

**ANALYSIS OF JOB RISK IN MANUFACTURING THE CONCRETE
BRICK BY USING HAZARD IDENTIFICATION, RISK ASSESSMENT,
AND RISK CONTROL (HIRARC) METHOD**

UNDERGRADUATE THESIS

**Submitted to the International Undergraduate Program in Industrial Engineering
in Partial Fulfilment of Requirement for the Degree of Sarjana Teknik at the
Faculty of Industrial Technology
Universitas Islam Indonesia**



Name : Muhammad Rizky Aditya
Student Number : 19 522 026

**UNDERGRADUATE PROGRAM IN INDUSTRIAL ENGINEERING
FACULTY OF INDUSTRIAL TECHNOLOGY
UNIVERSITAS ISLAM INDONESIA
YOGYAKARTA**

2024

AUTHENTICITY STATEMENT

For the sake of Allah SWT, I admit this work is the result of my own work except for the excerpts and summaries from which I have explained the source. If in the future it turns out that my confession is proven to be untrue and violates the legal regulations in the paper and intellectual property rights, then I am willing to get a bachelor degree that I have received to be withdrawn by the Universitas Islam Indonesia.

Yogyakarta, 18 July 2024



(Muhammad Rizky Aditya)

SUPERVISOR APPROVAL SHEET

Analysis of Job Risk in Manufacturing the Concrete Brick by Using Hazard Identification,
Risk Assessment, and Risk Control (HIRARC) Method

ISLAM

UNDERGRADUATE THESIS

By:

Name : Muhammad Rizky Aditya

Students Number : 19 522 026

UNIVERSITAS INDONESIA

Yogyakarta, 18 July 2024

Supervisor,



(Ir. Hartomo, M.Sc., Ph.D. IPU., ASEAN.Eng)

EXAMINERS APPROVAL SHEET

Analysis of Job Risk in Manufacturing the Concrete Brick by Using Hazard Identification,
Risk Assessment, and Risk Control (HIRARC) Method

UNDERGRADUATE THESIS

Written by:

Name : Muhammad Rizky Aditya
Students Number : 19 522 026

Has been defended before the board of examiners in partial fulfillment of the requirement for
a Bachelor Degree in Teknik Industri at the Faculty of Industrial Technology Universitas
Islam Indonesia
Yogyakarta, July 18, 2024

Board of Examiners

Ir. Hartomo, M.Sc., Ph.D., IPU., ASEAN.Eng
Chairman

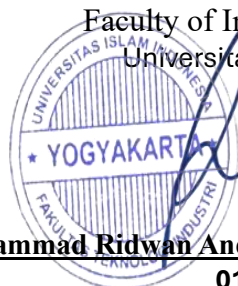
Dr. Ir. Agus Mansur, S.T., M.Eng.Sc., IPU.
Member I

Dr. Drs. Imam Djati Widodo, M.Eng.Sc.
Member II



الجامعة الإسلامية
الاستاذ المساعد
الهندسة

Acknowledged by
Head of Undergraduate Program in Industrial Engineering
Faculty of Industrial Technology
Universitas Islam Indonesia



Ir. Muhammad Ridwan Andi Purnomo, S.T., M.Sc., Ph.D., IPM
015220101

DEDICATED PAGE

Alhamdulillahirabbil'alamin

This undergraduate thesis that spent a lot of time and resources is dedicated to my mom,

Ir. Fitri Nugraheni, S.T, M.T, Ph.D., IPM

This undergraduate thesis also would not be possible to be completed without the assistance of my supervisor, Ir. Hartomo, M.Sc., Ph.D., IPU., ASEAN.Eng

MOTTO

“(Allah) is the creator of heaven and earth. When He wants to decree something, He simply says to it, "Be!" Then it becomes something." (Q.S Al-Baqarah verse 117)

“O you who believe! Ask for help (from Allah) with patience and prayer. Indeed, Allah is with those who are patient." (Q.S Al-Baqarah verse 153)

“Don't follow something you don't know. Indeed, hearing, sight and conscience, all of them will be called to account." (Q.S Al – Isra' verse 36)

PREFACE

Alhamdulillah, we give praise and gratitude to Allah Subhanahu Wata'ala. The One who only asks Him for help. Thank God for all His help, grace, and love so that the author can complete the thesis entitled "Analysis of Job Risk in Manufacturing the Concrete Brick by Using Hazard Identification, Risk Assessment, and Risk Control (HIRARC) Method". Shalawat and greetings to Rasulullah Shallallahu Alaihi Wasallam who has always been a source of inspiration and the best example for mankind.

Entering the era of global industrialization makes competition fiercer. To survive in competition, companies must optimize their resources and produce quality products product while reducing work accidents. Work accidents could occur because of people are not warned or careless actions while doing their job. In concrete bricks industry, some still use manual and some already use the machine. To reduce risk and injury in their workplace, it needs a quality OSH so it could reduce the chance of work accidents.

The researcher is aware of the many parties who provided support and assistance during the completion of this study and final assignment. Therefore, it is appropriate for the researcher to respectfully express his thanks and pray that Allah will give the best reward to:

- Prof. Dr. Ir. Hari Purnomo., M.T., IPU, ASEAN.Eng as Dean of Faculty of Industrial Technology
- Dr. Drs. Imam Djati Widodo, M.Eng.Sc. as the Head of Department of Industrial Engineering
- Ir. Hartomo, M.Sc., Ph.D. IPU., ASEAN.Eng as the author's supervisor in completing the undergraduate thesis.
- the Chairman of the Company of Pusat Inovasi Material Vulkanis Merapi, Universitas Islam Indonesia
- Lecturers at the Faculty of Industrial Technology, Islamic University of Indonesia
- Dr. Taufiq Immawan, S.T., M.M., who has been an examiner in research proposal seminars.
- Dr. Ir. Agus Mansur, S.T., M.Eng.Sc., IPU. And Dr. Drs. Imam Djati Widodo, M.Eng.Sc. who has been an examiner in research defense.

The researcher also thanks all parties who have helped the researcher in completing this undergraduate program, who the researcher cannot mention one by one.

Finally, the researcher realizes that nothing is perfect, the researcher still makes mistakes in preparing the thesis. Therefore, the researcher apologizes profusely for the mistakes made.

The researcher hopes that this thesis will be useful for readers and can be used as a reference for further development. Truth comes from Allah and error comes from humankind. May Allah SWT always bestow His mercy and blessings on all of us.

Yogyakarta, 18 July 2024

Researcher

A handwritten signature in black ink, appearing to read 'Rizky Aditya', with a large circular flourish at the beginning and a long horizontal stroke at the end.

Muhammad Rizky Aditya

ABSTRACT

Global industrialization leads to fiercer competition. To survive in competition, companies must optimize their resources and produce qualified products while reducing work accidents. Work accidents could occur because people are less warned or demonstrate careless actions while doing their job. In the industry of concrete bricks, some still use manual and some already use the machine. To reduce risk and injury in the workplace, a quality OSH is needed to reduce the chance of work accidents. This research aims to identify the risks from the hazards involved in the production process in Pusat Inovasi Material Vulkanis Merapi UII. The research data of this research is primary data, which is using literature review and field study, and secondary data, which is using AS/NZS 4360 and ISO 31000. The instruments of this research are observation sheets and interview sheets. The methods to collect data in this research are observation, interview, and literature study. The type of research used in this research is qualitative descriptive using the HIRARC method. The result of this research is From Hazard Identification, which reveals that there are several hazards of work-related concrete brickmaking. The hazards are getting sand by stooping, carrying out the bucket of sand, the bucket does not have rubber on it, a wet area close to the electric source, carrying out the sack of cement, clamping, slipping, carrying up while stooping, and carry up the concrete brick. Risk Assessment before risk control exposes the absence of extreme levels of risk, 54% high level of risk, 38% moderate level of risk, and 8% low level of risk. From Risk Control, several activities were identified to reduce the risk that may cause work accidents. The activities are using a long shovel, using a cart, safety gloves, and an isolation electric source, cart, clear the workplace, making a pipe from the mixer into a Mold, and squatting while lifting the concrete brick. This research concludes that the method of HIRARC can be used to identify hazards, identify risks and their levels, and finally determine activities to control the risks.

Keywords: Work Accidents, OSH, HIRARC

LIST OF CONTENTS

SUPERVISOR APPROVAL SHEET	iii
EXAMINERS APPROVAL SHEET	iv
DEDICATED PAGE	v
MOTTO	vi
PREFACE	vii
ABSTRACT	ix
LIST OF CONTENTS	x
LIST OF TABLES	xii
LIST OF FIGURES	xiii
CHAPTER 1	1
INTRODUCTION	1
1.1 Background.....	1
1.2 Problem Formulation.....	4
1.3 Research Objectives	4
1.4 Research Limitation	4
1.5 Research Benefit	5
1.6 Systematic Writing	5
CHAPTER 2	7
LITERATURE REVIEW	7
2.1 Deductive Review	7
2.2 Inductive Review	13
CHAPTER 3	24
RESEARCH METHODOLOGY	24
3.1 The Object of Research.....	24
3.2 Research Location.....	24
3.3 Research Data.....	24
3.4 Research Instruments.....	25
3.5 Data Collection Methods.....	28
3.6 Data Processing	28
3.7 Analysis Data	31
3.8 Flow Diagram.....	32
CHAPTER 4.....	35
DATA COLLECTION AND PROCESSING	35
4.1 Data Collection	35

4.2 Data Processing	36
CHAPTER 5.....	47
DISCUSSION	47
5.1 Analysis of the Hazard Identified	47
5.2 Analysis of Risk Assessed	49
5.3 Analysis of Risk Controlled	50
CHAPTER 6.....	54
CLOSING.....	54
6.1 Conclusion	54
6.2 Suggestions	55
REFERENCES	56
ATTACHMENT.....	60

LIST OF TABLES

Table 2.1 Previous Journal	28
Table 3.1 Production Process of Making Concrete Bricks	38
Table 3.2 Risk Rubric for Likelihood	42
Table 3.3 Risk Rubric for Severity/Consequences	42
Table 3.4 Risk Matrix	43
Table 3.5 List of 5W + 1H Questions	44
Table 4.1 Hazards Identification	53
Table 4.2 Risk Assessment	54
Table 4.3 Risk Control	56

LIST OF FIGURES

Figure 1.1 Area Concrete Bricks Industry in Pusat Inovasi Material Vulkanis Merapi UII	18
Figure 2.1 Flowchart of HIRARC based on the Guideline of HIRARC by Ministry of Human Resource Malaysia, 2008	23
Figure 3.1 Flowchart	48
Figure 4.1 Worker is taking the sand	51
Figure 4.2 Worker is pouring the water	52
Figure 4.3 Worker is pouring the cement	52
Figure 4.4 the mixer is mixing the material	53
Figure 4.5 the cement paste is out from the mixing machine	53
Figure 4.6 Concrete brick after being pressed	54
Figure 4.7 the worker is moving the concrete brick	54
Figure 5.1 Work posture when using long shovel	65
Figure 5.2 Worker is lifting the weight	67
Figure 5.3 Work posture when lifting	68
Attachment 1 Worker delivering sand into mixer	75
Attachment 2 Worker is taking a sand	75
Attachment 3 Worker pouring sand into mixer	75
Attachment 4 Carry up the bucket of sand	75
Attachment 5 The mixer is pouring out the cement paste	75
Attachment 6 Worker is digging the sand	75
Attachment 7 The worker is turning on the mixing machine	76
Attachment 8 Worker is cleaning the work area	76
Attachment 9 the worker is trying to carry the sack of cement	76
Attachment 10 the mixer machine is pouring out the cement paste	76

Attachment 11 the worker is pouring sand into mixing machine	76
Attachment 12 the mixing machine is mixing	76
Attachment 13 the worker is pouring cement from the sack of cement	77
Attachment 14 Silo	77
Attachment 15 the worker is turning on the mixing machine	77
Attachment 16 Unused concrete brick in Workplace	77
Attachment 17 Unused cable	77
Attachment 18 The rules in PIMVM UII	77
Attachment 19 Unused Workplace	78
Attachment 20 Failed concrete brick	78
Attachment 21 Rocks and Buckets for water	78
Attachment 22 Press machine	78
Attachment 23 Mixing machine after use	78
Attachment 24 A power source for press machine	78
Attachment 25 Press machine hydraulic	79
Attachment 26 Press machine table	79
Attachment 27 Messy Workplace	79
Attachment 28 hold closer in mixing machine	79
Attachment 29 Level for mixing machine	79
Attachment 30 The group of concrete brick	79
Attachment 31 Woodcutter	80
Attachment 32 Table wood cutter	80
Attachment 33 Drying concrete brick	80
Attachment 34 Unused press machine	80

Attachment 35 Drying concrete brick	80
Attachment 36 PIMVM UII	80
Attachment 37 Old concrete brick	81
Attachment 38 Old Sand Warehouse	81
Attachment 39 Sand area	81
Attachment 40 Tools Warehouse	81
Attachment 41 The worker lifting the undried concrete brick	81
Attachment 42 Concrete brick after pressing	81
Attachment 43 Worker lifts the concrete brick into pickup car	81

CHAPTER 1

INTRODUCTION

1.1 Background

At the era of global industrialization, industrial competition is becoming increasingly fiercer. This competition not only involves large companies but also among small and medium industrial companies (IKM). Therefore, small, and medium industrial companies (SME) must optimize company resources and produce quality products to survive in competition with other companies. Apart from that, the question is how to increase productivity while improving safety and health and reducing work accidents. Based on data obtained from BPJS Employment as of February 2017, it is known that there have been 383 work accidents, or an increase of 85% compared to last year which only had 201 cases (BPJS, 2017).

A workplace accident, commonly known as an industrial accident, is an unforeseen event in a workplace that results in employee injury or accident. Work Accidents occur because people are not warned or do careless actions while doing their job or responsibility. Thus, the tool or material that injures the worker causes death or bad injury. Every job has risks, which are caused by uncertainty that happen in the future.

As stated by a report from the Ministry of Labor (Kemnaker), there were around 234,270 victims of industrial accidents in Indonesia in 2021. Those victims were recorded from the five economic sectors with the largest number of victims in industry, namely trade, and services; various industries; consumer goods industry; agriculture-plantation-forestry-fishery; and basic materials and chemical industries. The number of work accidents occurred in the trade and service industry: 52,224 people, 48,195 people suffered from accidents in various industries, 38,879 people in the consumer goods industry, 38,476 people in agriculture, forestry, and fishery, and 27,187 in basic and chemical industrial accidents. In other sectors, work-related accidents in Energy-Telco-Transportation reached about 10,214 people, work-related accidents in Mining counted as 6,565 people, work-related accidents in Finance and Investment recorded 3,651 people, work-related accidents in Property and Real Estate were 3,402 people, and work-related accidents in other sectors with 5,577 people respectively.

The concrete brick industry is popular in Yogyakarta, especially in Sleman Regency, because the price is low, good quality, and affordable. The existence of industry in Yogyakarta,

especially in Sleman Regency, has many places that also sell it either. The concrete brickmaking tends to use sand from rivers in Sleman, where the river flow comes from Merapi volcano.

In the process of making concrete blocks, some concrete block industry still makes concrete blocks manually, which means that it still involves humans in the manufacturing process to mix, press, etc. Some concrete block industry makes concrete block already use machines, which means that they still use machines in all manufacturing processes like mixing, pressing, etc. Furthermore, it has an important role in the manufacturing process, which leads to quality control and occupational safety and health (OSH). Occupational Safety and Health (OSH) is very important in the concrete block industry because it could help workers lessen injury and reduce risks and accidents that may occur in the concrete block industry.

This Innovation Centre, Pusat Inovasi Material Vulkanis Merapi (PIMVM) UII was first established and operated on September 1, 2012, and is under the auspices of Universitas Islam Indonesia (UII). PIMVM UII focuses on research activities, community empowerment, and business incubators for the UII academic community and surrounding communities. This establishment is proof of UII's seriousness as the closest university to Merapi volcano in the context of empowering local resources (natural resources, human resources, and technological resources) so that the people around Merapi volcano can utilize local potential to significantly improve their lives.

The products developed by PIMVM are based on studies and research results conducted by UII lecturers and students who mainly focus on research on sand-cement-based building materials. These products have gone through a testing process in the community. For example: Batako Merapi, the result of PIMVM innovation, was initiated through a Focus Group Discussion with UII alumni as construction actors and has been evaluated at the UII Engineering Construction Materials Laboratory. Batako Merapi products received the Indocement Award in 2012. PIMVM prioritizes the goals embedded in the motto: MOVE, GROW, and SHARE within the framework of community empowerment, especially the community around Merapi volcano, where the UII Integrated Campus is located.

A pre-preliminary survey at PIMVM UII shows that no standard operation procedure is applied, and the place has many possibilities for the occurrence of work-related accidents. Due to no standard operation procedure being applied in PIMVM UII, there is a need to conduct

research about it. The first step to prepare a standard operational procedure is to do risk management by utilizing the HIRARC method.

In PIMVM UII, there are three areas which are the shelter area, production area 1, and production area 2. The workers who work most of the time use the production area 1 (Figure 1) as the place to produce the concrete brick. In Production Area 1, many concrete bricks are situated on the floor (Figure 1), also there are many concrete bricks in the dry session. They produce many kinds of concrete brick shapes such as Trass/White, Cement, and Concrete. In production area 1, 2 machines are operated which are the Mortar Machine and Press Machine.

A pre-preliminary survey at PIMVM UII, shows that there are many ways to cause work accidents such as being electrocuted by electrical equipment, having broken bolt nuts due to engine shocks, slipping due to areas full of gravel and leaking oil, falling by concrete brick, back pain, hands and feet being caught in machines, and they are not using Personal protective equipment.



Figure 1.1: Area Concrete Bricks Industry in Pusat Inovasi Material Vulkanis Merapi UII

PIMVM UII has six employees work in the industry. There is a rule available to guide them during their work. Early interviews have been conducted to find out their experience. It reveals that they do have accidents during their working time in PIMVM UII i.e. The accidents are falling by Concrete Brick, slipping, Back Pain, Electrocuted, and Sprained Feet, respectively. The frequency of each accident to occur are varied i.e. Seldom and Sometimes. workers experience work accidents Fall by Concrete Brick 10%, Slipped 20%, Back Pain 30%, Electrocuted 10%, and Sprained Feet 30%. This figure strongly captures why there is a need to have work-related risk management. The result of the research will act as a basic safety rule in the industry.

1.2 Problem Formulation

From the explanation in the background above, the workers are poor in Occupational Health and Safety to work safety. Therefore, obtained some formulas for the problem namely:

1. What kind of work-related hazards in concrete brick making?
2. What is the level of risks that cause work accidents?
3. How to reduce the risk that causes work accidents?

1.3 Research Objectives

From the problem formulation above, below is the objective of this study as follows:

1. To identify hazards of work-related concrete brickmaking.
2. To determine the level of risks that cause work accidents.
3. To find out the solution to reduce the risk that causes work accidents.

1.4 Research Limitation

Several limitations must be identified so it could be guidelines for conducting the research. The limitations of research are:

1. The research was conducted at Pusat Inovasi Material Vulkanis Merapi UII from September 12, 2023 to November 17, 2023.
2. This study only focuses on the risks that may occur in the workplace.
3. The object of this study is the workplace that makes concrete brick.
4. The method used in this study is HIRARC.
5. Variables and indicators are in accordance with what has been determined.

1.5 Research Benefit

The result of this research is expected to provide contributions to several sectors:

1.5.1 For Students

More attached to the application of Industrial Engineering science in Ergonomics or Human Factor Engineering, especially in Occupational Safety and Health, Ergonomics, and Risk Management and its impact on worker performance.

1.5.2 For Company

Providing complete information to workers and hopefully this research will be used as a recommendation to find out the potential risks of a hazard that exists at the Pusat Inovasi Material Vulkanis Merapi JTS UII to create a solution in reducing the occurrence of work accidents.

1.5.3 For University

Enriching knowledge as study material for fellow students and also as a consideration for students.

1.6 Systematic Writing

This undergraduate research will be organized into several chapters, which will be explained below:

CHAPTER I INTRODUCTION

The introduction contains the background for the undergraduate thesis and the problem formulation., it also contains the seven objectives of the research, the scope of the research, and the benefits of the research.

CHAPTER II LITERATURE REVIEW

Chapter 2 will summarize the findings from the prior studies and research that are relevant to this research. After reviewing the prior studies and seven research thoroughly, it will become the reference for this undergraduate research to resolve the existing problem.

CHAPTER III METHODOLOGY

This section describes the framework, flow chart, and data collection method of this undergraduate research. This will help to make the research more structured

and organized. Here, the flow of the research will be explained in detail so that the readers can understand the research methodology.

CHAPTER IV DATA COLLECTION AND PROCESSING

This chapter describes the data collection in the form of an overview of the company organization, problem issues, and sales quantitative data to be further processed to become a proposed performance improvement project in the company.

CHAPTER V DISCUSSION

The outcomes of this research will be discussed in Chapter 4. The result of the research will be analyzed subjectively using theoretical explanations and statistically based on the research findings and studies. The findings needed to satisfy the research objectives. Based on the analysis in this chapter, there will be recommendations on how to improve the supply chain of the metal casting company.

CHAPTER VI CONCLUSION AND SUGGESTION

Chapter 6 is the closing that contains conclusions and suggestions regarding the undergraduate thesis. The conclusion is made based on the result and discussion and also must answer the objective of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Deductive Review

HIRARC Method

According to Guideline of HIRARC (Ministry of Human Resource Malaysia, 2008), HIRARC (Hazard Identification, Risk Assessment, and Risk Control) is a method to identify all the factors that may cause harm to employees and others (the hazards) or to consider what the chances are of that harm actually be falling anyone in the circumstances of a particular case and the possible severity that could come from it (the risks) or to enable employers to plan, introduce and monitor preventive measures to ensure that the risks are adequately controlled at all times.

According to the Guideline of HIRARC (Ministry of Human Resource Malaysia, 2008), HIRARC requires 4 steps to identify risk so it could be reduced to minimum death or bad injury. The 4 simple steps of HIRARC are: first, we must classify the work activities in that place. Second, we can identify hazards from several work activities in the workplace. Third, we must conduct a risk assessment. According to ISO 31000, Risk assessment is the overall process of risk identification, analysis, and evaluation.

1. Risk identification: Through applying risk identification tools and techniques, the organization should identify risk sources, areas of impact, events and causes, and their potential consequences.
2. Risk analysis: Risk analysis involves the development of an understanding of the risk, consideration of the causes and risk sources, their positive and negative consequences, the likelihood that those consequences can occur, provides input to risk evaluation and a decision on whether risks need to be treated, and on the most appropriate risk treatment strategies and methods.
3. Risk evaluation: The purpose of this step is to assist in decision-making about which risks need treatment and priority for treatment implementation.

Fourth, we could decide if the risk is tolerable and apply control measures (if necessary).

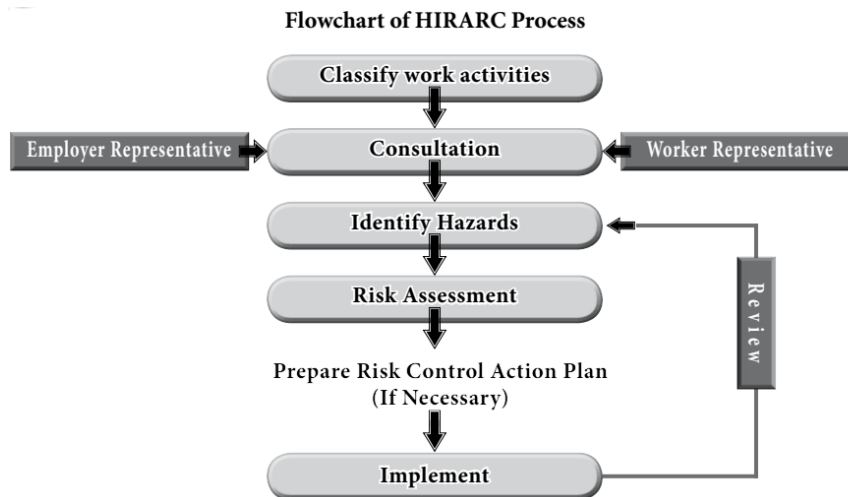


Figure 2.1: Flowchart of HIRARC based on the Guideline of HIRARC by Ministry of Human Resource Malaysia, 2008

According to the Guideline of HIRARC (Ministry of Human Resource Malaysia, 2008), The purpose of hazard identification is to highlight the critical operations of tasks, that is, those tasks posing significant risks to the health and safety of employees as well as highlighting those hazards pertaining to certain equipment due to energy sources, working conditions, or activities performed. Hazards could be identified and assessed from these sources i.e. first is any hazards that have been reported into investigation reports, second is that hazard could be from a source that is in first aid records and minor injury records, third is the hazard that is in workplace health protection programs, fourth is that hazard that in any results of workplace inspections, fifth is that hazard was recorded from any employee complaints and comments, sixth is that hazard that is recorded in any government or employer reports, studies, and tests concerning the health and safety of employees, seventh is that hazard that was recorded in any reports made under the regulation of Occupational Safety and Health Act, 1994, eighth is that hazard that was recorded in the record of hazardous substances, and ninth is that hazard came from the source of any other relevant information.

Besides, Risk is the determination of the likelihood and severity of the credible accident/event sequences to determine the magnitude and to prioritize identified hazards (Ministry of Human Resource Malaysia, 2008). It can be done by qualitative, quantitative, or semi-quantitative methods. A qualitative analysis uses words to describe the magnitude of potential severity and the likelihood that that severity will occur. These scales can be adapted or adjusted to suit the circumstances and different descriptions may be used for different risks. This method uses expert knowledge and experience to determine the likelihood and severity category. In semi-quantitative analysis, qualitative scales such as those described above are

given values. The objective is to produce a more expanded ranking scale than is usually achieved in qualitative analysis, not to suggest realistic values for risk such as is attempted in quantitative analysis. Quantitative analysis uses numerical values (rather than the descriptive scales used in qualitative and semi-quantitative analysis) for both severity and likelihood using data from a variety of sources such as past accident experience and scientific research. Severity may be determined by modeling the outcomes of an event or set of events, or by extrapolation from experimental studies or past data. Severity may be expressed in terms of monetary, technical or human impact criteria, or any of the other criteria. How severity and likelihood are expressed and the ways in which they are combined to provide a level of risk will vary according to the type of risk and the purpose for which the risk assessment output is to be used. In these guidelines, qualitative and semi-quantitative methods are used as an example.

Refer to the Guideline of HIRARC (Ministry of Human Resource Malaysia, 2008), Control is the elimination or inactivation of a hazard in a manner such that the hazard does not pose a risk to workers who have to enter into an area or work on equipment in the course of scheduled work. Hazards should be controlled at their source (where the problem is created). The closer a control to the source of the hazard is the better. This method is often referred to as applying engineering controls. If this does not work, hazards can often be controlled along the path to the worker, between the source and the worker. This method can be referred to as applying administrative controls. If this is not possible, hazards must be controlled at the level of the worker using personal protective equipment (PPE), although this is the least desirable control.

Occupational Safety and Health

According to the International Labour Organization, Occupational safety and health is an extensive multidisciplinary field, invariably touching on issues related to scientific areas such as medicine – including physiology and toxicology – ergonomics, physics, and chemistry, as well as technology, economics, law, and other areas specific to various industries and activities. Despite this variety of concerns and interests, certain basic principles can be identified, including the following:

- a. All workers have rights. Workers, as well as employers and governments, must ensure that these rights are protected and must strive to establish and maintain decent working conditions and a decent working environment. More specifically: — work should take place in a safe and healthy working environment; — conditions of work should be

consistent with workers' well-being and human dignity; — work should offer real possibilities for personal achievement, self-fulfillment and service to society (ILO, 1984).

- b. Occupational safety and health policies must be established. Such policies must be implemented at both the national (governmental) and enterprise levels. They must be effectively communicated to all parties concerned.
- c. A national system for occupational safety and health must be established. Such a system must include all the mechanisms and elements necessary to build and maintain a preventive safety and health culture. The national system must be maintained, progressively developed and periodically reviewed.
- d. A national program on occupational safety and health must be formulated. Once formulated, it must be implemented, monitored, evaluated, and periodically reviewed.
- e. Social partners (that is, employers and workers) and other stakeholders must be consulted. This should be done during the formulation, implementation, and review of all policies, systems, and programs.
- f. Occupational safety and health programs and policies must aim at both prevention and protection. Efforts must be focused above all on primary prevention at the workplace level. Workplaces and working environments should be planned and designed to be safe and healthy.
- g. Continuous improvement of occupational safety and health must be promoted. This is necessary to ensure that national laws, regulations, and technical standards to prevent occupational injuries, diseases, and deaths are adapted periodically to social, technical, and scientific progress and other changes in the world of work. It is best done by the development and implementation of a national policy, national system, and national program.
- h. Information is vital for the development and implementation of effective programs and policies. The collection and dissemination of accurate information on hazards and hazardous materials, surveillance of workplaces, monitoring of compliance with policies and good practice, and other related activities are central to the establishment and enforcement of effective policies.
- i. Health promotion is a central element of occupational health practice. Efforts must be made to enhance workers' physical, mental, and social well-being.

- j. Occupational health services covering all workers should be established. Ideally, all workers in all categories of economic activity should have access to such services, which aim to protect and promote workers' health and improve working conditions.
- k. Compensation, rehabilitation, and curative services must be made available to workers who suffer occupational injuries, accidents, and work-related diseases. Action must be taken to minimize the consequences of occupational hazards.
- l. Education and training are vital components of safe, healthy working environments. Workers and employers must be made aware of the importance of establishing safe working procedures and how to do so. Trainers must be trained in areas of special relevance to industries, so that they can address the specific occupational safety and health concerns.
- m. Workers, employers, and competent authorities have certain responsibilities, duties, and obligations. For example, workers must follow established safety procedures; employers must provide safe workplaces and ensure access to first aid; and the competent authorities must devise, communicate, and periodically review and update occupational safety and health policies.
- n. Policies must be enforced. A system of inspection must be in place to secure compliance with occupational safety and health measures and other labour legislation.

Some overlap exists among these general principles. For example, the gathering and dissemination of information on various facets of occupational safety and health underlies all the activities described. Information is needed for the prevention as well as the treatment of occupational injuries and diseases. It is also needed for the creation of effective policies and to ensure that they are enforced. Education and training demand information. While these key principles structure occupational safety and health programs and policies, the above list is by no means exhaustive. More specialized areas have corresponding principles of their own. Moreover, ethical considerations regarding such matters as individuals' rights to privacy must be taken into consideration when devising policies.

According to oshwiki.osha.european.eu, Prevention is a key concept in OSH. Prevention of workplace injuries and ill health must be the main objective of any OSH management system, rather than attempting to solve problems after they have occurred. This principle is assuming increased importance since organizations are rapidly changing (due to globalization, downsizing, part-time work, temporary work, subcontracting, ageing workforce), thus calling for a dynamic OSH approach. Such a dynamic approach requires a

systematic approach to OSH by establishing OSH programs based on clear goals and by integrating OSH management into other business systems and processes.

The general principles for the prevention of unsafe working conditions set by the Framework Directive have been continuously restated in the EU and further developed in other documents. For instance, the “Luxembourg Declaration on [Workplace Health Promotion](#) in the European Union” sets out several principles, which aim at preventing ill health at work (including work-related diseases, accidents, injuries, occupational diseases, and stress) and enhancing health-promoting potentials and well-being in the workforce ^[11]. These principles are:

- Company codes of conduct and guidelines that view employees not only as cost factors but as important success factors.
- [Company culture](#) and management policies that include [the participation of the employees](#) and encourage them to assume responsibility;
- Work organization that enables employees to balance the [demands](#) made by the job with their skills and to control their own work and social support;
- Personnel policies that incorporate health targets into all other areas of the company.
- Integrated [occupational safety and health services](#);
- Inclusion of employees in [health issues](#) at all levels (participation);
- Systematic implementation of [all measures and programs \(project management\)](#);
- Linking risk reduction strategies with the development of safety factors and health potentials (comprehensive approach).

Considering the above-mentioned principles and the need to focus on the prevention of workplace injuries and ill health, companies should implement and integrate an OSH Management system in their management system. Such system is intended to develop and implement the company’s OSH policies and manage its OSH risks.

2.2 Inductive Review

Table 2.0-1 Previous Journal

No	Title	Author&Years	Method	Result
1	Perancangan Fasilitas Kerja Untuk Mengurangi Keluhan Musculoskeletal Disorders (Msds) Dengan Metode Rappid Entire Body Assesment Pada Pekerja Pembuatan Paving Dan Batako Pada Ukm Usaha Baru	Mahardika, T., & Pujotomo, D. (2014).	Rapid Entire Body Assessment (REBA)	From the results of research that has been carried out on the process of making paving and bricks, the level of risk is categorized as medium, high and very high so that changes need to be taken. Using anthropometric data, work facilities are designed to reduce complaints of musculoskeletal disorders. The results obtained produced a standing worktable base measuring 65 cm long, 50 cm wide and 90 cm high for paving and 65 cm long, 50 cm wide and 77 cm high for bricks, the addition of a storage table, cement and sand bins to make it easier for workers.
2	Usulan Alat Bantu Pemindahan Batako untuk Mengurangi Risiko Musculoskeletal Disorders di PT. Xyz	Setiadi, M. Y. (2013).	work posture analysis using the REBA method and biomechanical approaches using the RWL, LI and MPL methods.	The results obtained state that this activity is classified as a very high-risk level, and the recommended limit for the weight of the load that should be lifted by the operator is 6.76 Kg, while

				the LI index value obtained is 3.25, as well as the limit for the amount of compressive force (Fc) on segment L5/S1 is 10415.908 N. This situation indicates that the activity is classified as dangerous and can cause the risk of MSDs
3	Analisis Risiko Gangguan Saluran Pernafasan Pada Kegiatan Pembuatan Batako Di Ud. Fatimah, Kota Padang	Suksmerri, S. (2023).	The design used in this study is the Environmental Health Risk Analysis (EHRA) method. The sample was an air sample measuring 10 micrometers and a worker sample of 6 workers.	The result of this research is that the concentration of PM10 at the milling point is 19.4 g/m3. At the point of imprinting is 20.5 g/m3. And at the point of combustion is 231 g/m3.
4	Perancangan Meja Kerja Pada Pembuatan Batu Batako Dengan Menggunakan Metode Mantra Tool (Manual Task Risk Assement Tool) Dan Pendekatan Anthropometri (Studi Kasus Ukm Anto)	Nurkhodi, A. a. N. A., Siboro, B. a. H., & Purbasari, A. (2019).	This research was conducted using the NBM (Nordic Body Map) questionnaire method and the ManTRA (Manual Task Risk Assessment) method	The research results show that an ergonomic table design reduces the percentage of very sick levels from (16.42%) to (0%). Meanwhile, the level of no pain increased from (35%) to (70.71%) in parts of the body that previously experienced complaints of pain. Apart from that, the ManTRA analysis results show a decrease in the score from the cumulative risk value which previously reached

				16-20 points (more than 15) to 12-14 points (<15).
5	Faktor Yang Berhubungan Dengan Penyakit Dermatitis Kontak Pada Pekerja Pembuat Batako Press Di Desa Tembawang Bale	Dodi, A. (2021)	This was an analytical observational study with a cross-sectional design. As many as 30 workers participated as the samples. The data were statistically analyzed using a chi square test.	The results indicated that 16,1% workers experienced contact dermatitis caused by history of skin disease factor ($P = 0,000$). While the unrelated factors included contact ($P = 0,112$, $PR = 2,667$), handwashing habits ($P = 0,525$, $PR = 0,593$), personal hygiene habits ($P = 0,422$, $PR = 0,429$), changing laundry habits ($P = 0,468$, $PR = 0,614$), changing workwear habits ($P = 0,687$, $PR = 0,960$), work tools hygiene habits ($P = 0,838$), and the use of Personal Protective Equipment ($P = 0,422$, $PR = 0,429$).
6	Classification of Potential Risk Factors through HIRARC Method in Assessing Indoor Environment of Museums	Dzulkifli, S. N. M. (2018, December 29).	HIRARC	It was discovered that 8 out of the 24 selected museums were found to have medium potential risks, while the rest of them are of low potential risks, as summarized in Table 18. Surprisingly, none of the selected museums had high potential risk. Based on

				these findings, it was proven that most of the current museums in Malaysia, particularly those around the vicinity of Kota Melaka, have been provided with reasonably sufficient ventilation since none of the investigated museums falls within the high potential risk category. Nevertheless, museums' management should always be concerned with the indoor environment issues as the pollutants are not only generated from indoor sources, which is common in museums, but also coming from outdoor environment especially those situated nearby the industrial areas
7	Hirarc: A Tool Of Safety Imporvement In The Construction Industry	Bakri et al. (n.d.)	HIRARC	From structured interviews conducted to 10 safety personnel who implemented HIRARC in their projects, it has been found that the basic process of HIRARC was 100 % implemented and carried out. The study also revealed that

				each and all process of HIRARC was found to be “effective”. In addition to that, another structured interviews conducted to 26 consultants engaged with construction projects on the effectiveness of the implementation of HIRARC shows that HIRARC is also “effective” in identifying all potential hazards; assessing all the risks of hazards; making adequate risk control and accident preventive measures; acting as an occupational safety and health management system; and reducing accidents on construction sites. Finally, a comparison is made on the safety performance between construction projects which implemented HIRARC and construction projects which did not implement HIRARC
8	HIRARC Assessment of Machining Processes	Harizah, I. (2012).	HIRARC	The impact of this project is to inflict awareness on

				the danger or hazard exist in the machine and the importance of practicing safe work procedure in order to prevent the hazard from being realized.
9	Towards Zero Accidents in Construction Projects: Promoting HIRARC As An Effective Tool to Reduce Accidents	Lee, C. (2010).	HIRARC	The effectiveness of HIRARC in reducing accidents can be identified by comparing the safety performance of projects with HIRARC, and projects without HIRARC. The average issuance of stop work order, average issuance of Notice of Improvement (NOI), average accident frequency rate, and average severity rate for HIRARC project and Non HIRARC projects are compared. The average number of these criteria will give a picture of the safety performance averagely and is portrayed in Figure 3, it can be seen that HIRARC project averagely has a better safety performance

				compared to non HIRARC project. Non HIRARC project averagely has higher NOI (Notice of Improvement), stop work order, near miss, accident frequency rate, and severity rate compared to HIRARC project
10	Risk Control Enhancement Using Safety Climate Factors For Hirarc Method In Steel Product Industry	ADIPUTRA, M. F. (2015).	HIRARC	The safety climate result was subject to Exploratory Factor Analysis (EFA). From the EFA result, it was found that five factors were safety climate in steel product industry, involving management commitment and actions for safety, worker's commitment towards safety, priority for safety over production, emergency preparedness in the organization, and safeness in work environment. From analyzing the factors, administrative control method was selected to enhance risk control that was already selected by incorporating techniques in administrative control

				parallel with other type of risk control.
11	Analisa Hazard Identification Risk Assessment And Risk Control (Hirarc) Pada Perguruan Tinggi Yang Berlokasi Di Pabrik	Putri and Trifiananto (2019)	HIRARC	Risk assessment results state that 2% low risk, 87% medium risk, and 11% high risk with the potential that will occur in the form of 23% eye irritation, 20% respiratory problems and 20% bruising on the Source's limbs. The highest danger lies in mechanical and environmental factors. Therefore, risk control is carried out with carry out engineering control on cement manufacturing machines and processes and impose sanctions on workers or students who do not use complete PPE to minimize the occurrence work accidents and occupational diseases.
12	Implementation of Occupational Health Safety in Informal Industry of Paving	Citra et al. (2021)	This is a descriptive qualitative research that uses the HIRADC, with data	Workers do not use personal protective equipment properly to protect themselves from

	Block and Concrete Brick		obtained through direct field observation and in-depth interviews.	sand, cement dust, as well as mechanical and physical hazards at the workplace.
13	Manufacturing optimization using Tsukamoto fuzzy inference system method: A case study in block paving and solid concrete block industry	Sayuti (2018)	fuzzy fiction	the number of solid concrete block produced by the company on the period of October 2016, December 2016 and February 2017 was not optimal. According to Tsukamoto's FIS, the optimal number of solid concrete block in the third period is 9973, 9562 and 12.087 unit of solid concrete block. While the number of block paving produced by the company on the period of November 2016, December 2016 and January 2017 was also not optimal. According to Tsukamoto's FIS analysis, the optimal number of block paving in the third period should be 9.116, 10.113 and 7.120 unit of block paving

14	Hubungan Kebisingan Dengan Gangguan Pendengaran Pada Pekerja Di Unit Produksi Paving Block Cv. Sumber Galian Makassar	(<i>Human Verification</i> , n.d.)	approaching observational cross-sectional study	The result analysis univariate and bivariate against the independent variable and dependent and the result stated that the workplace, age, old workings deal with the occurrence hearing loss due to noisy to workers in the workplace
15	Mesin Cetak Paving Block Dengan Sistem Pneumatik Untuk Home Industry di Kabupaten Indramayu	Rahmi (2018)	Pneumatic System	Based on the results of testing the paving block printing machine with a pneumatic system, the results showed the differences in the process flow for making paving blocks using a pneumatic system printing machine from six process stages to four process stages, the process time using a paving block printing machine was faster compared to the manual process namely from 25 minutes to 11 minutes, the time efficiency obtained is 52% faster, in one process the printing machine

				immediately produces two paving blocks, whereas the manual process only produces one paving block and productivity results increase to 60% in one day work (8 hours work / normal shift).
--	--	--	--	---

Based on the studies above, there was no research has been found on studies about the HIRARC method in the concrete brick industry but there are many research studies on ergonomics in the concrete brick industry. Therefore, in this study, an analysis was carried out regarding the HIRARC method in the concrete brick industry. This method can show how significant the hypothesis tested in this study is. A significant hypothesis can be an input for companies to develop companies, and it is hoped that this research can contribute to further research.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 The Object of Research

The object of this research is to identify the risk from the hazards involved in the production process in Pusat Inovasi Material Vulkanis Merapi UII. Therefore, the hazards originated from the process of activities carried out by workers as well as other work activities in the factory, which have the potential to cause danger to the workplace.

3.2 Research Location

The research with the title “Analysis of Job Risk in Manufacturing the Concrete Brick by Using Hazard Identification, Risk Assessment, and Risk Control (HIRARC) Method” took place in Pusat Inovasi Material Vulkanis Merapi UII at the concrete brick production department from September 12, 2023, to November 17, 2023.

3.3 Research Data

As reported by Toppr.com (2020), data can be defined as a systematic record of a particular quantity. It is the different values of that quantity represented together in a set. It is a collection of facts and figures to be used for a specific purpose such as a survey or analysis. Based on the source, data can be categorized into groups below:

1. Primary data

“Primary data is a type of data that is collected by researchers directly from main sources through interviews, surveys, experiments, etc”. Primary data are usually collected from the source—where the data originally originates from and are regarded as the best kind of data in research.” (Busayo Longe (2020). Therefore, primary data sources can be defined as direct data sources that provide information directly from the first person (usually through interviews) to the data collector. The main data of this research are as follows:

- a. Literature Review

Is a collection of information in the form of theories, definitions, and methodology in the form of a literature review that helps in the process of solving the problem of the study to be carried out. where the main areas of information collection are OSH, Risk Management, HIRARC, and Hazards and Risks.

b. Field Study

Researchers carried out field observations by observing the environment around the Pusat Inovasi Material Vulkanis Merapi UII, especially in the production process.

2. Secondary data

Secondary data is data obtained from researchers of previous research or journals as additional information which is processed as supporting information for primary data studies. Secondary data can be obtained through books, theories, journals, or previous research. Secondary data used in this research are as follows:

- a. Australian Standard/New Zealand for Risk Management (AS/NZS 4360:2004)
- b. Australian Standard/New Zealand for Risk Management (AS/NZS 4360:1999)
- c. International Standard for Risk Management (ISO Guide 31000:2018)

3.4 Research Instruments

According to www.sampoernauniversity.ac.id, research instruments are tools used in research activities, especially for measuring and collecting data. It can be in the form of a questionnaire, a collection of test questions, observation sheets, and so on. Research instruments are also tools that must be created to accommodate and process various data collected for research. The research tool used in this research is direct observation by the researcher in an industrial environment, so the data were obtained from observations of industrial workers.

Furthermore, the observation uses the form or table of HIRARC to identify the hazards that high chance of occurring. Table 3.1 Production Process of Concrete Brick shows potential hazards from the process of making concrete brick.

Table 3.0-1 Production Process of Making Concrete Brick

No	Process activity	Picture
1	Mixing	The first step is the worker digs the sand into a bucket and then pours the sand into the mixing machine. 
		The second step is the worker pours the water from the big bucket by using a small bucket into the mixing machine. 
		The third step is the worker pours the cement from the sack of into the mixing machine. 
		The fourth step is to mix all the ingredients, such as water, sand, and cement in the mixing machine. Then, turn on the mixing machine to blend the 

		ingredients for a few minutes.	
2	Printing	The fifth step, after all ingredients have been mixed in the mixing machine, then they were poured it on the floor	
		The sixth step is to shovel the paste into the pressing machine, after the cement paste is attached on the floor. First, put the Mold on the pressing machine then pour the cement paste into the Mold. Later, the pressing process can be started	
		The seventh is, after the pressing process, the cement paste became concrete brick. The concrete bricks	

		were carried out using pick-up to dry it and send to the customer.	
--	--	--	--

3.5 Data Collection Methods

For data collection methods in this research, several methods for the work process were used. The data collection methods are as follows:

1. Observation

The observation method is a direct observation stage where researchers visit the Pusat Inovasi Material Vulkanis Merapi UII in the production process to observe and collect data about the risks of danger that may occur and the possibility or potential to cause work accidents.

2. Interview

The next method is interviews. The interview method or question-and-answer activity is a way or step to obtain additional, more accurate, and detailed information from the workers involved or from someone responsible for the production section of the Pusat Inovasi Material Vulkanis Merapi UII.

3. Literature Study

The next method is a literature study. Literature study is the process of collecting data or information that supports writing reports. Literature studies are obtained from books, journals, papers, information on the internet, and other research that has been carried out previously.

3.6 Data Processing

The type of research used in this research is qualitative descriptive using the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) method. This type of qualitative descriptive research is research where the initial stage is carried out using the observation method, in which the researcher observes directly into the real environment and then continues to the data collection stage to analyze activities or conditions in the real environment and determine the level of risk of danger that has the potential or is likely to cause work accidents. After that, continue with the use of the 5W + 1H method to provide actions or solutions to deal

with existing potential risks and to discover every risk that would occur in Pusat Inovasi Material Vulkanis Merapi UII. Furthermore, the implementation of HIRARC is described as follows:

a) Hazards Identification

The first step in the HIRARC method is the HI, which is the hazard identification. This step is to determine all hazards and risks that may occur in the workplace. The hazards and risks are associated with the hazards that could lead to work accidents.

b) Risk Assessment

The second step in the HIRARC method is the RA, which is the risk assessment. This step is to count the score of all hazards and risks that may occur in the workplace and can lead to work accidents. The scores that are counted are based on the likelihood and severity of consequences, which are stated in the risk rubric. The risk rubric of likelihood and consequences and the indicator of the level of result of multiple likelihood and consequences.

Which can be seen based on the likelihood level and severity/consequences level then put into the group based on a result of the multiple of likelihood and severity. Likelihood is the probability of how those risks and hazards could happen. If we put the score, then the risk rubric for the likelihood is shown in Table 3.2 Risk Rubric for Likelihood:

Table 3.2 Risk Rubric for Likelihood

Likelihood				
1	2	3	4	5
Rare	Unlikely	Possible	Likely	Extreme Likely

Severity or Consequences is defined as how big the impact of risks and hazards when the risks and hazards happen, if it puts the score, then the risk rubric for the severity or consequences is shown in Table 3.3 Risk Rubric for Severity/Consequences:

Table 3.3 Risk Rubric for Severity/Consequences

Severity/Consequences				
1	2	3	4	5
Insignificant	Minor	Medium	Major	Catastrophic

To determine the level of risks and hazards, the two risk rubrics must be multiplied, which are the likelihood and severity/consequences. Then, the result of multiple the two risk rubrics, which are the likelihood and severity/consequences, we could determine the risk level based on the risk matrix shown in Table 3.4 Risk Matrix below:

Table 3.4 Risk Matrix

X		Severity/Consequences				
		1	2	3	4	5
Likelihood	5	Moderate	High	Extreme	Extreme	Extreme
	4	Moderate	High	High	Extreme	Extreme
	3	Low	Moderate	High	High	Extreme
	2	Low	Moderate	Moderate	High	High
	1	Low	Low	Low	Moderate	Moderate

The risk matrix has a level which is low, moderate, high, and extreme. The lowest score is 1 which results from multiplying a rare level of likelihood which is 1 and an insignificant level of severity or consequences which is 1. It means that the risks and hazards are rare, and if they happen, the impact of the risks and hazards is not significant or a small injury. The highest score is 25 which results from multiplying of extreme likely level of likelihood which is 5 and the catastrophic level of severity or consequences which is 5. It means that the risks and hazards often or even always happen and if it happens, the impact of risks and hazards is bad injury or even cause death.

c) Risk Control

The third step in the HIRARC method is the RC, which is the risk control. This step is to do the risk mitigation and give people a recommendation based on the scores on the risk assessment, which are the result of the likelihood and severity or consequences. Before giving recommendations, it must give a solution to all hazards to keep the score of the risk matrix low with 5 W + 1H.

According to Safety Culture (2023), The 5W + 1H is a questioning approach and a problem-solving method that answers all the basic elements within a problem

which are what, who, when, where, why, and how. It aims to view ideas from various perspectives and gain an in-depth understanding of a specific situation. This method is commonly utilized as a continuous process-improvement technique in an organization. The 5W1H, also known as the Kipling method—is a set of questions used by Rudyard Kipling to extensively answer existing questions and trigger ideas that could contribute to the resolution of a problem. The concept was eventually incorporated into business practices to eliminate mistakes, increase efficiency, and streamline processes.

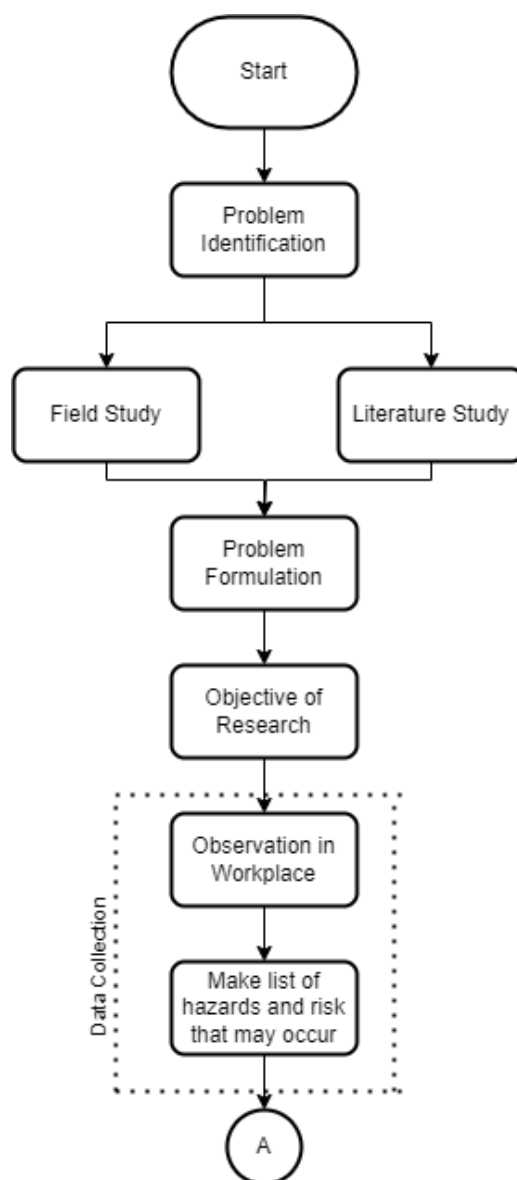
Table 3.5 List of 5W + 1H Questions

Who	A person who has an impact of hazards and risks
When	Time the hazards and risks occurs
Where	Place the hazards and risks occurs
Why	The cause of the hazards and risks occurs
What	Researchers want to relate to the hazards and risks
How	Solution to reduce the hazards and risks

3.7 Analysis Data

The data analysis used in this research to analyze the data is descriptive analysis, which describes the result of data processing and is the simplest form of data analysis. Descriptive analysis is a type of data study that helps describe, demonstrate, or summarize data points so that patterns emerge that satisfy all data conditions. This technique identifies patterns and relationships based on current and historical data. Descriptive analysis identifies patterns in data to answer questions about who, what, where, when, and to what extent. This descriptive analysis explains how to process, conduct, and communicate qualitative descriptive analysis more effectively. The descriptive analysis describes the result from HIRARC and 5W + 1H.

3.8 Flow Diagram



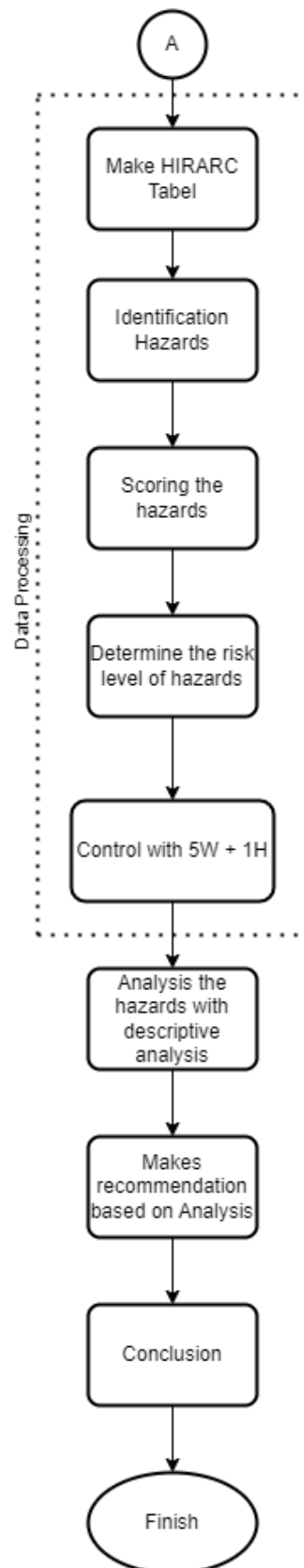


Figure 3.1: Flowchart

Below are the steps of the research:

1. Problem Identification

This stage is the first step to do before starting the research. Identification based on social phenomena that are worth studying.

2. Field Study

The aim is to observe directly on the field or workplace to obtain data more accurately.

3. Literature Preview

The aim is to establish a reference or theoretical basis used in this research which can come from journals or books. A

4. Problem Formulation

It contains questions that describe the issues that will be studied in this research.

5. Problem Limitation

Contains certainty about the boundaries of the problem to be researched and what elements constitute the area of the research.

6. Data Collection

This stage begins with making direct observations in the field, then making a list of potential hazards and risks that could occur in Pusat Inovasi Material Vulkanis Merapi UII from the date on 12 September 2023 until 17 November 2023.

7. Data Processing

After all the necessary data has been collected, data processing begins with the HIRARC method stage. Furthermore, through the HIRARC approach, recommendations for risk control efforts will be provided based on the job descriptions that have been previously identified with the help of 5H + 1W method.

8. Result and Discussion

Next, carry out analysis and discussion regarding the results obtained from data processing.

9. Conclusion and Suggestions

Finally, provide conclusions on the analysis that has been produced and provide suggestions for the company and further research.

CHAPTER 4

DATA COLLECTION AND PROCESSING

4.1 Data Collection

4.1.1 Primary Data Collection

4.1.1.1 Observation

In Pusat Inovasi Material Vulkanis Merapi UII, there are 3 areas which are the shelter area, production area 1, and production area 2. The workers who work most of the time use production area 1 as the place to produce the concrete brick. In Production Area 1, many concrete bricks are located on the floor, also there are many concrete bricks in the dry session. They produce many kinds of concrete brick shapes such as Trass/White, Cement, and Concrete. In production area 1, 2 machines are operated which are the Mortar Machine and Press Machine.

A pre-preliminary survey at Pusat Material Vulkanis Merapi UII shows that many potentials may lead to work accidents such as being electrocuted by electrical equipment, having broken bolt nuts due to engine shocks, slipping due to areas full of gravel and leaking oil, falling by concrete brick, back pain, hands and feet being caught in machines, and they are not using Personal protective equipment.

4.1.1.2 Interview

In Pusat Inovasi Material Vulkanis Merapi UII, There are 6 employees who work in the industry. There is a rule available to guide them during their work. Early interviews have been conducted to find out their experience. It reveals that they do have accidents during their working time in Pusat Inovasi Material Vulkanis Merapi UII i.e The accidents are Hit by Concrete Brick, Slipping, Back Pain, Electrocuted, and Sprained Feet respectively. The frequencies of each accident to occur are varied i.e. Seldom and Sometimes. workers experience work accidents Fall by Concrete Brick 10%, Slipped 20%, Back Pain 30%, Electrocuted 10%, and Sprained Feet 30%. This figure strongly captures why there is a need to have work-related risk management. The result of the research will act as a basic safety rule in the industry.

4.1.2 Secondary Data Collection

Secondary data was collected through a literature review to look out for risk assessment. the standards that are used are ISO 31000:2018. The risk assessment that was attached to ISO 31000:2018 is Risk Identification → Risk Analysis → Risk Evaluation. Risk identification identifies risks that may occur in Pusat Inovasi Material Vulkanis Merapi UII by observation and interview of the worker. Risk Analysis is the analysis of the risk that may occur with scoring by risk rubric of likelihood and risk rubric of severity or consequences. Risk evaluation is an evaluation that helps the decisions to do the mitigation for risk that may occur to reduce the likelihood to happen and lower the consequences if it happens.

4.2 Data Processing

4.2.1 Production Process

The data that are used in this research is direct observation in Pusat Inovasi Material Vulkanis Merapi UII. The data was observed through the production process below:

The first step is to get the sand and put it into the mixer



Figure 4.0-1: Worker is taking the sand

The second step is pouring the water



Figure 4.1: Worker is pouring the water

The third step is pouring the cement



Figure 4.2: Worker is pouring the cement

The fourth step is mixing the material



Figure 4.3: The mixer is mixing the material

The fifth step is pouring out the cement paste



Figure 4.4 :The cement paste is out from the mixing machine

The sixth step is to press the concrete on the mold



Figure 4.5: Concrete brick after being pressed

The seventh step is to carry out the concrete to drying



Figure 4.6: The worker is moving the concrete brick

4.2.2 HIRARC Analysis

4.2.1 Hazards Identification

Table 4.1 Hazard Identification

No	Hazards Identification		
	Production Process	Hazards	Risks
1	Get the sand and put it into the mixer	- Get sand by stooping - Carry out the bucket of sand - The bucket does not have rubber on it	- Back Pain - Shoulder Pain - Finger Joint Pain
2	Pour water into the mixer	- Wet area close to electric source	- Electrocuted
3	Pour cement into the mixer	- Carry out the sack of cement - Clamp	- Shoulder Pain - Hand Pain
4	Mixing the Material	- Slipped	- Foot Pain
5	Pour out the cement paste	- Clamp	- Hand Pain
6	Pour the cement paste into Mold and press	- Clamp - Slipped	- Hand Pain - Foot Pain
7	Carry out the concrete brick	- Carry up while stooping - Carry up the concrete brick	- Back Pain - Finger Pain

4.2.2 Risk Assessment

Table 4.2 Risk Assessment

No				Risk Assessment			
	Production Process	Hazards	Risks	Likelihood	Consequences	Risk Level	Status
1	Get the sand and put it into the mixer	- Get sand by stooping	- Back Pain	3	2	6	Moderate
			- Shoulder Pain	4	3	12	High
		- Carry out the bucket of sand	- Finger Joint Pain	4	3	12	High
		- The bucket does not have rubber on it					
2	Pour water into the mixer	- Wet area close to electric source	- Electrocuted	2	5	10	High
3	Pour Cement into the mixer	- Carry out the sack of cement	- Shoulder Pain	3	3	9	High
		- Clamp	- Hand Pain	2	4	8	Moderate
4	Mixing the Material	- Slipped	- Foot Pain	3	2	8	Moderate
5	Pour out the cement paste	- Clamp	- Hand Pain	1	3	3	Low

6	Pour the cement paste into Mold and press	- Clamp - Slipped	- Hand Pain - Foot Pain	2 3	3 3	6 9	Moderate High
7	Carry out the concrete brick	- Carry up while stooping - Carry up the concrete brick	- Back Pain - Finger Pain	2 3	2 3	4 9	Moderate High

4.2.4 Risk Control

Table 4.3 Risk Control

no	Hazards Identification			5W + 1H					
	Process	Hazards	Risk	Who	Where	When	What	Why	How
1	Get the sand and put it into the mixer	- Get sand by stooping - Carry out the bucket of sand - The bucket does not have rubber on it	- Back Pain - Shoulder Pain - Finger Joint Pain	- Worker - Worker - Worker	- Taking a sand station - Mixer station - Mixer Station	- During the process of get the sand - During the process of carry a bucket of sand - During the process of pouring the sand	- get sand method to avoid back pain - carry bucket of sand not in shoulder - Not hurt when carry the bucket of sand	- Stressed back muscle - Stressed shoulder muscle - Stressed Finger joint muscle	- Use long shovel - Use cart - Use safety gloves

2	Pour water into the mixer	- Wet area close to electric source	- Electrocuted	- Worker	- Mixer station	- During the process of turning on the mixer	- Not get electric shock	- Uncover hand	- Use safety gloves, isolation electric source
3	Pour Cement into the mixer	- Carry out the sack of cement - Clamp	- Shoulder Pain - Hand Pain	- Worker - Worker	- Silo - Mixer Station	- During the process of carry the sack of cement - During the process of pouring the cement	- Carry sack of cement not in shoulder - Not get clamp while pouring	- Stressed shoulder muscle - Hand is between the sack of cement and mixer	- Use cart - Use safety gloves
4	Mixing the Material	- Slipped	- Foot Pain	- Worker	- Mixer Station	- During the process of putting the cement, water, sand while the mixer is mixing	- Not get slipped when pour the material	- The floor is full of rocks, sand, and broken concrete brick	- Clear the workplace

5	Pour out the dough	- Clamp	- Hand Pain	- Worker	- Mixer Station	- During the process of opening and closing the hole closer of mixer	- Not get clamp while open and close the hole closer	- Hand is between the hold closer and the mixer	- Use safety gloves
6	Pour the dough into mold and press	- Clamp - Slipped	- Hand Pain - Foot Pain	- Worker - Worker	- Press Station - Press Station	- During the process of putting out the concrete brick from the mold - During the process of put the dough into the mold	- Not get chafed while putting out the concrete brick from the mold - No slipped when shove the	- Less careful when pull out the concrete brick from mold - The dough is messy	- Use safety gloves - Make a gutter from the mixer into the mold

							dough into mold		
7	Carry out the concrete brick	- Carry up while stooping - Carry up the concrete brick	- Back Pain - Finger Pain	- Worker - Worker	- Press station - Press Station	- During the process of lifting the concrete brick - During the process of lifting the concrete brick	- Lift up the concrete brick not by stooping - Not hurt while lifting up the concrete brick	- Stressed back muscle - Stressed finger joint muscle	- Squat while lifting the concrete brick - Use safety gloves

CHAPTER 5

DISCUSSION

From the results of observations during the research, it is revealed that the Merapi Volcanic Materials Innovation Center UII (PIMVM UII) have not yet equipped with applicable safety rules and Standard Operational Procedure rules. This causes workers to wear clothes and footwear freely, one of them choosing to wear sandals instead of shoes, not wearing gloves, and choosing not to wear a mask. In other words, workers do not use Personal Protective Equipment. PIMVM UII has a work environment that tends to be messy. This is characterized by a large number of broken concrete bricks or paving blocks scattered around, lots of gravel scattered around, and areas of used cement around the press and mixer machines so that the work environment can create the potential for harm to workers while work activities are in progress.

Apart from the work environment which tends to be messy, work accidents that can occur at PIMVM UII can be caused by the workers' work methods. This work method affects workers' gestures, postures, and actions which are wrong and not in accordance with ergonomics when work activities are in progress. Based on the K3 (Occupational Safety and Health) standards stated in Minister of Manpower Regulation No. 5 of 2018, the PIMVM UII work environment and the ergonomic conditions of the workers are inappropriate and do not comply with applicable regulations so that the work environment and ergonomic conditions of the workers can threaten the safety of the workers. workers while work activities are in progress.

5.1 Analysis of the Hazard Identified

Based on the results of Table 4.1, it is identified that the Pusat Inovasi Material Vulkanis Merapi UII has 7 production processes in making bricks with a total of 12 potential hazards and risks.

The first production process is taking sand and pouring it into the mixer. In this process there are potential dangers in the form of collecting sand by bending over, carrying a bucket of sand, and the bucket does not have rubber on it. A danger that may happen from collecting sand by bending over is back pain or back-part muscle getting pressured/stressed. According to a journal by Aminoto and Berbudi L. (2017), back pain could happen due to an imbalance in the

abdominal and lumbar muscles that support the spine. A danger that may happen from Carrying a bucket of sand is shoulder pain or muscle in the shoulder getting pressured/stressed. According to a journal by Amalia (2017), Lifting inappropriate weights will cause back injury. A danger that may result from the bucket with no rubber on it is finger pain or muscle in the finger getting pressured/stressed. Based on a report by the West Sumatera Public Health Office (2016), Increased muscle effort in response to high strength requirements will increase fatigue and the risk of MSD. Therefore, a job using lots of muscle in finger joints will cause fatigue and tiredness.

The second production process is pouring water into the mixer. In this process, there is a potential danger in the form of a wet area near the power source. A danger that may happen from a wet area near the power source is electrocution. Based on reporting by Introduction to Electrical Safety - HSE (n.d.), the main hazards of working with electricity are injury from exposure to arcing (when electricity jumps from one circuit to another) and static electricity igniting flammable vapors or dust, for example in a spray-paint booth.

The third production process is pouring cement into the mixer. In this process, there are potential dangers in the form of carrying cement and getting clamped. A danger that may arise from carrying cement is shoulder pain or muscle in the shoulder getting pressured/stressed. According to the journal by Amalia (2017), Lifting inappropriate weights will cause back injury. A danger that may occur from getting clamped is hand pain. According to a report by Yakes-Telkom (2022), hand pain could happen due to musculoskeletal disorders (MSDs) in the hand that happen repeatedly, body posture is not good, or excessive fatigue when working.

The fourth production process is mixing materials. In this process, there is a potential danger in the form of slipping. A danger that may happen from slipping is Foot pain. Based on a reported by Roth (2021), Slips contributed 15% disabling injuries at workplace and usually lack of attention to foot safety in the workplace.

The fifth production process is pouring cement paste. In this process, there is a potential danger in the form of being trapped. A danger that may occur from the clamp is hand pain. According to a report by Yakes-Telkom (2022), hand pain could happen because of musculoskeletal disorders (MSDs) in the hand that happen repeatedly, body posture is not good, or excessive fatigue when working.

The sixth production process is pouring cement paste into the mold and press. In this process, there are potential dangers in the form of clamping and slipping. A danger that may

happen from clamp is hand pain. According to a report by Yakes-Telkom (2022), hand pain could happen because of musculoskeletal disorders (MSDs) in the hand that happen repeatedly, body posture is not good, or excessive fatigue when working. A danger that may occur from slipping is foot pain. Based on a report by Roth (2021), Slips contributed to 15% of enabling injuries at the workplace and usually lack of attention to foot safety in the workplace.

In the seventh production process, namely carrying concrete bricks. In this process, there is a potential danger in the form of lifting the bricks by bending and carrying the concrete bricks. A danger that may occur from lifting the bricks is back pain or back-part muscle getting pressured/stressed. According to a journal by Aminoto and Berbudi L. (2017), back pain could happen due to an imbalance in the abdominal and lumbar muscles that support the spine. A danger that may happen from Carrying the concrete bricks is Finger Pain or muscles in finger joints got pressured/stressed. Based on a report by the West Sumatera Public Health office (2016), Increased muscle effort in response to high strength requirements will increase fatigue and the risk of MSD. Therefore, a job using lots of muscle in finger joints will cause fatigue and tiredness.

5.2 Analysis of Risk Assessed

Based on Table 4.2, Pusat Inovasi Material Vulkanis Merapi UII Industry has 13 potential dangers and risks of the 7 production processes have 0% extreme risk levels, 54% high-risk levels, 38% moderate risk levels, and 8% low-risk levels. This is shown in Table 4.2. The extreme risk level will occur if it has a high chance of happening and if happens, it could lead to serious injury or death. The range score of extreme level is 15 – 25. However, in PIMVM UII there was no extreme risk level. The high level will occur if it has a high chance of happening and if eventually happens, it could lead to hard injuries or medium consequences. The range score of high level is 8 – 12. Therefore, in PIMVM UII there are 7 actions in high-risk levels like close to an electric source. The moderate level will occur if it has a high chance of happening and if happens, it could lead to low injuries or a small chance to happen and if happens, it could lead to hard injuries. The range score of moderate level is 4 – 6. Moreover, in PIMVM UII there are 5 actions in moderate risk levels like back pain. The low level will occur if it has a small chance of happening and if happens, it could lead to minor or insignificant injuries. The range score of low level is 1 – 3. Furthermore, in PIMVM UII there is 1 action i.e. open and close the hold closer.

5.3 Analysis of Risk Controlled

In order to reduce the level of risk that may occur to a lower level, risk control needs to be carried out. With a lower level, workers have a lower chance of experiencing an accident while working. Carry out risk control can be based on the risk control hierarchy and using 5W + 1H reasoning.

In the first production process, namely taking sand and pouring it into the mixer, it is handled in the form of engineering control. Recommended activities are using long shovels so that workers do not bend over to pick up sand, thereby reducing the risk to back muscles. The tolerance limit for stooping is 25 – 40 degrees and over 50 degrees could cause kyphosis in long-term effect (Halodoc, 2019). When workers use short shovels, they should stoop approximately 70 – 90 degrees to get the sand but when workers use long shovels, they should stoop approximately 20 – 40 degrees to get the sand.

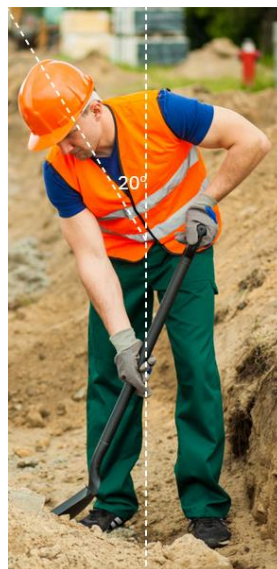


Figure 5.1: Work Posture when using a long shovel (Flexion)

The second recommendation is that the worker should use cement carts so that workers do not need to carry sand using buckets on their shoulders. Lifting the sand using the cart could reduce stress on the shoulder muscle and neck muscles. Moreover, the worker carries the bucket of sand in the shoulder, the worker should move the neck to the left 20 degrees so that the weight could carry more space in the shoulder. The third recommendation is that workers must wear safety gloves to reduce pain in finger joints. Since the weight was carried using the cart, the worker must wear safety gloves while bring and pushing the cart from the sand station to the mixer station.

The second production process, namely pouring water into the mixer is handled in the form of engineering control. The recommended activities are to wear safety gloves and isolate the electricity source so that workers avoid electrocution when their bodies and hands are still wet. The combination of water and electricity is dangerous because water is a good conductor of electricity, increasing the risk of electric shock. Furthermore, it could risk the workers with electric shock so the worker should use safety gloves and isolate the electric source to prevent electric shock.

In the third production process, namely pouring cement into the mixer. The recommended activity is that the worker should use cement carts so that workers do not need to carry a sack of cement on their shoulders. When push and bring the cart of cement could reduce stress on shoulder muscle and neck muscle. Moreover, if the worker carries the sack of cement on the shoulder, the worker should move the neck to the left 20 degrees so that the weight can occupy more space in the shoulder. The second recommendation is that workers must wear safety gloves to reduce pain in finger joints. Since the weight was carried using the cart, the worker must wear safety gloves while bring and pushing the cart from the silo to the mixer station.

In the fourth production process, namely mixing materials, it is handled in the form of engineering control. The recommended activity is to clean the work area so that workers do not slip when pouring sand, cement, and water back into the mixer during the material mixing process. As stated by Jostes (2013) is that a messy work environment or business not only looks terrible, but it can be stressful and unproductive. Always pushing things to the side to do people's jobs is inefficient. Having to step over objects on the floor or in the walkway is never a good idea. It takes more time out of people's workday, it's unpleasant as a work environment, and it increases the chances of hurting everyone.

The fifth production process, namely pouring cement paste, is handled in the form of engineering control. The recommended activity is to wear safety gloves so that workers' hands are not pinched when opening and closing the hole closer. The hole closer is a bit hard to open because there is so much cement paste on the hole closer ankle and it may cause small injuries like chaffed skin if the workers are not careful.

The sixth production process, namely pouring cement paste into mold and presses, is handled in the form of engineering control. The recommended activities are to wear safety gloves so that workers' hands don't get chafed when removing the bricks from the mold. The

second recommendation is to use a gutter from the mixer to the mold so that workers don't slip from the messy cement paste in the area between the press machine and the mixer machine. It is aimed to avoid the slippery workplace because of the messy area due to the existence of cement paste. Furthermore, to move the cement paste from the machine mixer to the press machine gutter can be used as the bridge. With a gutter, the worker won't slip in the workplace due to messy area as the result of cement paste that came out from the mixer machine.

In the seventh production process, namely carrying bricks, it is handled in the form of engineering control. Recommended activities are squatting when carrying bricks to reduce pressure on the muscles in the back when lifting bricks. When people want to lift a weight, people often stoop 90 degrees which could damage the back and cause back pain. Furthermore, the squad position is positioned to reduce the stress on the lower back but the stress moves to the legs. The tolerant limit of stoop is 25 – 40 degrees and over 50 degrees may cause kyphosis in long-term effect (Halodoc, 2013).

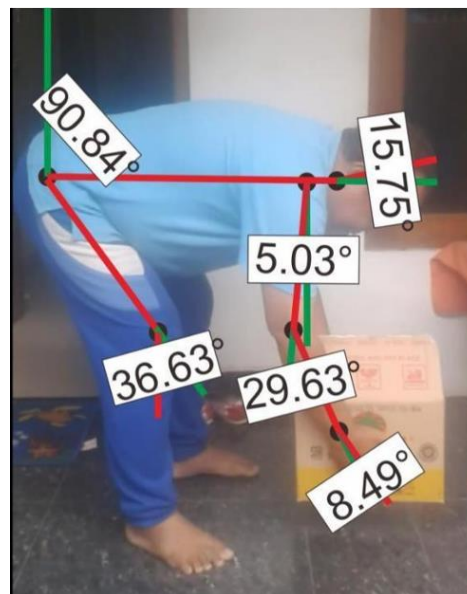


Figure 5.2: Worker is lifting the weight

The second recommendation is that workers should wear safety gloves when lifting bricks to reduce pain in finger joints. Apart from squatting to lift heavy objects, workers must also wear gloves to avoid scratching their fingers

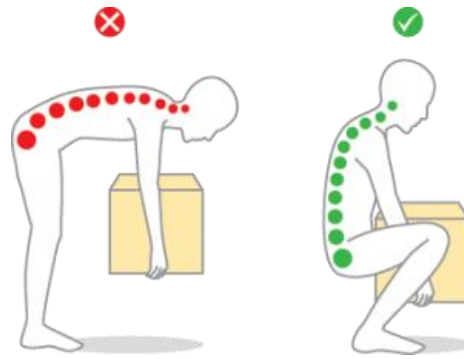


Figure 5.3: Work posture when lifting

Apart from engineering control, PIMVM UII needs to provide administrative control for risk control. A manifestation of administrative control is the availability of official work procedures (SOP) for all work activities at PIMVM UII

CHAPTER 6

CLOSING

6.1 Conclusion

Based on research that has been done in Pusat Inovasi Material Vulkanis Merapi UII with a set from problem formulation and research limitation, this research could draw conclusions as follows:

1. Hazard Identification reveals several potential hazards of work-related concrete brickmaking. The hazards are getting sand by stooping, carrying out the bucket of sand, the bucket does not have rubber on it, a wet area close to the electric source, carrying out the sack of cement, clamping, slipping, carrying up while stooping, and carrying up the concrete brick.
2. Risk Assessment before risk control exposes that there are no extreme levels of risk, 54% are identified as high level of risk, 38% moderate level of risk, and 8% low level of risks.
3. From Risk Control, it results with several activities chosen to reduce the risk that causes work accidents. The activities are using a long shovel, using cart, using safety gloves, using safety gloves and an isolation electric source, use cart, use safety gloves, clear the workplace, use safety gloves, use safety gloves, make a pipe from the mixer into a Mold, squatting while lifting the concrete brick, and use safety gloves.

It can be seen from the results that the method of HIRARC can be used to identify hazards, identify risks and their levels, and finally determine activities to control the risks.

6.2 Suggestions

Based on the research that has been carried out, the following are several suggestions that are expected to provide input in efforts to reduce the risk of accidents and occupational health problems, including the following:

1. It is hoped that companies will further improve and provide standard personal protective equipment (PPE) to workers and educate them about the dangers in the workplace so that they are more aware of the risks that may arise.
2. For companies, it is necessary to enforce stricter regulations relating to OSH in companies and provide training to improve the quality of human resources regarding OSH (Health, Work Safety).
3. It is necessary to procure personal protective equipment (PPE) to support OSH in the production process, such as: safety helmets, safety glasses, masks, respirators, gloves, safety shoes, long-sleeved shirts or protective clothing (wear pack)
4. Clean the work environment from broken concrete bricks and rocks so they don't scatter.
5. For further research with research of the same type, to be more specific and thorough in identifying the hazards of each work item so that the results of the control carried out can have more diverse findings and it is hoped that the JSA method will be used for making SOPs and PPE.

REFERENCES

- Ltd, W. S. (n.d.). *10 most common workplace injuries* | *Waldrons Solicitors*. Blue Fusion Web CMS.
<https://www.waldrons.co.uk/insights/common-injuries-in-the-workplace/#:~:text=Slips%2C%20Trips%20%26%20Falls,or%20debris%20on%20the%20floor.>
- Foulis, M. (2021). The five most common types of workplace injuries. *Canadian Occupational Safety*.
[https://www.thesafetymag.com/ca/topics/safety-and-ppe/the-five-most-common-types-of-workplace-injuries/316462#:~:text=The%20National%20Safety%20Council%20\(NSC,at%20work%2C%20says%20the%20NSC.](https://www.thesafetymag.com/ca/topics/safety-and-ppe/the-five-most-common-types-of-workplace-injuries/316462#:~:text=The%20National%20Safety%20Council%20(NSC,at%20work%2C%20says%20the%20NSC.)
- ADIPUTRA, M. F. (2015). RISK CONTROL ENHANCEMENT USING SAFETY CLIMATE FACTORS FOR HIRARC METHOD IN STEEL PRODUCT INDUSTRY. *Universiti Teknologi Malaysia*.
<http://eprints.utm.my/id/eprint/53531/1/MohamadFarizAdiputraMFKM2015.pdf>
- Department of Occupational Safety and Health [Ministry of Human Resource Malaysia]. (2008). *Guidelines for Hazard Identification, Risk Assessment, and Risk Controls (HIRARC)* (1st ed.).
<https://www.dosh.gov.my/index.php/legislation/guidelines/hirarc-2/1846-01-guidelines-for-hazard-identification-risk-assessment-and-risk-control-hirarc-2008/file>
- Dodi, A. (2021). FAKTOR YANG BERHUBUNGAN DENGAN PENYAKIT DERMATITIS KONTAK PADA PEKERJA PEMBUAT BATAKO PRESS DI DESA TEMBAWANG BALE. *Universitas Muhammadiyah Pontianak*.
<https://repository.unmuhpnk.ac.id/1732/1/BAB%20I%20DAN%20V.pdf>
- Dzulkifli, S. N. M. (2018, December 29). *Classification of Potential Risk Factors through HIRARC Method in Assessing Indoor Environment of Museums*.
<https://publisher.uthm.edu.my/ojs/index.php/ijie/article/view/2512>
- Harizah, I. (2012). *HIRARC Assessment Of Machining Processes*.
<https://www.semanticscholar.org/paper/HIRARC-Assesment-Of-Machining-Processes-Harizah/20c6ba0b0c79ad3eed7a51a3cd5eeee04fa52a03>
- Lee, C. (2010). *Towards Zero Accidents In Construction Projects : Promoting Hirarc As An Effective Tools To Reduce Accidents*. <https://www.semanticscholar.org/paper/Towards-Zero-Accidents-In-Construction-Projects-%3A-Lee-Hasahudin/e7a4fedbef23b5a8360f6ec8e7081568c1307c6b>

- Mahardika, T., & Pujotomo, D. (2014). PERANCANGAN FASITILAS KERJA UNTUK MENGURANGI KELUHAN MUSCULOSKELETAL DISORDERS (MSDS) DENGAN METODE RAPPID ENTIRE BODY ASSESMENT PADA PEKERJA PEMBUATAN PAVING DAN BATAKO PADA UKM USAHA BARU. *J@Ti Undip: Jurnal Teknik Industri*, 9(2). <https://doi.org/10.12777/jati.9.2.109-116>
- Nurkhodi, A. a. N. A., Siboro, B. a. H., & Purbasari, A. (2019). PERANCANGAN MEJA KERJA PADA PEMBUATAN BATU BATAKO DENGAN MENGGUNAKAN METODE ManTRA Tool (Manual Task Risk Assessment Tool) DAN PENDEKATAN ANTHROPOMETRI (STUDI KASUS UKM ANTO). *PROFISIENSI: Jurnal Program Studi Teknik Industri*, 7(1), 55–62. <https://doi.org/10.33373/profis.v7i1.2480>
- Pecb. (n.d.). *ISO 31000 Risk Management – Principles and guidelines*. <https://pecb.com/whitepaper/iso-31000-risk-management--principles-and-guidelines#:~:text=Risk%20assessment%3A%20Risk%20assessment%20is,causes%2C%20and%20their%20potential%20consequences>.
- Setiadi, M. Y. (2013). *Usulan Alat Bantu Pemindahan Batako untuk Mengurangi Risiko Musculoskeletal Disorders di PT. Xyz. Neliti*. <https://www.neliti.com/publications/219258/usulan-alat-bantu-pemindahan-batako-untuk-mengurangi-risiko-musculoskeletal-diso>
- Suksmerri, S. (2023). ANALISIS RISIKO GANGGUAN SALURAN PERNAFASAN PADA KEGIATAN PEMBUATAN BATAKO DI UD. FATIMAH, KOTA PADANG. *Suksmerri | Sulolipu: Media Komunikasi Sivitas Akademika Dan Masyarakat*. <https://doi.org/10.32382/sulolipu.v23i1.3082>
- Damkar. (2020, July 13). *Pengertian (Definisi) Bahaya dan 5 Faktor Bahaya K3 di Tempat Kerja – damkar*. <https://damkar.bandaacehkota.go.id/2020/07/13/pengertian-definisi-bahaya-dan-5-faktor-bahaya-k3-di-tempat-kerja/>
- Kenton, W. (2023). Risk control: what it is, how it works, example. *Investopedia*. <https://www.investopedia.com/terms/r/risk-control.asp#toc-what-is-risk-control>
- Bakri, A., Zin, R. M., Omar, W., & Kuang, L. C. (n.d.). HIRARC: A TOOL OF SAFETY IMPORVEMENT IN THE CONSTRUCTION INDUSTRY. *Universiti Teknologi Malaysia*. <http://eprints.usm.my/34745/1/HBP34.pdf>
- Data: types of data, primary data, secondary data, solved examples*. (2020, June 24). Toppr-guides. <https://www.toppr.com/guides/maths/statistics/data/>

- Busayo.Longe. (2020, January 15). What is Primary Data? + [Examples & Collection Methods]. *formpl.us*. Retrieved January 12, 2024, from <https://www.formpl.us/blog/primary-data>
- The 5W1H Method: Elements & example* | SafetyCulture. (2023, December 21). SafetyCulture. <https://safetyculture.com/topics/5w1h/>
- Account suspended*. (n.d.). <https://safetysignindonesia.id/standar-k3-baru-ini-4-poin-penting-dalam-permenaker-no-5-tahun-2018-yang-wajib-anda-ketahui/>
- Amalia, A. (2017, June 5). *Selamatkan Tulang Belakang Anda: 8 Tips untuk Mengangkat Benda yang Berat dengan Aman* – Samson Tiara. <https://www.samson-tiara.co.id/blog/2017/06/selamatkan-tulang-belakang-anda-8-tips-untuk-mengangkat-benda-yang-berat-dengan-aman/>
- Ergonomi dan kesehatan*. (n.d.). <https://dinkes.sumutprov.go.id/artikel/ergonomi-dan-kesehatan>
- Introduction to electrical safety - HSE*. (n.d.). <https://www.hse.gov.uk/electricity/precautions.htm#:~:text=an%20avoidable%20accident-,The%20main%20electrical%20hazards,faulty%20electrical%20equipment%20or%20installations>
- Nunukan, R. (n.d.). *POSISI ERGONOMIS dalam Aktivitas Sehari-hari*. RSUD KABUPATEN NUNUKAN. <https://rsud.nunukankab.go.id/detailpost/posisi-ergonomis-dalam-aktivitas-sehari-hari>
- Roth, C. L. (2021, October 11). Ergonomics for the feet. *Health & Safety International*. Retrieved May 3, 2024, from <https://www.healthandsafetyinternational.com/article/1843787/ergonomics-feet>
- Saptiansyah, R., Haqi, D. N., & Juwono, K. F. (2023). Proposed workstation design in laboratory for Musculoskeletal Disorder complaints. *The Indonesian Journal of Occupational Safety and Health*, 12(3), 382–390. <https://doi.org/10.20473/ijosh.v12i3.2023.382-390>
- UNAIR NEWS. (2024, January 25). *Stasiun Kerja Ergonomis di Laboratorium untuk Mencegah Keluhan Muscolo Skeletal Disorders - Universitas Airlangga Official Website*. Universitas Airlangga Official Website. <https://unair.ac.id/stasiun-kerja-ergonomis-di-laboratorium-untuk-mencegah-keluhan-muscolo-skeletal-disorders/>

- Yakes-Telkom. (2022, August 3). *Mengenal gangguan sendi, tulang, & otot (Musculoskeletal disorder)*. Retrieved May 3, 2024, from <https://yakestelkom.or.id/serba-serbi-kesehatan/mengenal-gangguan-senditulang-otot-musculoskeletal-disorder>
- Halodoc, R. (2019, April 3). *Waspada, kebiasaan membungkuk ketika duduk bisa menjadi gejala awal bahwa tulang belakang kamu mengalami kifosis*. Halodoc. <https://www.halodoc.com/artikel/postur-tubuh-bungkuk-waspada-gejala-kifosis>
- Jostes, L. (2023, June 29). *Effects and hazards of a messy workplace*. Clean Method. <https://cleanmethod.com/blog/effects-hazards-messy-workplace/#:~:text=It%20takes%20more%20time%20out,customers%2C%20employees%2C%20and%20visitors.>

ATTACHMENT



Attachment 1: Worker delivering sand into mixer



Attachment 2: Worker is taking a sand



Attachment 3: Worker pouring sand into mixer



Attachment 4: Carry up the bucket of sand



Attachment 5: The mixer is pouring out the cement paste



Attachment 6: Worker is digging the sand



Attachment 7: The worker is turning on the mix machine Attachment 8: Worker is cleaning the work area



Attachment 9: The worker is trying to carry the sack of cement Attachment 10: The mixer machine is pouring out the cement paste



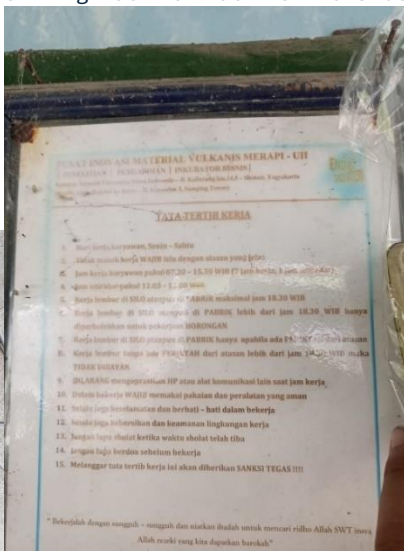
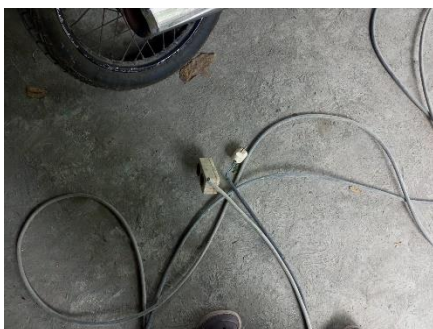
Attachment 11: The worker is pouring sand into mix machine Attachment 12: The mix machine is mixing



Attachment 13: The worker is pouring cement from the sack of cement Attachment 14: Silo



Attachment 15: The worker is turning on the mixing machine Attachment 16: Unuse concrete brick in workplace



Attachment 17: Unuse cable

Attachment 18: The rules in PIMVM UII



Attachment 19: Unuse workplace



Attachment 20: Failed concrete brick



Attachment 21: Rocks and Bucket for water



Attachment 22: Press Machine



Attachment 23: Mixing machine after use



Attachment 24: Power source for press machine



Attachment 25: Press Machine Hydraulic



Attachment 26: Press machine table



Attachment 27: Messy workplace



Attachment 28: Hold closer in Mixing Machine



Attachment 29: Lever for mixing machine



Attachment 30: The group of concrete brick



Attachment 31: Wood Cutter



Attachment 32: table wood cutter



Attachment 33: Drying concrete brick



Attachment 34: unuse press machine



Attachment 35: Drying concrete brick



Attachment 36: PIMVM UII



Attachment 37: Old concrete brick



Attachment 38: Old sand warehouse



Attachment 39: Sand area



Attachment 40: Tools Warehouse



Attachment 41: The worker lifting the undried concrete brick



Attachment 42: concrete brick after pressed



Attachment 43: Worker lifts the concrete brick into the pickup car

Attachment 43: Worker lifts the concrete brick into the pickup car