage of work carried out in the field to be known and studied further. After that, it is conveyed to the source of the danger, such as what the danger is and how to prevent accidents from happening again.
6. Review it periodically.

2.2.3. Hazard

Hazard is a source, situation, or action that has the potential to harm humans or identified physical or mental disorders that originate from and or get worse due to work activities or work-related situations (OHSAS 18001, 2007).

Hazard is a source of potential damage or situations that have the potential to cause harm (Cross, 1998). Something is called as a source of harm if it has the risk of producing a negative outcome. Hazard is everywhere, both in the workplace or in the environment, but the danger will only affect if there is a contact or exposure (Tranter, 1999). In terms of occupational safety and health, hazards are classified into two, which are:

1. Safety Hazard

   Type of hazard that impacts accidents, which can cause injury (injury) to death, as well as damage to the Company's property. The impact is acute.

   The types of safety hazard include:

   a. Mechanical hazards, caused by machines or mechanical work tools such as cuts, falls, crashes and slips.
   b. Electrical hazards, caused by equipment that contains an electric current.
   c. Fire hazard, caused by chemical substances that are flammable (flammable).
   d. Explosion hazard, caused by explosive chemical substances.

2. Health Hazard

   Type of hazard that has an impact on health, could lead to health problems and occupational diseases. The effects are chronic.

   The types of health hazard include:

   a. Physical hazards include noise, vibration, ionic and non-ionizing radiation, extreme temperatures, and lighting.
   b. Chemical hazards include those related to materials or materials such as antiseptics, aerosols, insecticides, dust, fumes, gases.
   c. Biological hazards are related to living things in the work environment, which are bacteria, viruses, fungi that are pathogenic in nature.
   d. Psychological hazards include overly heavy workloads, associated with uncomfortable working conditions.

2.2.4. Hazard Analysis.

There are several methods of hazard analysis, including HIRA (Hazard Identification and Risk Assessment), HAZOP (Hazard Analysis and Operability Study), and HAZID (Hazard Identification) (Wardana, 2015). In this research, the method used is the HIRA method. The method used is based on hazard identification in each implementation activity and based on operational hazard analysis in the field. This study did not use the HAZID method since this method only identifies hazards at each work location. To be clearer, it can be understood from Figure 2.1 below.

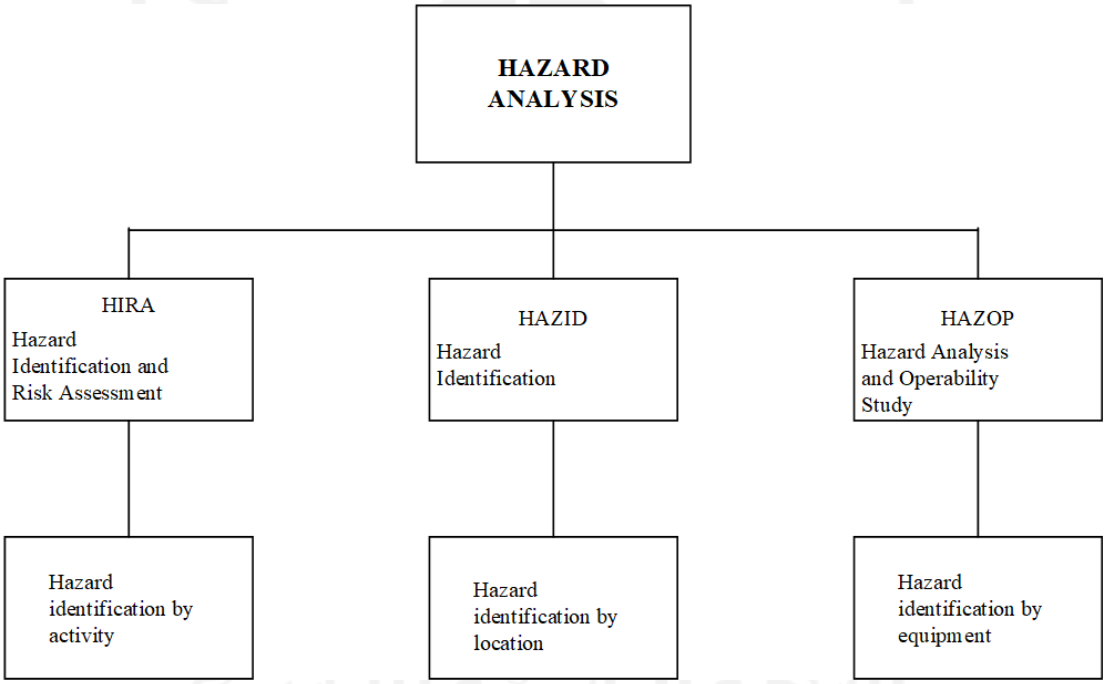

Figure 2. 1. Hazard Analysis Chart (Wardana, 2015)

2.2.5. Hazard Identification and Risk Assessment (HIRA)

HIRA (Hazard Identification and Risk Assessment) is a method or technique for identifying potential work hazards by defining the characteristics of the hazards that may occur and evaluating the risks that occur through a risk assessment using a risk assessment matrix. (Wardana, 2015).

There are two important criteria for measuring risk (Sepang, 2013), which are:

1. Probability

   Probability is the possibility of an accident/loss due to hazard. For example:

   a. Chance of people falling over slippery roads
   b. Chance of getting electrocuted
   c. Chance of crashing, etc.

2. Consequences

Consequences are a level of severity or loss resulting from an accident because of the existing hazards. This could be related to people, property, environment, etc.

The occurrence risk assessment is given a range between a risk that rarely occurs to a risk that occurs at any time (AS / NZS 4360, 2004). Can be seen in table 2.1 below:

Table 2. 1. Assessment of Risks Possibility (AS/NZS 4360, 2004)

Scale	Consequences	Consequences Definition
1	Rare	Almost never, very rare
2	Unlikely	Rare
3	Possible	It can happen once in a while
4	Likely	Often
5	Almost Certain	It can happen at any time

The impact risk assessment or consequence starts from insignificant injury to fatal or catastrophic injury (AS / NZS 4360, 2004). Can be seen in table 2.2 below:

Table 2. 2. Risk Impact Assessment (AS/NZS 4360, 2004)

Scale	Consequences	Consequences Definition
1	Insignificant	No injuries, minimal financial losses
2	Minor	Minor injury, moderate financial loss
3	Moderate	Moderate injury, need medical attention, significant financial loss

Scale	Consequences	Consequences Definition
4	Major	Serious injury (>1 person), significant loss, bothering production process
5	Catastrophic / Fatal	Fatal (>1 person), the loss was considerable, and the impact was far-reaching. All activities were stopped

No injury: Small incidents occurred or accompanied by zero to minimal material losses (Rp. 0 to Rp. 50,000) per person

Minor injury: An accident occurred, and a local first aid kit was needed, or a dissertation of moderate material losses (Rp. 50,000 to Rp. 100,000) per person

Moderate Injury: An accident occurred and required medical assistance (outpatient treatment) or accompanied by substantial material losses (Rp. 100,000 to Rp. 400,000) per person

Serious Injury: An accident occurred and required hospitalization at the hospital, or accompanied by large material losses (Rp. 400,000 to 10,000,000) per person, thus hampering the production process

Catastrophic / Fatal: An accident caused permanent disability or death, or was accompanied by huge material losses (> Rp. 10,000,000) per person and could stop all project activities.

Risk analysis in risk management is the process of assessing the impact and occurrence of an identified risk. This process is carried out by arranging risks based on their effect on project objectives. There are four level of risk, which are Low (L), Moderate (M), High (H), and Extreme (E). Below is the definition of the four level of the risk:

E Extreme Risk cannot be tolerated, so it needs to be handled immediately.

H	High risk, an unwanted risk, can only be accepted if risk reduction cannot be implemented so that it needs special attention from management.
M	Moderate Risk, an acceptable risk but requires clear responsibility from management.
L	Low Risk, a risk that can be overcome with routine procedures.

2.2.6. Occupational Safety and Health (OSH)

According to the Department of Man Power regarding to the basics of occupational safety and health, the definition of Occupational Safety and Health is:

1. Philosophically, occupational safety and health are thoughts and efforts to ensure the state of wholeness and perfection, both physically and spiritually, as well as the work and culture aimed at human welfare in general.
2. Scientifically, occupational safety and health is a branch of science and its application that studies procedures for preventing and controlling work accidents in the workplace.
3. Practically, occupational safety and health are an effort of protection. Workers are always in a safe and healthy condition while doing work in the workplace and likewise for people who enter the workplace and the source and production process can safely and efficiently use them.
4. Occupational safety and health from the law is a provision that regulates accident prevention in order to protect workers for staying safe and healthy.

The Effectiveness of implementing and management benefits of implementing the safety and health management such as (Yoon, et al., 2013):

1. Prevention of accidents
2. Legal compliance
3. Improving quality

4. Improving productivity
5. Reducing management costs
6. Improving safety consciousness of management
7. Improving safety consciousness of workers
8. Improving Company’s image

2.2.7. Occupational Safety and Health in Construction

In developing countries, deaths in construction projects are three times higher than in developed countries due to weak law enforcement. A high level of safety and health in the workplace is a worker's right that the company must fulfil besides the other normative rights. Companies should be aware and understand that workers are not a resource that is continually being used, but as social beings that must be maintained and considered given the many factors and risks of hazards that exist in the workplace (King & Hudson, 1985). Apart from companies, the government is also responsible for protecting the implementation of occupational safety and health.

Building construction service work is also carried out in stages, starting from the preparation stage, the implementation stage, and the demolition maintenance stage. By considering various safety and health problems in construction work and not optimal supervision due to the complexity of construction works as well as the lack of supervision of OSH construction, those will cause the construction work process and workplace conditions to be reluctant to be posed with potential hazards.

The government's efforts are to issue Legislation, regulating OSH, which is Law No. 1 of 1970 in Occupational Safety and Health (OSH). This is important in its application in the Company, as a form of workers' rights to safety in carrying out work activities and creating a work atmosphere and a healthy environment. According to production processes or materials that can cause work accidents such as falls, environmental pollution, and occupational diseases, it is mandatory to apply the OSH management system.

The legal bases for safety and health in construction work are:

1. *Undang- Undang Dasar 1945*
   Constitution of the Republic of Indonesia
2. *Undang- Undang No. 01/ 1970 tentang Keselamatan Kerja*
   Law No. 01/ 1970 about Safety Work
3. *Surat Keputusan Bersama Menteri Tenaga Kerja dan Menteri Pekerjaan Umum No. Kep. 174/ MEN/ 1986 dan No. 104/ KPTS/ 1986*
   Joint Decree of the Minister of Manpower and the Minister of Public Works No. Kep. 174/ MEN/ 1986 and No. 104/ KPTS/ 1986
4. *Permenaker No. 28/ MEN/ 2000 tentang Bangunan Gedung*
   Minister of Manpower Regulation No. 28/ MEN/ 2000 about the building
5. *Permenaker No. 05/ MEN/ 1996 tentang Sistem Manajemen Kesehatan dan Keselamatan Kerja (SMK3)*
   Minister of Manpower Regulation No. 05/ MEN/ 1996 about Occupational Safety and Health Management System

The OSH construction management system regulations are written in Legislation, which are:

1. *Pasal 22, ayat (2) huruf L, Undang- undang RI No. 18 tahun 1999 menyebutkan kontrak kerja konstruksi sekurang- kurangnya harus mencakup uraian mengenai perlindungan pekerja, yang memuat ketentuan tentang kewajiban para pihak dalam pelaksanaan keselamatan dan kesehatan kerja serta jaminan sosial.*
   Article 22, paragraph (2) letter L, of the Constitution of the Republic of Indonesia No. 18 of 1999 states that the construction work contract must at least include a description of the protection of workers, which contains provisions regarding the obligations of the parties in the implementation of occupational safety and health as well as social security.
2. *PP No. 29 tahun 2000 Pasal 17 tentang Penyelenggaraan Jasa Konstruksi. Pada salah satu ayatnya menyebutkan bahwa penyedia jasa dalam pemilihan penyedia jasa berkewajiban untuk menyusun dokumen penawaran yang memuat rencana dan metode kerja, rencana usulan biaya, tenaga terampil dan tenaga ahli, dan rencana anggaran Keselamatan dan Kesehatan Kerja dan Peralatan.*

Government Regulation No. 29 of 2000 Article 17 about the Implementation of Construction Services. In one of the paragraphs that the service provider in the election mentions to prepare a document offering that contains a work plan and method, a proposed cost plan, experts and experts, and an occupational safety and health budget plan and equipment.

3. *Pasal 30 ayat (1) PP No. 29 tahun 2000 menyebutkan bahwa untuk menjamin terwujudnya tertib penyelenggaraan pekerjaan konstruksi, penyelenggara pekerjaan konstruksi wajib memenuhi ketentuan tentang tempat kerja konstruksi sesuai dengan peraturan perundang- undangan yang berlaku dan pelaksanaan pekkerjaan konstruksi sesuai dengan peraturan perundang-undangan yang berlaku.*

   Article 30 paragraph (1) Government Regulation no. 29 of 2000 states that in order to ensure the realization of an orderly implementation of construction work, construction work operators are required to comply with the provisions concerning construction work sites in accordance with applicable laws and regulations and the implementation of construction work in accordance with applicable laws and regulations.

2.2.8. Data Collection Tools and Techniques

Researchers use questionnaires as a tool in collecting data and risk control as a way to solve the problems.

a. Questionnaire

   The questionnaire is an instrument for collecting data or information operationalized in the form of questions or items. The questionnaire was prepared to identify what attributes the respondent thought were important. The purpose of preparing the questionnaire was to improve the parts that were deemed inappropriate to be applied in collecting data on respondents. The basis for limitation in determining these variables is that the benefits must be understood and felt.

   The questionnaire can be functioned as a tool and a data collection technique that contain a series of questions in the form of closed questions.

Open questions are meant to lead the respondent to an answer where the alternative has been predetermined so that the respondent just chooses the column provided by giving an 'x' sign (Arikunto, 2006).

In this case, the questionnaire for consumers is divided into 2 (two) parts:

1. Part I contains questions regarding the general data of respondents.
2. Part II contains questions regarding the occurrence and impact of risk.

The form of the question is closed, and the respondent determines the choice of answer based on what has been determined. Determining the occurrence and severity value regarding the activities carried out consists of five parts, which 1, 2, 3, 4, and 5.

The weights for the occurrence rating are:

1. Very Unlikely : 1
2. Improbable : 2
3. Moderate : 3
4. Probable : 4
5. Very Probable : 5

The weights for the severity rating are:

1. No Injury Occurred : 1
2. Minor injury : 2
3. Moderate Injury : 3
4. Serious Injury : 4
5. Fatal / Catastrophic : 5

b. Sample

Sample is a part or representative of the population to be studied (Arikunto, 2006). In this study, the samples employed were workers and staff associated with the construction projects.

c. Risk Control

Control of hazards in the work environment is taken to minimize or eliminate the risk of work accidents through elimination, substitution, engineering control, warning systems, administrative control, and personal protective equipment (Socrates, 2013).

1. Elimination

The top hierarchy is the elimination, where the hazards that exist must be eliminated during the manufacturing/design process. The aim is to eliminate human error in running a system due to design flaws. The elimination of hazards is the most effective method so that it does not rely solely on the behavior of workers in avoiding risks. However, proper elimination of hazards is not always practical and economical. For example, fall hazards, ergonomic hazards, confined space hazards, noise hazards, chemical hazards. All of these should be eliminated if they are potentially dangerous.

2. Substitution

   This control method aims to change materials, processes, operations, or equipment from being dangerous to be less dangerous. This control will reduce the danger and risk through system re-system and redesign. For example, automation systems in machines to reduce the interaction of dangerous machines with operators, use less dangerous chemical cleaning agents, reduce speed, power, and electric current, replace raw materials that cause dust to become liquid or wet materials.

3. Engineering Control

   This control is carried out with the aim to separate hazards from workers and to prevent human error. This control is installed in a machine or equipment system unit.

4. Warning System

   Hazard control is carried out by providing warnings, instructions, signs, labels that will alert people to hazards at the location. It is very important for everyone to know and pay attention to the warning signs on the job site so that they can anticipate any hazards that will impact them. Applications in the industrial world for this type of control are alarm systems, smoke detectors, warning signs.

5. Administrative Control

   Control the hazards by making modifications to workers' interaction with the work environment, such as job rotation, training, development of work standards (SOP), work shifts, and housekeeping.

6. Personal Protective Equipment (PPE)

Personal protective equipment is designed to protect oneself from hazards in the work environment and pollutants, to keep it safe and healthy. The PPE safety steps:

a. Always wear PPE.
b. Consult if personal protective equipment is being used that is inappropriate for the job, or uncomfortable or inappropriate by telling colleagues or supervisors.
c. Ensure the work environment is kept informed about the nature of the hazards or risks that may be encountered.
d. It is not allowed to damage or change the ability of PPE to reduce its usefulness. Because the condition of PPE determines the benefits of protection, it provides.
e. Not allowed to bring hazardous contamination from work to your family or friends at home, leave PPE at work.

CHAPTER III

RESEARCH METHODOLOGY

3.1. Research Object

This research was taken place at the Construction Project of Baloi Permai Community Health Centre Batam. The object of this research was the project activities carried out by the construction workers.

3.2. Literature Review

In this research, a literature review is categorized into two parts: inductive and deductive. The inductive study correctly arranged procedure literature, so it will provide readers with headmost knowledge and show the differences between this research and another research. While, the deductive study is the part where the fundamental theory relating to the research topic is explained. The objective deductive study is designated to provide the necessary understanding for the readers about this research.

3.3. Method of Collecting Data

At this stage, data collection was carried out. The data needed in this study are primary data and secondary data:

1. Primary data is data obtained from observations or observations and interviews directly with employees through questionnaires. The number of questionnaires distributed was fifty-five questionnaires. Also, to collect the data of probability of

accidents that could possibly occur, the researcher used the expert judgment method by conducting interviews with the project supervisor as an experienced expert in handling several construction projects. This method is also used to determine the Occurrence and Severity parameters in this study.

2. Secondary data is data obtained through literature related to research, such as previous literature studies which are still related to research on hazard analysis or occupational safety and health. The researchers also used the E-commerce website as a reference to determine the price of each personal protective equipment.

3.4. Data Processing

After obtaining the required data, the next step is to apply the HIRA (Hazard Identification and Risk Assessment) method. The HIRA method is used to determine the level of risk of each work carried out on the project by multiplying each variable's Occurrence and Severity using Microsoft Excel. There are five variables in Occurrence, as follows; Rare, Oddly, Possible, Likely, and Almost Certain. Also, in Severity, there are five variables, which are; Insignificant, Minor, Moderate, Major, and Catastrophic/Fatal. With the results of the multiplication, the researcher can determine the level of the risk, which are; Extreme Risk with a total score > ten, High Risk with a total score of eight to nine, Moderate Risk with a total score of five to six, and Low Risk with a total score of one to four using a risk map.

3.5. Discussion

After risk category is identified, the researcher wants to know the risk priority that must be mitigated first by creating a risk map based on the risk categories obtained previously.

3.6. Conclusion and Recommendation

The conclusion contains the answers to the problem formulation in chapter one, in this part chapter, the recommendations are also provided to improve or even enhance further research.

3.7. Research Flow Framework

This research flow is designed to illustrate the overall process. It is an important part to be included since it illustrates the concept of how the researcher moves from the beginning to the end of the research. Figure 3.1 below is a research flowchart framework.

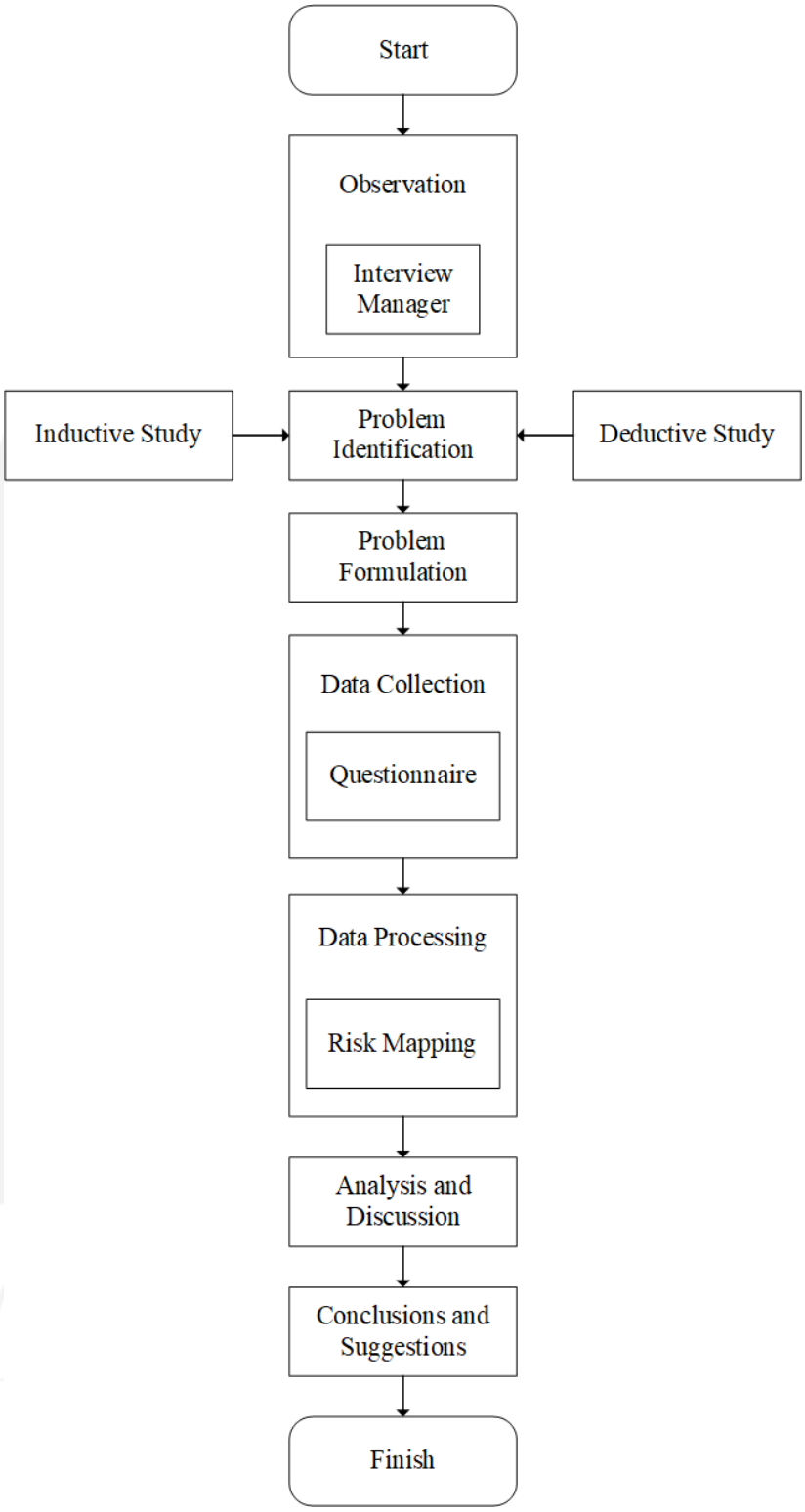

Figure 3. 1. Research Flowchart Framework

CHAPTER IV

DATA COLLECTION AND PROCESSING

4.1. Data Collection

This research was conducted by collecting data on the risk of work accidents in the Community Health Centre's construction project.

4.1.1. Baloi Permai Community Health Center Profile

Baloi Permai Community Health Center is one of the Community Health Centers located in Batam City District. Baloi Permai Community Health Center has one main health center and two auxiliary health centers located in Bandar Sri Mas Housing and Anggrek Sari Housing. To make Community Health Center more representative, the government has decided to relocate it because the old Community Health Center building is located in the middle of the housing. The budget is sourced from the Special Allocation Fund (DAK) and has become the prototype of the Health Ministry. The data regarding to the project profile are shown below:

Activity	:	The Facility Improvement for PUSKESMAS BALOI PERMAI
Project Type	:	Building Construction/Relocation of PUSKESMAS BALOI PERMAI
Contract No.	:	004/KONTRAK/FISIK/YANKES/DK/V1/2020
Contract Value	:	Rp 7,618,173,162

Work Duration	:	180 Working Days
Contractor	:	PT. XYZ
Consultant	:	PT. ABC

4.1.2. Risk Identification

The researcher used two methods to determine the risks that could occur in this construction project. The first was conducting interviews with project supervisors, and the second through journal reviews from Indrayani (2017). After carrying out the two stages of the method, the researcher found as many as thirty-five risks from the fifteen activities in this construction project. Table 4.1 below shows a list of activities and the risks.

Table 4. 1. List of activities and the risks

No.	**Risk Event**			**Source**
	Source		Variable	
1.	Excavation	X1	Landslide on excavation	Interview
		X2	The worker falls into the dug hole	Interview
		X3	Error/malfunction in the excavation tool	Indrayani (2017)
		X4	Heavy tools hit the workers	Interview
2.	Assembly and disassembly of scaffolding	X5	Collapsed scaffolding	Indrayani (2017)
		X6	The worker falls from a height	Interview
3.	Iron cutting	X7	Workers are injured while cutting the iron	Interview
		X8	Worker's eyes were exposed to debris	Indrayani (2017)
4.	Iron welding	X9	Worker's skin was exposed to welding sparks	Interview
		X10	The occurrence of a short circuit	Indrayani (2017)

5.	Foundation	X11	The worker fell while laying the foundation into the excavation	Interview
		X12	The worker slipped and hit the foundation iron lying carelessly	Interview
6.	Formwork installation	X13	Collapsed formwork	Indrayani (2017)
		X14	Workers hit by the hammer	Indrayani (2017)
		X15	Workers scratched by formwork material	Indrayani (2017)
7.	Casting the lower building	X16	Workers slip when moving Ready-mix using wheelbarrows	Interview
		X17	The worker was splashed with cement	Interview
		X18	The workers' eyes were splashed with concrete	Indrayani (2017)
8.	Installation of formwork at height	X19	The worker falls from a height	Interview
		X20	Workers hit by the hammer	Indrayani (2017)
9.	Casting the upper building	X21	Workers fall while climbing to fill the column	Interview
		X22	The workers below were hit by mortar	Interview
10.	Installation of the frame and roof cover	X23	The worker falls from a height	Interview
11.	Ceiling Installation	X24	The worker falls from a height	Interview
		X25	The worker's eye is exposed to ceiling debris	Indrayani (2017)
12.	Plastering	X26	The worker was splashed with cement	Indrayani (2017)
		X27	The worker falls from a height	Interview
13.	Ceramic installation	X28	Disturbance on workers' ears	Indrayani (2017)
		X29	Workers are exposed to ceramic cutting tools	Interview
14.	Installation of doors and windows	X30	Workers are injured by drill bits	Indrayani (2017)
		X31	The occurrence of a short circuit	Indrayani (2017)
15.	Painting	X32	The worker falls from a height	Interview
		X33	Long inhaled wall paint	Interview
		X34	Workers' eyes have been splashed with paint or paint solvents	Indrayani (2017)
		X35	Skin irritation from paint splashes or paint solvents	Indrayani (2017)

After identifying each risk that could occur, the researcher collected data using a questionnaire.

4.1.3. Questionnaire

This study uses a questionnaire to collect data. This questionnaire is given to workers and staff embroiled in Baloi Permai Community Health Center construction project. In filling out this questionnaire, the respondents simply choose each risk's occurrence and severity level. This measurement level is obtained from the results of interviews with the expert. Tables 4.2 and 4.3 below are the measurement level of occurrence and severity.

Table 4. 2. Measurement Parameter Level of Occurrence

Level	Occurrence	Description
1	Very Unlikely	Accidents May Only Occur under Extraordinary / Doubtful conditions (Occurs one time during the project)
2	Improbable	Incident Can Happen at Any Time / Small Probability (Occurs one to two times during project)
3	Moderate	Accidents will Happen at a Time / Probably between Happening or Not (Occurs three to four times during project)
4	Probable	Accidents are likely to happen under every condition (Occurs five to six times during project)
5	Very Probable	Accidents Ensure to Happen in Every Condition (Occurs seven to more than seven times during project)

Table 4. 3. Measurement Parameter Level of Severity

Level	Severity	Description
1	No Injury Occurred	Small accidents occur, does not affect the worker’s productivity

2	Minor injury	Accidents occur, and local first aid measures are needed, less negative impact on the worker's productivity
3	Moderate Injury	An accident occurs, and medical personnel are needed (outpatient treatment), which has a negative effect on the worker's productivity
4	Serious Injury	An accident occurs, and hospitalization is required in the hospital, has a negative effect on the worker's productivity
5	Fatal	There is a work accident that results in permanent disability or even death, which has a very negative effect on the worker's productivity

4.2. Data Processing

After the data have been collected, it is calculated the average of each variable of occurrence and severity. Table 4.4 is the average of each variable of the occurrence and severity.

Table 4. 4. Average of Each Variable of the Occurrence and Severity

Variable	Occurrence	Severity
X1	1	2
X2	1	3
X3	1	3
X4	1	4
X5	2	3
X6	2	5
X7	2	2
X8	2	2
X9	2	2
X10	2	3
X11	1	4
X12	1	3

X13	2	3
X14	3	2
X15	2	2
X16	2	2
X17	2	1
X18	1	2
X19	2	4
X20	2	3
X21	1	4
X22	1	3
X23	1	5
X24	2	5
X25	2	2
X26	2	1
X27	2	5
X28	2	2
X29	2	2
X30	2	2
X31	1	2
X32	1	5
X33	2	2
X34	2	2
X35	2	1

4.2.1 Risk Mapping

Based on the occurrence and severity data, a risk mapping is carried out based on a matrix table so that it can be seen that the risk is included in the Low (L), Moderate (M), High (H), or Extreme (E) category.

Table 4. 5. Risk Category (Wardana, 2015)

Risk Score	Risk Category
1,2,3,4	L
5,6	M
8,9	H
>10	E

Where:

L = Low Risk

M = Moderate Risk

H = High Risk

E = Extreme Risk

After the average of the occurrence and severity is obtained, the next step is matrix classification. The matrix categorization table is attained from the average multiplication of the occurrence with the severity's average result. The results of the research can be seen in table 4.6 below.

Table 4. 6. Matrix Classification Table

No.	Risk Event			Occurrence	Severity	Total	Matrix
	Source		Variable				
1.	Excavation	X1	Landslide on excavation	1	2	2	L
		X2	The worker falls into the dug hole	1	3	3	L
		X3	Error / malfunction in the excavation tool	1	3	3	L
		X4	Heavy tools hit the workers	1	4	4	L
2.	Assembly and disassembly of scaffolding	X5	Collapsed scaffolding	2	3	6	M
		X6	The worker falls from a height	2	5	10	E
3.	Iron cutting	X7	Workers are injured while cutting the iron	2	2	4	L
		X8	Worker's eyes were exposed to debris	2	2	4	L
4.	Iron welding	X9	Worker's skin was exposed to welding sparks	2	2	4	L
		X10	The occurrence of a short circuit	2	3	6	M
5.	Foundation	X11	Worker fell while laying foundation into the excavation	1	4	4	L
		X12	The worker slipped and hit the foundation iron lying carelessly	1	3	3	L
6.	Formwork installation	X13	Collapsed formwork	2	3	6	M
		X14	Workers hit by the hammer	3	2	6	M
		X15	Workers scratched by formwork material	2	2	4	L
7.	Casting the lower building	X16	Workers slip when moving Ready-mix using wheelbarrows	2	2	4	L
		X17	The worker was splashed with cement	2	1	2	L
		X18	The workers' eyes were splashed with concrete	1	2	2	L
8.	Installation of formwork at height	X19	The worker falls from a height	2	4	8	H
		X20	Workers hit by the hammer	2	3	6	M
9.		X21	Workers fall while climbing to fill the column	1	4	4	L

	Casting the upper building	X22	The workers below were hit by mortar	1	3	3	L
10.	Installation of the frame and roof cover	X23	The worker falls from a height	1	5	5	M
11.	Ceiling Installation	X24	The worker falls from a height	2	5	10	E
		X25	Worker's eye is exposed to ceiling debris	2	2	4	L
12.	Plastering and Neat-plaster	X26	The worker was splashed with cement	2	1	2	L
		X27	The worker falls from a height	2	5	10	E
13.	Ceramic installation	X28	Disturbance with workers' ears	2	2	4	L
		X29	Workers are exposed to ceramic cutting tools	2	2	4	L
14.	Installation of doors and windows	X30	Workers are injured by drill bits	2	2	4	L
		X31	The occurrence of a short circuit	1	2	2	L
15.	Painting	X32	The worker falls from a height	1	5	5	M
		X33	Long inhaled wall paint	2	2	4	L
		X34	Workers' eyes splashed with paint or paint solvents	2	2	4	L
		X35	Skin irritation from paint splashes or paint solvents	2	1	2	L

The risk matrix above can be made into a risk map to simplify risk classification.

Figure 4.1 below is a risk map based on the risk matrix above.

OCCURRENCE \ SEVERITY	1	2	3	4	5
1	LOW (1) -	LOW (2) (X1) (X17)	LOW (3) (X2) (X3)	LOW (4) (X8) (X33) (X9) (X34) (X4)	MODERATE (5) (X32)
2	LOW (2) X26) (X35)	LOW (4) (X15) (X7) (X16) (X11)	MODERATE (6) (X10) (X13) (X14)	HIGH (8) (X19)	EXTREME (10) (X27)
3	LOW (3) (X12) (X22)	MODERATE (6) (X5) (X20)	HIGH (9) -	EXTREME (12)	EXTREME (15) -
4	LOW (4) (X21) (X28) (X25) (X29) (X30)	HIGH (8) -	EXTREME (12) -	EXTREME (16) -	EXTREME (20) -
5	MODERATE (5) (X23)	EXTREME (10) (X6) (X24)	EXTREME (15) -	EXTREME (20) -	EXTREME (25) -

Figure 4. 1. Risk Map

From the results of the risk matrix above, it is known that there are three categories of extreme risk, which are the impact of workers falling from a height at the source of activities for assembly and disassembly of scaffolding, ceiling installation, and plastering and neat-plaster. Meanwhile, one risk is in the high-risk category, and seven risks are in the moderate risk category when there are twenty-four risks in low-risk category.

4.2.2 Risk Control

Risk Control is an important and decisive step in overall risk management. If there were more concepts and planning in nature in the previous step, then at this step, it is a realization of risk management efforts. After identifying the level of risk from the HIRA method results, then the following table 4.7 is the risk control in this project activities.

Table 4. 7. Risk Control

Source (Activity)	Risk Event Variable		Risk Level	Control
Excavation	X1	Landslide on excavation	Low	Warning system: Safety Line PPE: Safety Helmet, Safety boots
	X2	The worker falls into the dug hole	Low	Warning system: Safety line PPE: Safety helmet, Safety boots
	X3	Error/malfunction in the excavation tool	Low	Warning system: Safety line Engineering Control: Routine maintenance on heavy equipment Administrative Control: SOP and Supervision PPE: Safety helmet, Safety boots

Source (Activity)	Risk Event Variable		Risk Level	Control
	X4	Heavy tools hit the workers	Low	Warning system: Safety line Engineering Control: Routine maintenance on heavy equipment Administrative Control: SOP and Supervision PPE: Safety Helmet, Safety Boots
Assembly and disassembly of scaffolding	X5	Collapsed scaffolding	Moderate	Administrative Control: Adanya SOP PPE: Safety helmet
	X6	The worker falls from a height	Extreme	Warning system: Safety line Administrative Control: SOP PPE: Safety helmet, safety boots, Full body harness, Lanyard, Absorber, Anchor point
Iron cutting	X7	Workers are injured while cutting the iron	Low	PPE: Safety Gloves
	X8	Worker's eyes were exposed to debris	Low	PPE: Face Shield
Iron welding	X9	Worker’s skin was exposed to welding sparks	Low	PPE: Safety Jacket, Safety Glasses, Safety Gloves
	X10	The occurrence of a short circuit	Moderate	Administrative Control: SOP PPE: Safety boots, Safety gloves

Source (Activity)	Risk Event Variable		Risk Level	Control
Foundation	X11	The worker is fell while laying the foundation into the excavation	Low	Warning system: Safety line Administrative Control: SOP PPE: Safety helmet, Safety boots, Full body harness, Lanyard, Absorber, Anchor point
	X12	The worker is slipped and hit the foundation iron lying carelessly	Low	Warning system: Safety line Administrative Control: SOP PPE: Safety helmet, Safety boots
Formwork installation	X13	Collapsed formwork	Moderate	Warning system: Safety line Administrative Control: SOP PPE: Safety Helmet
	X14	Workers are hit by the hammer	Moderate	PPE: Safety Gloves
	X15	Workers are scratched by formwork material	Low	PPE: Safety Gloves
Casting the lower building	X16	Workers are slipped when moving Ready-mix using wheelbarrows	Low	PPE: Safety Helmet, Safety Boots
	X17	The worker is splashed by cement	Low	PPE: Safety Gloves
	X18	The workers' eyes were splashed by the concrete	Low	PPE: Face Shield, Safety Glasses
Installation of formwork at height	X19	The worker falls from a height	High	Warning system: Safety line

Source (Activity)	Risk Event Variable		Risk Level	Control
				Administrative Control: SOP PPE: Safety helmet, safety boots, Full body harness, Lanyard, Anchor point
	X20	Workers are hit by the hammer	Moderate	PPE: Safety Gloves
Casting the upper building	X21	Workers fall while climbing to fill the column	Low	Warning system: Safety line Administrative Control: SOP PPE: Safety helmet, Safety boots, Full body harness, Lanyard, Absorber, Anchor point
	X22	The workers below are hit by mortar	Low	PPE: Safety Helmet
Installation of the frame and roof cover	X23	The worker falls from a height	Moderate	Warning system: Safety line Administrative Control: SOP PPE: Safety helmet, Safety boots, Full body harness, Lanyard, Absorber, Anchor point
Ceiling Installation	X24	The worker falls from a height	Extreme	Warning system: Safety line Administrative Control: SOP PPE: Safety helmet, Safety boots, Full body harness, Lanyard, Absorber, Anchor point
	X25	The worker's eye is exposed to ceiling debris	Low	PPE: Face Shield, Safety Glasses

Source (Activity)	Risk Event Variable		Risk Level	Control
Plastering	X26	The worker was splashed by the cement	Low	PPE: Safety Gloves
	X27	The worker falls from a height	Extreme	Warning system: Safety line Administrative Control: SOP PPE: Safety helmet, Safety boots, Full body harness, Lanyard, Absorber, Anchor point
Ceramic installation	X28	Disturbance on workers' ears	Low	PPE: Earplug, Earmuff
	X29	Workers are exposed to ceramic cutting tools	Low	PPE: Safety Gloves
Installation of doors and windows	X30	Workers are injured by drill bits	Low	PPE: Safety Gloves
	X31	The occurrence of a short circuit	Low	Administrative Control: SOP PPE: Safety boots
Painting	X32	The worker falls from a height	Moderate	Warning system: Safety line Administrative Control: SOP PPE: Safety helmet, Safety boots, Full body harness, Lanyard, Absorber, Anchor point
	X33	Long inhaled wall paint	Low	PPE: Face Mask, Respirator
	X34	Workers' eyes have been splashed by paint or paint solvents	Low	PPE: Face Shield, Safety Glasses
	X35	Skin irritation from paint splashes or paint solvents	Low	PPE: Safety Gloves

After risk control is carried out, the following results are obtained:

Table 4. 8. Matrix Classification Table After Risk Control

No.	Risk Event		Occurrence	Severity	Total	Matrix
	Source	Variable				
1.	Assembly and disassembly of scaffolding	X6 The worker falls from a height	2	2	4	L
2.	Ceiling Installation	X24 The worker falls from a height	2	2	4	L
3.	Plastering and Neat-plaster	X27 The worker falls from a height	2	2	4	L

From the table above, after carrying out risk control, the occurrence value is obtained by two. This is because there is still the possibility of human error occurring to the workers. While the score on severity dropped to two, this is due to special PPE that can reduce the impact when the worker falls from a height. After that, the HIRA method is applied again by multiplying Occurrence and Severity, so the result becomes four. It can be seen by carrying out risk control such as the existence of a warning system in the form of a safety line, administrative control with SOPs, as well as the use of PPE such as safety helmets, safety boots, full body harness, lanyards, and also anchor points can reduce the level of risk in the risk category from Extreme to Low risk.

4.2.3 Cost Analysis

Based on table 4.7, it can be seen that there are three risks with extreme levels, which is “The worker falls from a height” from Assembly and disassembly of scaffolding, Ceiling Installation, and Plastering activity that must be a priority for the company's mitigation, as for the mitigation steps that companies can implement by procuring a safety line as a

warning system, as well as PPE such as safety helmets, safety boots, full-body harness, lanyard, and anchor point. The following is a price list for these items:

Table 4. 9. Mitigation Items Price

Item	Price	Source
Safety Line	Rp 45,000	Tokopedia: https://www.tokopedia.com/indobuilder/police-line-2-inci-x-300-meter-pita-pengaman-pembatas-proyek
Safety Helmet	Rp 75,174	Krisbow: https://www.krisbow.com/safety-equipment/head-protection/safety-helmet/helmet-front-brim-yellow.html
Safety Boots	Rp 90,000	Tokopedia: https://www.tokopedia.com/teknik-safety/safety-boots-strenght-karet-kuning?whid=0
Full Body Harness + Lanyard & Absorber	Rp 561,935	Krisbow: https://www.krisbow.com/full-body-harness-with-lanyard.html
Anchor Point	Rp 222,722	Blibli: https://www.blibli.com/p/outdoor-4holes-paw-rigging-plate-rock-climbing-multi-anchor-point-connector-gear/pc--MTA-8752533

To get the total price, each item is multiplied by the number of workers, which is fifty-five workers. Table 4.9 below shows the total price of the items.

Table 4. 10. Total Price of the Items

Item	Price	Amount	Total
Safety Line	Rp 45,000	55	Rp 2,475,000
Safety Helmet	Rp 75,174	55	Rp 4,134,570
Safety Boots	Rp 90,000	55	Rp 4,950,000
Full Body Harness + Lanyard & Absorber	Rp 561, 935	55	Rp 30,906,425
Anchor Point	Rp 222,722	55	Rp 12,249,710
Total			Rp 54,715,705

From the table above, it can be seen that the costs that need to be incurred by the company to provide special PPE for working at heights are pretty high. The company's strategy to reduce the company's expenses in providing PPE is in the form of division of labor for workers because not all workers do the same job. This strategy aims to accommodate workers with different type of PPE so that the company only needs to provide some special PPEs for some workers. With the implementation of this strategy, it is hoped that the company can carry out cheap and fast mitigation as well as effective and efficient. The table below shows the total price of the items after the implementation of the above strategy.

Table 4. 11. Total Price of the Items After Using Strategy

Item	Price	Amount	Total
Safety Line	Rp 45,000	11	Rp 495,000
Safety Helmet	Rp 75,174	11	Rp 826,914
Safety Boots	Rp 90,000	11	Rp 990,000
Full Body Harness + Lanyard & Absorber	Rp 561,935	11	Rp 6,181,285
Anchor Point	Rp 222,722	11	Rp 2,449,942
Total			Rp 10,943,141

It can be seen from Table 4.11 that carrying out above strategy can minimize company expenses in providing special PPEs for working at heights, so that companies can do cheap and fast mitigation, as well as practical and efficient.

CHAPTER V

DISCUSSION

5.1 Result and Discussion

Based on the results obtained in chapter four, the type of work with the highest level of risk involved in the Baloi Permai Community Health Center construction project is a fall from a height during the assembly and disassembly of scaffolding, ceiling installation, and plastering activities.

To prevent work accidents of falling from a height, facilities and equipment are needed to support it. However, for the provision of such facilities and equipment, there are costs to be incurred by project management, even though the amount spent is relatively large, it should be accomplished to encourage OSH regulations, sourced from company policy towards zero accidents. So far, the implementation of OSH is often considered costly or expensive. Yet, if a company implements OSH correctly, many benefits can be obtained and avoid unnecessary losses. For example, suppose there is a work accident with a hip fracture due to falling from a height. In that case, there will be more costs that must be spent in vain, or in other words, the costs incurred at the beginning (it appears) only a fraction of the other costs that must be incurred (not visible), because the costs incurred are not only for medical treatment. The following is an analysis of losses from work accidents falling from a height:

a. The costs of hip fracture surgery are enormous.
b. Cost of work process losses, such as stopping work at the location of the incident after a work accident.
c. The company must give compensation fees to the victim for permanent disability.
d. The increase in insurance premiums for BPJS Ketenagakerjaan because of work accidents.

e. Decreasing company image and influencing marketing and company revenue because clients will choose contractors who care more about OSH's importance.

The items listed above certainly have a very detrimental effect if the company does not have a mitigation strategy/hazard control system to prevent work accidents from falling from a height.

a. Procedure

The procedure for working at height is established to explain how the contractor intends to control and coordinate the subcontractor's work. The use of these procedures ensures everyone's health, safety, and environment and is directly enforced by project agreements. This procedure describes the systems and equipment used, which requires personnel to perform any tasks at an altitude area. The safety issue at height will be considered when there is a potential risk of causing a person to fall over two meters.

According to Peraturan Menteri Tenaga Kerja No. 05/MEN/ 1996 about *Sistem Manajemen Keselamatan dan Kesehatan Kerja lampiran II bagian 6* mention that "*Prosedur kerja dan instruksi kerja dibuat oleh petugas yang berkompeten dengan masukan dari tenaga kerja yang dipersyaratkan untuk melakukan tugas dan prosedur di sahkan oleh pejabat yang ditunjuk*".

The regulation of Minister of Man Power No. 05/MEN/1996 on Management System of Occupational Safety and Health Attachment II section 6, mentioned that "Work procedure and instruction are tailored by competent officer by involving inputs from man-power who is assigned for performing such task and procedures, in which they are validated by appointed official"

Some of the procedures that might be done are:

1. All persons who work above two meters in high must follow the procedures for working at a height and preventing falling objects.
2. Must wear the Full Body Harness and attach the lanyard or strap over the chest or a safe place.
3. Protecting hand tools when working at heights.

4. Avoiding to drop material/anything down.
5. Responsible for using PPE.

b. Personal Protective Equipment (PPE)

In addition to procedures, PPE can also be used as a strategy in mitigating the danger of falling from a height. Using PPE can benefit all parties, both companies and workers. Below is a comparison table of the advantages and disadvantages of companies, which prefer to provide or not to provide the PPE.

Table 5. 1. The Advantages and Disadvantages of Companies Provide PPE

No.	Advantages	Disadvantages
1.	As an effort to reduce the risk of work accidents	Requires a large amount of money in the procurement and maintenance
2.	Can provide a sense of safety to workers	Some workers often feel uncomfortable when using PPE
3.	As proof of the company's concern for its workers, both permanent workers, and daily workers	Companies need to hold workshops/counseling related to the use of PPE
4	Train worker's discipline as one of the supporting aspects to create workers with a good work ethic	

Table 5. 2. The Advantages and Disadvantages of Companies do not Provide PPE

No.	Advantages	Disadvantages
1.	Companies do not require more costs for the procurement and maintenance of PPE	The cost required in the event of a work accident falling from a height will be greater than the cost of procuring PPE
2.		The impact if a work accident occurs will be even more severe

As shown in the table above, in the researcher's opinion, the company should provide PPE because PPE can have more positive impacts than without PPE. PPE is crucial to isolate part or all of the body from potential hazards in the workplace. PPE helps reducing the risk of exposure or contact with hazards. The danger may not be eliminated by wearing PPE, but the risk of injury can be minimized.

Some of the PPEs needed to work at height are:

1. Safety Line

   The safety line is used as a barrier and marker in the construction zone.
2. Safety Helmet

   A safety helmet helps protecting the head from collisions, blows, or falling sharp and heavy objects floating or sliding in the air. This helmet can also protect the head from heat radiation, fire, chemical sparks, or extreme temperatures. A helmet must be used to protect the head from falling objects and be equipped with a chain strap or chin strap to prevent the helmet from falling.
3. Safety Boots

   Safety boots protect the workers from slipping.
4. Full Body Harness + Lanyard and Shock Absorber

   The full-body harness is designed to transmit the energy generated when it falls on the shoulders, thighs, and buttocks. The harness is designed precisely to provide support when workers fall without disturbing the blood flow, which could cause internal injury. A lanyard connects the full body harness to secure support. The material must be made of woven nylon. The lanyard must be kept short to limit the distance to fall. Consideration should be given to apply a lanyard attached as a shock absorber to reduce pressure during a fall
5. Anchor Point

Before starting work at height, workers must ensure that the anchor attached to the lifeline or lanyard is strong, stable, and properly located. If the use of anchors is intended to protect workers from falling, the anchor must withstand a load of at least 3.5 kN (363 kg) or equivalent to four times of worker's weight.

CHAPTER VI

CONCLUSION AND RECOMMENDATION

6.1. Conclusion

1. From the questionnaire results distributed to the Baloi Permai Community Health Center construction project workers, the probability and severity value of each risk was obtained. The results are processed using the HIRA method by multiplying probability and severity. The value is obtained to know the category of each risk. In the category of the highest risk/extreme risk level, there is a risk of falling from a height in the assembly and disassembly of scaffolding, ceiling installation, and plastering activities with a score of ten.

2. The mitigation that companies need to do is proper procedures and the use of PPE. Some of the procedures that the company can perform are:
    a. All persons who work above 2 meters in high must follow the procedures for working at a height and preventing falling objects.
    b. Must wear the Full Body Harness and attach the lanyard or strap over the chest or a safe place.
    c. Protecting hand tools when working at heights.
    d. Avoiding to drop material down.
    e. Responsible for wearing the PPE.

    The use of PPE provides more positive impact than without PPE. Therefore, companies need to accommodate workers with PPE such as:

    a. Safety Line
    b. Safety Helmet
    c. Safety Boots

d. Full Body Harness + Lanyard and Absorber
e. Anchor Point.

6.2. Recommendation

1. This research can be added with other quantitative methods to get more accurate results.
2. In future research, it is expected that researchers will be able to find out the details of project costs to determine the allocation of funds for the procurement of PPE.
3. For further research, researchers can categorize each level of probability and severity in more detail.

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ATTACHMENT I

KUESIONER PENELITIAN

Assalammualaikum Wr. Wb.

Kepada Yth

Bapak/ Ibu/ Sdr/ Sdri Staf dan Pegawai

Di Proyek Pembangunan Gedung / Relokasi Puskesmas Baloi Permai

Dengan Hormat,

Sebagai salah satu syarat dalam penyelesaian Tugas Akhir / Skripsi pada Program Studi Teknik Industri Internasional Program Universitas Islam Indonesia Yogyakarta, maka dilakukan penelitian untuk mendapatkan data yang diinginkan, maka dibuatlah kuisioner ini. Kuisioner ini bertujuan untuk mengetahui tingkat kemungkinan dan dampak yang terjadi di lapangan. Untuk itu mohon kuisioner ini diisi sesuai dengan yang diperoleh di lapangan.

Setiap jawaban yang anda berikan merupakan pertolongan yang tak ternilai harganya bagi penelitian ini.

Atas ketersedian dan kerjasamanya, saya ucapkan terima kasih

Wassalammualaikum Wr. Wb.

Peneliti

Moch. Agung Perdana

1. **Data Responden**

   Nama :

   Jabatan / Posisi :

   Pendidikan Terakhir :

2. **Petunjuk Pengisian Kuesioner**

   - Jawablah pertanyaan dengan memilih skala 1/ 2/ 3/ 4/ 5 dimana setiap angka memiliki definisi seperti yang telah tertera.
   - Bila ada yang tidak sesuai dengan proyek, maka tidak perlu diisi.

Skala Pengukuran dari Kemungkinan Terjadinya

Skala	Kemungkinan	Definisi Kemungkinan
1	Sangat Jarang (SJ)	Peristiwa Hanya Mungkin Terjadi pada Kondisi yang Luar Biasa/ Sangat Tidak Mungkin Terjadi
2	Jarang (J)	Peristiwa Dapat Terjadi pada Suatu Waktu/ Kemungkinan Terjadi Kecil
3	Cukup Sering (CS)	Peristiwa akan Terjadi pada Suatu Waktu/ Kemungkinan antara Terjadi atau Tidak
4	Sering (S)	Peristiwa Kemungkinan akan Terjadi Dalam Setiap Kondisi
5	Sangat Sering (SS)	Peristiwa Dipastikan Terjadi di Setiap Kondisi

Skala Pengukuran dari Dampak Terjadinya

Skala	Dampak	Definisi Dampak
1	Tidak Terjadi Cidera	Terjadi Insiden Kecil, Sangat Tidak Berpengaruh terhadap Produktivitas Tenaga Kerja
2	Cidera Ringan	Terjadi Kecelakaan dan Dibutuhkan Tindakan P3K Setempat, Kurang Berpengaruh Negatif Terhadap Produktifitas Tenaga Kerja
3	Cidera Sedang	Terjadi Kecelakaan dan Dibutuhkan Bantuan Tenaga Medis (Berobat Jalan), Cukup Berpengaruh Negatif terhadap Produktifitas Tenaga Kerja
4	Cidera Berat	Terjadi Kecelakaan dan Dibutuhkan Perawatan Inap di Rumah Sakit, Berpengaruh Negatif Terhadap Produktifitas Tenaga Kerja
5	Fatal	Terjadi Kecelakaan Kerja yang Menimbulkan Cacat Tetap atau bahkan Kematian, Sangat Berpengaruh Negatif Terhadap Produktifitas Tenaga Kerja

Kolom Kuesioner

Silang (X) yang menjadi jawaban anda

No	Risiko Kejadian		Kemungkinan					Dampak				
	Sumber	Potensi										
1.	Penggalian	Galian longsor	1	2	3	4	5	1	2	3	4	5
		Pekerja terjatuh kedalam galian	1	2	3	4	5	1	2	3	4	5
		Terjadi *error* / malfungsi pada alat galian	1	2	3	4	5	1	2	3	4	5
		Alat berat menabrak pekerja	1	2	3	4	5	1	2	3	4	5
2.	Pemasangan dan pembongkaran *scaffolding*	*Scaffolding roboh*	1	2	3	4	5	1	2	3	4	5
		Pekerja terjatuh dari ketinggian	1	2	3	4	5	1	2	3	4	5
3.	Pemotongan besi	Pekerja terluka saat pemotongan besi	1	2	3	4	5	1	2	3	4	5
		Mata pekerja terkena serpihan material	1	2	3	4	5	1	2	3	4	5
4.	Pengelasan besi	Kulit pekerja terkena percikan api las	1	2	3	4	5	1	2	3	4	5
		Terjadinya korsleting	1	2	3	4	5	1	2	3	4	5
5.	Pemancangan Pondasi	Pekerja terjatuh saat meletakkan fondasi ke dalam penggalian	1	2	3	4	5	1	2	3	4	5
		Pekerja terpeleset/terjatuh dan terkena besi pondasi yang tergeletak sembarangan	1	2	3	4	5	1	2	3	4	5
6.	Pemasangan bekisting	Bekisting rubuh	1	2	3	4	5	1	2	3	4	5
		Pekerja terpukul palu	1	2	3	4	5	1	2	3	4	5
		Pekerja tergores material bekisting	1	2	3	4	5	1	2	3	4	5
7.	Pengecoran lantai bawah	Pekerja tergelincir saat pemindahan *Ready mix* yang menggunakan gerobak dorong	1	2	3	4	5	1	2	3	4	5
		Pekerja terkena percikan semen	1	2	3	4	5	1	2	3	4	5

No	Risiko Kejadian		Kemungkinan					Dampak				
	Sumber	Potensi										
		Mata pekerja terkena percikan beton	1	2	3	4	5	1	2	3	4	5
8.	Pemasangan bekisting di ketinggian	Pekerja terjatuh dari ketinggian	1	2	3	4	5	1	2	3	4	5
		Pekerja terpukul palu	1	2	3	4	5	1	2	3	4	5
9.	Pengecoran lantai atas	Pekerja terjatuh saat naik untuk mengisi kolom	1	2	3	4	5	1	2	3	4	5
		Pekerja dibawah tertimpa adonan beton	1	2	3	4	5	1	2	3	4	5
10.	Pemasangan rangka dan Penutup atap	Pekerja terjatuh dari ketinggian	1	2	3	4	5	1	2	3	4	5
11.	Pemasangan Plafond	Pekerja terjatuh dari ketinggian	1	2	3	4	5	1	2	3	4	5
		Mata terkena serpihan plafond	1	2	3	4	5	1	2	3	4	5
12.	Plester dan aci	Pekerja terkena percikan semen	1	2	3	4	5	1	2	3	4	5
		Pekerja terjatuh dari ketinggian	1	2	3	4	5	1	2	3	4	5
13.	Pemasangan keramik	Gangguan telinga	1	2	3	4	5	1	2	3	4	5
		Pekerja terkena alat potong keramik	1	2	3	4	5	1	2	3	4	5
14.	Pemasangan pintu dan jendela	Pekerja terluka oleh mata bor	1	2	3	4	5	1	2	3	4	5
		Terjadinya konsleting	1	2	3	4	5	1	2	3	4	5
		Pekerja jatuh dari ketinggian	1	2	3	4	5	1	2	3	4	5
15.	Pengecatan	Menghirup cat dinding dalam waktu yang lama	1	2	3	4	5	1	2	3	4	5
		Mata pekerja terkena percikan cat atau pelarut cat	1	2	3	4	5	1	2	3	4	5
		Iritasi kulit terkena percikan cat atau pelarut cat	1	2	3	4	5	1	2	3	4	5

ATTACHMENT II

Occurrence attribute recap

Variable	Occurrence																																																						
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26	X27	X28	X29	X30	X31	X32	X33	X34	X35	X36	X37	X38	X39	X40	X41	X42	X43	X44	X45	X46	X47	X48	X49	X50	X51	X52	X53	X54	X55	Average
X1	1	1	1	2	1	1	1	1	1	1	2	1	1	1	2	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1	2	1	2	1	1	1	2	2	1	1	1	1	1	1	2	1	3	1	1	1
X2	1	1	1	2	1	2	1	1	1	1	1	1	1	1	3	1	1	1	2	1	1	2	2	3	1	1	1	1	1	1	1	1	2	1	1	1	3	1	1	2	1	1	2	1	1	1	1	1	1	1	3	1	1	1	1	1
X3	1	1	1	2	1	1	1	2	1	1	1	1	1	1	3	1	1	1	2	1	1	2	1	3	1	1	1	1	1	1	1	1	2	1	1	1	3	1	1	1	1	1	2	1	1	1	1	1	1	1	3	1	2	1	2	1
X4	1	1	1	2	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1
X5	1	1	1	1	2	1	1	1	1	1	2	1	1	1	3	1	1	2	2	3	1	2	1	3	2	1	2	1	2	1	1	1	2	1	1	1	3	1	1	1	2	1	2	1	2	1	3	2	2	1	3	2	4	2	1	2
X6	1	1	1	1	3	1	2	2	1	1	3	1	1	1	3	3	1	1	2	3	2	2	1	3	1	1	1	1	1	1	1	1	2	1	2	2	3	1	1	2	1	2	2	1	1	1	3	1	1	1	3	1	3	1	1	2
X7	1	1	3	1	1	2	2	1	2	3	1	2	3	1	2	1	1	3	3	2	1	3	2	2	2	1	3	2	2	1	2	2	3	2	1	1	2	2	1	1	3	1	3	2	2	1	2	3	2	2	2	2	4	3	2	2
X8	1	1	3	1	2	1	1	1	1	4	1	2	1	1	2	2	2	3	4	2	1	4	1	2	2	1	3	2	2	2	1	2	4	2	1	1	2	2	2	1	3	1	4	2	2	2	2	3	2	2	2	2	3	3	1	2
X9	1	1	2	3	1	1	1	2	2	3	1	1	2	2	3	3	2	2	3	3	1	3	2	3	2	1	2	2	2	2	2	2	3	2	3	1	3	2	3	1	2	1	3	3	2	2	3	2	2	2	3	2	4	2	2	2
X10	1	1	1	2	3	2	2	1	1	2	3	2	1	2	2	2	1	1	2	1	2	2	2	2	1	1	1	1	2	1	1	1	2	1	2	1	2	1	2	2	1	2	2	1	1	1	2	1	1	1	2	1	3	1	1	2
X11	1	1	1	2	1	1	2	1	1	1	2	1	1	1	2	2	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	2	1	1	1	2	1	3	1	1	1
X12	1	1	1	1	2	1	1	2	1	1	1	1	1	1	2	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	2	1	1	1
X13	2	2	1	2	3	2	1	1	2	3	1	2	1	1	2	2	2	1	2	1	1	2	2	2	2	1	1	1	2	2	2	2	2	1	2	2	2	1	2	1	1	1	2	1	2	2	2	1	2	1	2	2	1	1	2	2
X14	2	2	3	4	3	2	2	4	2	2	3	3	3	3	3	2	3	3	3	4	2	4	3	3	2	1	3	4	3	3	2	2	3	3	2	3	3	2	1	2	3	1	3	2	2	3	3	3	2	3	3	2	4	3	2	3
X15	2	2	3	2	1	2	1	2	1	4	2	3	3	2	2	1	3	3	4	2	1	3	3	2	1	1	3	2	1	3	3	1	4	1	2	2	2	2	2	1	3	1	4	2	1	3	2	3	1	2	2	1	4	3	1	2
X16	2	2	1	2	2	2	1	2	2	1	1	1	1	2	4	2	1	1	2	2	1	2	2	4	2	1	1	1	2	1	2	2	2	1	2	2	4	1	2	1	1	2	2	1	2	1	4	1	2	1	4	2	4	1	2	2
X17	2	1	4	1	1	1	2	1	2	2	1	4	3	2	2	1	2	4	1	2	1	1	1	2	1	1	4	3	1	2	1	1	1	2	2	2	2	3	3	1	3	1	1	2	1	2	2	4	1	3	2	1	2	4	2	2
X18	1	1	2	1	1	1	1	1	1	2	1	2	2	1	2	1	1	2	1	1	1	1	1	2	1	1	2	2	1	1	1	1	1	1	1	1	2	2	1	1	2	1	1	2	1	1	2	2	1	2	2	1	3	2	1	1
X19	1	2	1	2	2	2	2	1	2	3	2	1	1	2	3	2	1	1	2	1	1	2	2	3	2	1	1	1	2	1	2	2	2	1	1	1	3	1	2	1	1	1	2	1	2	1	3	1	2	1	3	2	3	1	2	2
X20	2	3	3	4	4	3	3	4	1	2	1	3	4	1	2	3	3	3	2	2	1	2	1	2	3	4	3	3	1	2	2	3	2	2	4	3	2	3	1	1	3	3	2	2	1	2	2	3	4	3	2	3	2	3	3	3
X21	1	1	1	1	2	1	1	1	1	3	1	1	1	1	2	1	1	1	2	1	1	2	2	2	2	1	1	1	1	1	2	2	2	1	1	1	2	1	1	1	1	1	2	1	2	1	2	1	2	1	2	1	4	1	1	1
X22	1	2	1	1	1	2	1	2	1	1	1	1	2	1	2	1	1	1	1	2	1	1	1	2	1	2	2	1	1	1	1	1	1	2	1	1	2	2	2	1	1	1	1	2	1	1	1	1	2	1	2	1	1	1	1	1
X23	1	1	2	1	2	2	1	2	1	1	1	1	1	2	1	2	1	1	2	1	1	2	1	1	1	1	1	1	2	2	1	1	2	1	2	1	1	2	3	1	1	2	2	1	1	1	1	1	2	1	1	2	1	2	1	1
X24	1	2	1	2	1	1	1	2	2	1	2	1	2	2	1	2	2	1	2	1	1	2	1	2	1	3	1	1	2	1	1	1	2	1	2	1	2	1	2	1	2	1	2	1	1	1	1	1	1	2	1	2	1	2	2	2
X25	2	1	2	2	3	1	3	3	2	1	2	2	2	2	1	1	1	2	3	2	1	3	3	1	3	1	2	2	2	1	3	2	3	2	2	2	1	2	2	1	2	1	3	2	2	1	1	2	3	2	1	2	2	2	2	2
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Severity attribute recap

Variable	Severity																																																							
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23	X24	X25	X26	X27	X28	X29	X30	X31	X32	X33	X34	X35	X36	X37	X38	X39	X40	X41	X42	X43	X44	X45	X46	X47	X48	X49	X50	X51	X52	X53	X54	X55	Average
X1	1	1	2	1	1	1	3	2	1	1	3	1	1	1	1	2	1	4	1	1	2	1	1	1	1	4	1	2	1	2	2	4	1	2	1	1	3	4	1	1	1	1	2	2	3	1	1	1	2	1	2	1	2	4	3	2
X2	1	3	3	4	3	1	2	2	1	1	5	2	2	1	1	2	3	4	3	4	3	1	2	3	4	5	3	3	3	3	3	4	2	3	3	4	4	4	2	3	4	3	3	3	4	3	3	2	3	3	2	3	3	4	3	3
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