



**ADDIS ABABA UNIVERSITY**

**ADDIS ABABA INSTITUTE OF TECHNOLOGY**

***SCHOOL OF MECHANICAL AND INDUSTRIAL ENGINEERING***

**Investigating the Impact & Predicting Occupational  
Safety & Health in Metal Manufacturing Firms:  
A Case Study of Addis Machine & Spare Parts  
Manufacturing Industry**

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This is to certify that the thesis prepared by: **Woubeshet Kebede, entitled: “ Investigating the Impact & Predicting Occupational Safety and Health (OSH) in metal manufacturing Firms: A case study of Addis Machine & Spare Part manufacturing Industry”** and submitted in partial fulfillments of the requirements for the degree of Master of Science (Mechanical and Industrial Engineering) complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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## Declaration

I Here declare that, the work which is done in this thesis entitled “**Investigating the Impact & Predicting Occupational Safety and Health (OSH) in metal manufacturing Firms: A case study of Addis Machine & Spare Part manufacturing Industry**” is the original work of my own and has not been presented for a degree of any other university and all the resources of references used for the thesis have been duly acknowledged.

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## Abstract

Occupational safety and health practice in the manufacturing industry appears to be relatively low, as evidenced by observations and writings from various scholars regarding the problems in case company working environments. This study aims to examine, the impact of Occupational safety and health (OSH) which ultimately affect the overall performance of metal manufacturing industry. A random sampling method was used to select 147 participants with combination of primary and secondary data sources. The collected data were analyzed & interpreted using IBM SPSS Version 27 software. The study's analysis results indicate that, the impact of OSH challenges includes: 62.1% reporting workplace health and safety issues, 66.3% experiencing high safety exposure rates, 56.5% expressing job dissatisfaction, and 72.6% noting inconsistent use of PPE and lack of safety equipment. Only 27.4% reported adequate provision of PPE in the workplace. Conversely, from 2020 to 2022, there were 405 sick leaves (168 male, 237 female) and 434 absences (112 male, 322 female), attributed to long work hours, frequent machine breakdowns, inadequate use of PPE, worker reluctance, and insufficient health and safety controls. In the same way, based on the observed data of health & safety (HS), the predicted values injury rate range from 1.54 (lower risk) to 3.81 (higher risk), reflecting varying levels of health and safety risk associated with dependent variable. Additionally, the mean predicted injury rate of 2.59 indicates a moderate level of health and safety conditions, with values below 2.59 requiring urgent action. Moreover, study found the dependent variable can be expressed by independent variable with  $R^2 = 80.7\%$ , Adjusted  $R^2 = 79.4\%$ , F-statistics (8, 88) = 61.3,  $P = 0.001$  and giving the number of independent variables providing an explanatory estimate to the model. Furthermore, issues like lower safety & health rules & regulations, lower use of essential equipment, high injury rate on leg, shoulder, head, ear & human resource system problems. The study identified only one statistically significant independent variable among six, yet the cumulative results still yield reliable predictions for health and safety. However, a limitation of the study is that, it did not address the impact of all variables. The overall result of the study might give beginning point for researchers, academicians & policy makers to further elaborate and develop mitigation strategies in enhancing workplace health & safety practice in manufacturing industry. The study emphasizes improvement strategy aiming to create safer & more productive environment, strong safety practice, reduce accidents & enhance safety culture.

**Key words:** Occupational safety & health (OSH), Manufacturing industry, Data analysis, Regression modeling, Injury rate, Strategy & Work environment

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## **List of Acronyms**

AAiT: Addis Ababa Institute of Technology  
ANNs: Artificial Neural Networks  
ILO: International labor Organization  
ML: Machine learning  
NLP: Natural language processing  
OHSMS: Occupational health & safety management system  
OSH: Occupational safety and health  
PPE: Personal protective equipment  
R&D: Reaserch & development  
RF: Random Forest  
ROS: Random over-sampling  
RUS: Random under-sampling  
SMOTE: Minority over-sampling Technique  
SPSS: Statistical packages for social science  
WHO: World health organization

# Chapter One

## 1. Introduction and Problem Justification

### 1.1 Introduction

Nowadays, occupational health and safety is one of the most important aspects of human concern & it contributes a lot in ensuring safety & productivity of workers Dafit Feriyanto et al. (2020) . In addition, Dafit Feriyanto et al. (2020), emphasizing safety and health concerns in the workplace can significantly contribute to creating a positive working environment and minimizing potential harm and injuries. On the other hand, Kassu Jilcha et al. (2016) predicts that, the issues regarding occupational safety and health challenges are becoming a global concern in industrial and service sectors. According to the ILO estimate, each year there are around 3 million workers get die due to causes of work-related diseases, which shows, an increase of 5% each year. According to an approximate by ILO, the number of men compared to women is more which accounted 51.4 % (per 100,000 adults) & 17.2% (100,000) men & women respectively (ILO, 2023a).

As explained, by world health organization (WHO), workplace condition contribute to one –third of back pain cases, 16% hearing Problem, nearly 10 % lung problems & overall workplace risks results about 8% burden of depression (Shiferaw et al., 2021). Ensuring safety & health to become the well-being of human, the working environmental issues regarding Occupational & Health that improved (Ndegwa, 2015). Additionally, the International labor Organization (ILO) estimates approximately ,120million occupational injuries, 210,000 fatal accidents, 160 million population affected by occupational diseases , and 2 million deaths annually (Ndegwa, 2015). In similar manner, the author indicates, a 5% of world GDP lost by the injury Caused by occupational Safety & health issues .Hence, according to the studies & results obtained by Surienty (2019b), OSH issues need big attention to keep workplace environment safety & protect workers from Injuries. The study by Bayram (2020) found that, to enhance safety and productivity organizational managers should focus on employee training, encompassing knowledge, skills, motivation, and employee compliance. In a similar manner, Mutegi et al. (2023)

indicate that, occupational safety is highly beneficial for enhancing employee productivity and creating a positive impact. In addition, Authors emphasize that; improving safety practices and increasing productivity go hand in hand, leading to positive outcomes for employees.

On the other hand, management involvement is required for the implementation of OSH requirements in organization. In addition, participation in this regard, incorporates training and rewarding, has its own big contribution for successful implementation of Occupational safety & health (Surienty, 2019b). Besides, working environments plays great role for employees & as well, negative impression on workplace impact employees in having different problems & affecting productivity as well (Ali et al., 2013). Also, The willingness & the involvement of the company management & employees will brings changes in reducing injuries & accidents at workplace (Abidin et al., 2021). Similarly, predicted that, the Involvement in organization groups of members on basis of OSH allows in creating & addressing to all through motivations has an impact on changes to reduce accidents levels. On contrary, Gbadago et al. (2017) shows , the management of OSH in organization, can makes changes workers behavior in workplace towards securing safety & health issues considered as a positive impacts. Accordingly, organization should use the right PPE (personnel protective equipment) & Improvement strategies (Mozaffari et al., 2023). In addition, the researcher indicates the effects of workplace exposure on workers' health by giving recommendation through the analysis of the manufacturing firm. However, the study limits to predict its effect & consequence for the workers' health, Productivity & organizational Performance.

According to a study conducted by Berhan (2020c) it was found that, out of 14,914 organizations 25,812 employees, experienced permanent physical disability, unable to perform normal duties & deaths. This situation raises a significant concern regarding the safety of the work environment for employees. The study also indicated that, the manufacturing industry had the highest percentage of accidents reported which accounted for 56.05%, which notably higher compared to other sectors. As a conclusion, the author recommends in changing the culture of using right PPE's at workplace, which may

requires awareness & the intervention of other concerned bodies, which aims to improve the work place environment as well.

On the other hand, the study in small-scale industries faced a notable incidence of work-related injuries (Asrat Meleko et al., 2017). Among the contributing factors, smoking, alcohol consumption, working for prolonged hours, and working night shifts found to have a higher likelihood of causing occupational injuries. Similarly, the use of personal protective equipment (PPE) and giving occupational health and safety training identified as effective preventive measures. Consequently, it is essential for both workers and industry owners to collaborate closely to address these challenges and effectively mitigate the associated problems (Asrat Meleko et al., 2017). As can be noted, manufacturing industries in our country are currently struggle with known gaps in occupational health and safety measures. It is extremely important that, significant attention and collaborative efforts needed towards addressing these gaps and enhancing the working conditions for employees (Asgedom, 2023). According to, Mengesha et al. (2023) on industry employees in Ethiopia indicating there is an average of 5596 health injury accidents reported in the industry. These accidents are associated with a death rate of 21.5 per 100,000 workers and an injury rate of 16,426 per 100,000 employees. Therefore, the findings indicate that the industry can characterized as high risk due to the prevalence of occupational and health-related issues. Hence, it is evident that, there is a crucial need for a comprehensive study, to conduct at the national level regarding occupational health and safety (OSH) in our country. This study would help identify the existing gaps and formulate effective strategies to improve OSH standards and ensure the well-being of workers in metal manufacturing industry.

In general, there is a significant concern regarding occupational health and safety (OSH) in the manufacturing industry and its impact on workers' productivity. Therefore, the aim of this study is to provide insights on how to analyze the impact of occupational safety and health (OSH) on workers' in case company as well as metal manufacturing firms. Therefore, the study intends to use a case company as a model and aims to create an improvement strategy regarding health and safety issues in the manufacturing industry,

thereby predicting accidents aiming to reduce the workplace occupational injury incidents.

## **1.2 Background and Justification of the study**

The manufacturing industries today encounter significant risk regarding Occupational safety & health problems. It directly affects workers & results in various consequences like high frequency of accidents, creating a hazardous environment, and decrease in productivity as well. A study by Jilcha (2023), emphasized that the metal manufacturing industry is associated with significant occupational safety and health (OSH) related injury problems. This is attributed to the existence of a substantial number of resources throughout the world.

The study predicts that, challenges related to occupational injuries specifically in metal industry are considered to be very high. This is due to the potential for severe or dangerous occurrences that could arise (Bulut & Ersöz, 2022). According to a study, occupational accidents can lead to long-term disabilities or fatalities. Consequently, the death or permanent disability of employees causes economic losses and poses social challenges for employers, employees, and their families (Hassan, 2019)

On the other hand, occupational safety and health aim to safeguard employees from various health issues, including illnesses and injuries caused directly by hazardous conditions in the workplace environment (Amenyah & Tansu, 2023). The research study, focus on one of the governmental metal manufacturing industry in Addis Ababa, which aims to produce different spare parts & machineries for local customers. Specifically, study aims to look on the influence on Occupational Safety & health (OSH) on the productivity of organization workers. It also emphasized by Abidin et al. (2021) workplace health & safety is very much related to organization production process as well. Hence, the study aims to work on metal manufacturing firm, which focuses on OSH Impacts on workers' Productivity in organization. Consequently, the study by Umugwaneza et al. (2019) indicates, workplace safety is keeping workers in good conditions & it ensures good physical conditions as well. Also, occupational safety & health Injuries should be given a priority concern for industrial workers (Debela, Azage,

Deyessa, & Begosaw, 2022). Another study aims to assess, the practice of occupational safety and health (OSH) in manufacturing sector & it revealed that, individual workers' characteristics could potentially affect the injury rate in the industry (Fatemi et al., 2020). It indicated by, Fatemi et al., 2020, work-related injuries attributed to various body parts, with 25% of injuries resulting from objects, 30% from injuries to other body parts, and 44% from injuries to the upper body (specifically the arm). As a recommendation, workers should receive training tailored to their specific tasks and duties in order to address the challenges associated with health and safety aspects

According to, (Hunegnaw et al., 2021) workplace injuries are significant issues that have a profound impact on both individuals and the social economy. It highlighted that, these injuries pose challenges that lead to additional costs, estimated to be around 4% of the gross domestic product (GDP). In similar manner, the economic losses incurred will have a substantial effect on various aspects, including organizational structures, individuals, and entire communities. Furthermore, these injuries have a broad impact on workers as a collective group.

Research aimed to assess the burden of occupational safety and health (OSH) and its contributing factors in Ethiopia revealed a yearly prevalence rate of 45.2%. The study identified the handling of equipment as a significant challenge in this regard (Mengistu et al., 2021). The study on the prevalence and associated factors in the automotive manufacturing industry reported an annual injury rate of 29.4% (Tolera & Terefa, 2022b).

The most common types of injuries observed were rubbing, cuts, and injuries to the eyes, legs, and hands. The authors identified several key factors contributing to these injuries. Problems related to sleep, monthly income and the proper use of personal protective equipment (PPE) found to be major and crucial factors in this context.

The research aims to study the impact of occupational safety and health (OSH) in the metal manufacturing industry. It assesses the OSH impact and explores ways to mitigate potential risks. The study reveals that, the implementation of OSH practices in the manufacturing industry has yielded positive outcomes, resulting in a low level of injury

incidents. The findings indicate that, work quantity and quality account for 76.6%, workers' work initiation 76.7%, and work participation 76.2% in the study (Bwengye, 2021)

According to the World Steel Organization WSA (2020), the major causes of occupational injury incidents classified as falling, machinery in motion, objects dropping from a height, and fire-related incidents. Falling refers to falls from heights or slips and trips on the same level. Machinery in motion pertains to injuries resulting from contact with moving machinery or equipment. Objects dropping from a height can cause harm when they fall from elevated locations. Lastly, fire-related incidents occur due to factors such as fire causing burning problems. This classification emphasizes the common causes of occupational injuries in the steel industry and keeps the importance of implementing appropriate safety measures to prevent such incidents.

The case company for the study” Addis machine & Spare Parts manufacturing Industry” is one of the governmental owned metal manufacturing industries. It incorporates major production areas having capability of producing different types of spare parts for Local markets for, governmental owned & private sectors. The industry focus is producing of different varieties & types of products depend on the capacity of production unit’s facilities accordingly. In this regard, industry performance is measured on basis of incoming customer orders in each of manufacturing units with its own limitations. The case company, Injury Evident, faces challenges related to health and safety aspects. This is evident from the record presented in Table 1 below, which includes data obtained from the company's health center (HS), HS (2020-2022) injury records in Addis machine & spare part manufacturing industry.

Table 1.1 Health Injury Records

Source: (HS (2020-2022))

Year (2020-2022)					
Year	Injury part	Gender		Injury causes	Total Injury
		Male	Female		
	Leg Part	3	2	Improper handling	5
	Eye	7	2	Machine fault	9

<b>2020</b>	Hand	4	1	Improper Handling	5
	Head	0	1	falling	1
	Other Body part	4	1	Machine fault	5
	Back Bone	1	0	Improper handling	1
	Ear	1	0	Unsafe working	1
<b>2021</b>	Hand	9	1	falling	10
	Other Body part	2	0	unsafe working	2
<b>2022</b>	Leg Part	2	0	Machine fault	2
	Hand	6	0	Improper handling	6
	Other Body part	0	1	unsafe working	1
	Back Bone	2	0	Improper handling	2

Based on the data observed, the prevalence of injuries in the case company primarily attributed to improper handling, machine fault & falling from height with different health reported cases.

Hence, from major cause recorded in case company health & safety (HS) office (HS, 2020-2022) indicating, in year 2020 machine fault accounts: (14-injury case, 11 males, 3 Females), in year 2021 falling (10 injury case, 9 males, 1 Female). In addition, in year 2022 improper handling accounts for: (8-injury case, 8 males only). Hence, information shows the majority of injury cases in the manufacturing industry observed among male accounting for 87.5%, while females account for the remaining 12.5%. Conversely, evidence from history records indicating, 405 sick leaves, (168 male & 237 females) & (112 male & 322 female totals of 434 workdays absenteeism obtained. Therefore, it is imperative to make the enhancement of working conditions and issues related to high rate of workplace exposure records and faults in the manufacturing industry.

Apart from that, study aims filling literature gaps on basis of topic area. To begin, research conducted by Ekowati and Amin (2019) indicates, direct impact of occupational safety on employee performance is limited, because, some employees do not practicing to safety regulations and fail to use the provided safety equipment (PPEs) as required by the company. Similarly, the effect of occupational health on employee performance is minimal. Even though, company provides health services for its employees, these

services are inadequate and consequently have a negative impact on employee performance.

On the other hand, to achieve optimal performance, it is essential to enhance safety measures that ensure employee satisfaction in the workplace. Therefore, the study acknowledges its limitations and suggests that, further elaboration is needed to clarify the direct relationship between occupational safety and health (OSH) and employee performance.

The productivity of employees in an organization can be influenced by various factors, and from which one of the factor in the manufacturing industry is the implementation of an occupational safety and health program (Ahmad Sutisna et al., 2019). According to the researcher view, the employee's productivity affected through the development of safety & health program in the workplace environment. Other study predicts that, the implementation of occupational safety and health measures indicating a positive impact on productivity of workers. The research by, Maulana and Sulistyowati (2020), found that, the productivity of workers influenced by their work discipline. The author argues that, work discipline is a significant factor that affects productivity. Therefore, to maintain high levels of productivity, it is essential for workers to follow company regulations, arrive on time during working hours, and ensure the correct usage of personal protective equipment (PPE) in their workplace while following the company's rules and regulations (Rahmi & Ramdhan, 2021).

The study on the metal manufacturing industry, in Addis Machine & Spare Part Manufacturing Industry as a case company, aims to explore the major areas where there exist health and safety challenges and bottlenecks for the organization. The study addressing major manufacturing industry production units specifically focusing on: machine building & chrome plating, bolt & nut production, fabrication & precision production unit. Hence, it conducts an in-depth analysis of accidents, injuries or hazards, and the associated causes and factors related to Occupational Safety and Health (OSH), addressing the specific goal & aim of the study.

Based on the findings, this study presents an opportunity to address the existing problems in the metal manufacturing industry and provides mitigation methods. The aim is to develop a strategy that supports industry, policy makers, and stakeholders and academicians in addressing OSH (occupational safety & health) concern, suitable for both the case company & today's metal manufacturing industries.

### **1.3 Problem Statement**

The global issue of workplace safety & health continues to be a significant concern. It is predicted by Bhavika Mamtani and Mahajan (2020) on basis of report from the International Labor Organization (ILO), around 125 million workers are affected by occupational accidents and illnesses every year. Out of this number, approximately 220,000 workers lose their lives, and about 10 million suffer severe disabilities. According to a recent study conducted by Amirah et al. (2024), the International Labor Organization (ILO) estimates that there are approximately 160 million cases of workplace injury challenges worldwide each year. Additionally, the study reports that there have been around 340 million work-related incidents recorded

Research conducted in the metalworking industry on assessing of occupational health, identifies the prevalent mechanical and chemical hazards. The research results indicated that, cutting (20%), impacts (17%), and crushing (16%) were the primary mechanical hazards faced by workers. Additionally, welding fumes (40%) and paints/solvents (35%) identified as the main chemical hazards present in the industry. These findings clearly highlight the need for the metalworking industry to enhance awareness of occupational safety and health among its workers (Langat, 2020).

The study based on prevalence of occupational injury conducted in Ethiopian manufacturing shows that, the major factors, which affects work-related injuries, include drinking alcohol, smoking, work experience, sleep disorder, job satisfaction, use of PPE, working hours, health & safety training & work schedule (Alamneh et al., 2020). Furthermore, the study assessing factors related to occupational safety and health among industry workers revealed major challenges in areas such as the proper usage of personal

protective equipment (PPE), non-compliance with safety regulations, and inadequate health check-ups (Debela et al., 2023).

Looking into case company, its primary activities include producing spare parts, building machines, fabrication, welding, and machining for end customers. The company aims to serve its clients by providing machine spare parts, engineering services such as metallurgy lab tests, and other related tasks. To establish effective working procedures and practices, it is crucial to focus on occupational safety and health (OSH) aspects within the work environment. However, the major production areas currently face challenges, including a lack of smooth workflow and incidents of injuries and safety issues. Additionally, the company struggles with the handling of chemicals, with some items being improperly managed in certain work units, raising concerns about worker safety and health.

On the other hand, the symptoms of occupational safety and health (OSH) problems were observed through site visits, interviews, and discussions with workers and the safety and health office. The current industry situation reveals clear signs of health and safety issues both within and around organizations. As noted in the background and justification section of the study, there are significant health problems affecting workers. Data records from 2020 to 2022 show a total of 32 major injury cases caused by improper machine handling, machine faults, and falls from heights: 14 cases in 2020, 10 in 2021, and 8 in 2022. Additionally, records indicate 405 sick leaves, comprising 168 male and 237 female employees, along with a total of 434 workdays of absenteeism, which includes 112 male and 322 female workers. For example, the findings highlight several key challenges, such as irregular shift hours, frequent machine malfunctions, inadequate use of personal protective equipment (PPE), worker reluctance, and a lack of effective health and safety measures. On the other hand, the data records show a decreasing trend in injury incidents within the case company, as noted during the document review. However, feedback from experienced personnel, safety officers, and health centers reveals gaps in accurate data completion and a lack of clarity. Additionally, site visits and discussions with factory workers and representatives revealed that several manufacturing units exhibit significant health and safety issues. Among these units, some production

areas face considerable challenges related to occupational safety and health (OSH). Workers have expressed serious concerns about safety and health, particularly regarding the inadequate provision of safety materials. Furthermore, the handling and storage of chemicals in some work areas present notable challenges. On the other hand, through discussion made with safety department, workers & members noted that, the current situation in the industry is not good & there are big challenges on OSH in the case company. Similarly, industrial Safety department tries to give safety awareness training on yearly basis for workers but no change on minimizing or reduction of safety issues in manufacturing units.

As previously mentioned, concerns regarding safety and health persist. However, data collected from various aspects may also be necessary to explore accurate information. This study aims to capture the underlying realities of incidents in different working environments. Engaging directly with frontline workers, including those in the safety and health office, provides valuable insights, as these individuals are exposed to similar challenges in their roles. Due to the limited capacity of the industrial safety office and health center, the challenges related to occupational safety and health (OSH) continue to exist. This study confirms these issues through site visits and discussions with the workforce, alongside data that highlights the situation in various ways. Feedback from workers in the production units emphasizes the ongoing challenges that are adversely affecting their health in the workplace.

The study tries to forward & address the current concerns in metal industry regarding workplace health & safety. Also, study overlooks the challenges through investigating the existing situation and potential injury incidents. Furthermore, study incorporates in developing an improvement strategy to tackle these issues by addressing the identified research questions and aligning with the study's objectives.

## **1.4 Research Questions**

The research addresses the following questions related to the problems faced by the case company, aiming to achieve the objectives of the topic:

- What are the factors that significantly impact occupational safety and health (OSH) within metal manufacturing industry?
- How can occupational safety & health (OSH) incidents be predicted in metal manufacturing industry?
- What improvement strategy could be developed to overcome the challenges faced in metal manufacturing industry?

## **1.5 Objective of the study**

### **1.5.1 General Objectives**

The general goal & aim of the study is to investigating the Impact & Predicting occupational safety & health on workers' in improving organizational performance in case company.

### **1.5.2 Specific Objectives**

The study addresses the following specific objectives in relation to the challenges faced by the case company:

- To investigate factors impacting occupational safety and health (OSH) in the metal manufacturing industry.
- To assess the level of OSH practice, management commitment and workers awareness in metal manufacturing industry.
- To develop a predictive model for reducing injury incidents affecting workers in metal manufacturing industry.
- To develop a Comprehensive improvement strategy for occupational safety and health (OSH) that effectively enhances workers health & safety and improves organizational performance in metal manufacturing industry.

## **1.6 Scope and limitation of study**

### **1.6.1 Scope of the study**

The study specifically focusing & limited on, investigating occupational injuries and related hazards within case company working environment. It related to workplace accidents, which considers injury incidents of workers who reported to safety office, health center & hospitals with exclusion of injury records outside working hours. Hence, addressing health and safety issues that influences workers' health and the performance of the organization by predicting in terms of dependent & independent variables is a key focus area. Specifically, working areas where there exists high rate of health and occupational injuries will then be one of the key areas of study. Hence, the study delimited on issues of OSH which is related to existing manufacturing bottlenecks aims to more elaborate the existing situational problems in case company.

### **1.6.2 Limitations of the study**

One of the limitations may arise from the challenge of obtaining accurate and comprehensive data, as well as the need for appropriate personnel in the working area to provide relevant information. Additionally, collaboration from frontline workers, along with clear communication and close support, affects the validity of the results. To address these limitations, the study employs various strategies. Firstly, it establishes direct contact with workers and team members through site visits and face-to-face interviews. This approach aims to enhance data reliability by engaging directly with the individuals involved in each working area. Furthermore, the study seeks to fill any gaps by utilizing focus group discussions and leveraging the expertise of experienced personnel as alternative mechanisms.

## **1.7 Significance of the study**

The significance of the study has an advantage for the manufacturing industry to overcome the safety & health issues in the workplace. Also, it would give a good insight on Safety & health issues in the working environment by keeping workplace free of danger & improved employees productivity & organizational performance. In addition, it

allows the organization to practice good safety health programs, develop safety & health trainings, exercising rules & regulation in the working environment & it creates continuous improvement in the working environment. Similarly, it provides inputs for researchers who want to make further study, concerned bodies to be aware of workplace health & safety; it would enable organizations, government bodies, R&D centers to develop strategies. Provide additional sources of reference to investigation on problem areas, gives additional knowledge, awareness creation, and would explore gaps in the study area & valuable information.

## **1.8 Organization of the Paper**

The overall research study consists of six chapters. The first chapter focuses on the introduction and problem identification. It incorporating: background information, statement of problem, the research aim & objectives, scope, limitations, significance of the study & organization of the paper as well.

The second chapter delves into the related literature reviews. It begins with an introduction and provides a conceptual understanding of the subject matter. It discusses the factors influencing occupational safety and health (OSH), the impact of OSH on worker productivity, predicting OSH accidents, development strategies, and the global and Ethiopian metal manufacturing industry's occupational safety and health practices. Additionally, it provides a summary of the literature gaps identified.

The third chapter addresses the research methodology. It incorporates: the research design, sources of primary and secondary data, sample size determination, research ethical considerations, dissemination of research findings, and data analysis methods and tools.

The fourth and fifth chapters focus on data presentation and analysis & recommendations and conclusions respectively. At end, the study's reference sources and materials are included

## Chapter Two

### 2 Literature Review

#### 2.1 Introduction

The literature review focuses on occupational safety and health (OSH) in the metal manufacturing industry, aiming to analyze its impact on workers' and organizational performance. It provides a comprehensive understanding of OSH and its significance in metal manufacturing, referencing global and national research studies. The review also addresses the causes of injuries that negatively affect workers health and highlights related health challenges. Utilizing major academic sources such as Google Scholar, Emerald, Research Gate, and Science Direct, the review summarizes findings under various subheadings. Ultimately, it discusses the overall concepts and outputs of the literature, focusing on the existing research gaps that this thesis intends to address.

#### 2.2 Definition of terms in occupational safety & health (OSH)

As described by Zafar (2023), giving attention for OSH key terminology can help to improve the safety & degree of injury in working area. Accordingly, one of the key terms “exercising safety & health”, makes to understand regarding health injury, risks, hazards which creates potential ways to mitigate the courses & hazards in workplace. Similarly, creating workers active participation, allows engaging workers in safety aspects as one major part, this also creates to have working environment to be safe. According to S. Zafar (2023), it emphasizes the significance of defining key terms in the field of Occupational Safety and Health (OSH) as follows:

- **Health**

Health encompasses the holistic state of one's physical well-being, encompassing both the absence of illness and the presence of optimal wellness. It serves as the foundation for the well-being of all individuals (Svalastog et al., 2017)

- **Safety**

Safety can be described as the state be protected and out of harm's way (Nas, 2015). Safety primarily focuses on ensuring the well-being of employees by preventing physical injuries, harm, or illnesses while they perform their job responsibilities.

- **Welfare**

Welfare encompasses the provision of essential facilities, services, and amenities within the workplace to support the health, well-being, and comfort of employees. These facilities include but are not limited to sanitation facilities, restrooms, access to drinking water, adequate heating and lighting, suitable seating arrangements, eating facilities, and first-aid provisions (Odeku & Odeku, 2024)

- **Hazards**

A hazard defined as any possible source or circumstance within the workplace that possesses the capability to result in harm, injury, or damage to employees, property, or the environment. Hazards can manifest in physical, chemical, biological, ergonomic, or psychosocial forms, originating from diverse origins such as machinery, equipment, substances, procedures, work structure, and human conduct (Ameer, 2023)

- **Occupational Health**

It refers to the prevention of diseases and injuries, as well as the management of work and workplace factors that influence the ability to perform job duties and can improve overall health (Guidotti & Ivanov, 2020).

- **Accidents**

An accident described as an incident that occurs without prior planning or anticipation, leading to injury, damage, or loss. An unexpected event can have adverse outcomes. Accidents have the potential to transpire in various settings, including the workplace, on roadways, within residential premises, or in public areas. They can transpire at any given moment and location (Anderson, 2024).

- **Workplace**

The term "workplace" encompasses any physical setting where work is conducted, irrespective of its characteristics. This includes both indoor and outdoor environments, whether they are of a temporary or permanent nature. The concept of a workplace encompasses a wide range of settings, such as offices, factories, construction sites, warehouses, retail stores, and numerous other types of work locations (S. Zafar (2023)).

- **Occupational Illness**

Occupational illness refers to any disease, disorder, or medical condition that is caused by exposure to hazards in the workplace. These hazards can encompass a wide range of factors, including physical, chemical, biological, or psychological elements that affect the health and well-being of workers. Examples of occupational illnesses include lung diseases caused by exposure to dust, asbestos, or other toxic substances, repetitive strain injuries, hearing loss resulting from prolonged exposure to loud noise, skin diseases caused by contact with irritants, and mental health disorders induced by workplace stress or other contributing factors (Keefe et al., 2020)

## **2.3 Concept of occupational safety & health (OSH)**

“Industrial or occupational accidents can have, and in fact do have great effect on the mental health of victims as well as others who witnessed the incident. Health and safety of employees at the workplace are costly to the individual employees and their families, employers and the nation as a whole” (Asumeng et al., 2015). So that, Safety & health is an important concern today to keep well-beings of human by protecting from harm & hazards. Hence, safety & health is an important aspect which to be considered & exercised in community & workers (Taufek et al., 2016). Occupational safety & health focuses on developing, promoting & keeping the workplace maintained which aims to ensure mental, physical & well-beings of workers. In addition, it keeps work environment free from hazards, which harms the employees (Taufek et al., 2016). Today, the emerging technologies require more focus to experience OSH & currently, it becomes an important part, which will increase the productivity of workers in industrial environment. Since, the manufacturing sector involving working equipment's which may acquire knowledge &

skill to properly use work-related injury has to be taken into consideration, due, it have its own impact & affects the overall working environment & workers as well (Ibrar et al., 2021). Study by Haidarravy et al. (2023) indicates, occupational health primarily concentrates on safeguarding the health and safety of individuals within the work environment. It necessitates considerable attention to minimizing the risk and severity of injuries. Occupational safety and health pose predictable challenges in current industrial setups due to work-related injuries and issues encountered for various reasons. Today, the introduction of recent emerging technologies brings its own impact and additional risks, leading to related accidents and causing injuries (Park et al., 2023).

In summary, industrial or occupational accidents greatly affect not only the mental health of victims and witnesses but also impact families, employers, and society at large. Thus, ensuring workplace safety and health is essential for safeguarding individuals from various hazards. Occupational safety and health initiatives aim to create and sustain an environment that supports the mental, physical, and overall well-being of workers while minimizing risks. With the advent of new technologies, it is increasingly important to prioritize occupational safety and health to improve productivity in industrial environments.

## **2.4 Factors influencing occupational safety & health (OSH) practice**

The study conducted by Mappangile and Ramdhan (2022) indicated that, factors related to individuals or personnel, knowledge, Technical and the environment are associated with the implementation of occupational safety and health effectively. Therefore, according to the author among the factors individuals knowledge, is one of the major which can affect & reduce health & safety performance & the result data shows that, 80% of Physical health problems or hazards occurs due the personal behavior of workers & in parallel a strategy needs to be implemented (Mappangile & Ramdhan, 2022). According to a study conducted by Tesfaye (2023), there are several factors that contribute to the practice of Occupational Safety and Health (OSH). The study conducted in metal manufacturing identified several critical factors contributing to occupational health

issues, including a lack of management commitment, poor safety performance, an unfavorable safety climate, ineffective hazard management, a weak safety culture, and insufficient safety and health training. Specific occupational health problems highlighted in the research included slips, falls, incidents involving heat and explosions, body burns, and electric shocks. Additionally, concerns related to noise, vibration, high temperatures, and exposure to hot materials were recognized. The cross-sectional study also emphasized that insufficient knowledge about hazardous substances significantly contributed to these occupational health challenges. Specifically, it was found that 48.3% of the issues were attributed to heat, 51.3% to body pain, and 44.3% to irritation (Dehury & Kumar, 2023).

On the other hand, the practice of occupational safety and health (OSH) in organizations influenced by various factors, as indicated by Surienty (2019a), these factors include safety practices implemented by management, regulatory bodies, and the demographics of the population. However, the author argues that it needs a conducive study regarding the identification of other factors that affect OSH. Additionally, the research discusses the concept of safety culture, which related to the active involvement of workers in acquiring knowledge and building capacity regarding safety requirements within the workplace environment. This aspect is considered one of the factors influencing occupational safety and health (OSH) practices (Ishanuddina et al., 2019). Study revealed that the implementation in safety management system of company resulted in an 87.85% reduction in injury rates. Additionally, this led to increased worker availability in the working areas and also resulted in cost reductions related to safety and health issues (Prince Grandez et al., 2022). Similarly, approximately 15% of adults within the population experience health issues at any given time. Stress and discomfort significantly contribute to this impact, resulting in an estimated annual cost of US \$1 trillion. This cost primarily is from productivity losses among workers (WHO, 2022). Other studies have found out, studying occupational safety and health (OSH) and its benefits in one of maintenance company activities by predicting the factors that contribute to it. Among these factors, individual factors, control factors, and workplace environments have been identified as significant outputs from the study by indicating a good achievement which keeps the advantage of the company (Kamisdan et al., 2023).

The study by Ghahramani and Amirbahmani (2021) investigates the reasons behind workplace safety and health incidents in the manufacturing industry, identifying unusual worker practices as a significant contributor to injury challenges. In response, the authors recommend mitigation strategies that include safety and health training to reduce complexity. Additionally, the review by Dyreborg et al. (2022) suggests that implementing control measures, such as hazard reduction or elimination, can significantly enhance workplace safety, rather than relying solely on feedback from training and practice. However, this does not suggest that the latter approach is ineffective. Instead, it underscores the significant gaps in safety that persist without the intervention of these additional factors or methods (Dyreborg et al., 2022). The impact of occupational safety and health (OSH) in the steel manufacturing industry largely depends on individual workers' commitment to safety regulations. The study indicates that the use of protective clothing is low, primarily due to workers' reluctance and complaints about the equipment provided. (Umugwaneza et al., 2019). Conversely, a study in the iron and steel industry found that achieving effective safety and health practices requires adequate resource allocation. By investing in these areas, organizations can improve safety standards and foster a healthier work environment (Blaou et al., 2019). A study by Debela et al. (2023) investigating workplace safety and health issues in the Ethiopian manufacturing industry identified several key findings. Firstly, it revealed inadequate utilization of personal protective equipment (PPE), indicating a significant gap in ensuring worker safety. Secondly, the study highlighted insufficient provision of materials essential for maintaining a safe working environment. These findings suggest a need for improved resource allocation to support occupational safety and health (OSH) measures. Additionally, the study emphasized that a lack of close integration and support contributes to OSH challenges within the industry. Together, these insights highlight the importance of addressing these factors to enhance OSH practices in the Ethiopian manufacturing sector (Debela et al., 2023).

In summary, the studies identified a common theme regarding the impact of individual behavior and safety practices on workplace safety and health. Mappangile and Ramdhan (2022), emphasized the significance of personnel behavior, while Kamisdan et al. (2023) highlighted individual factors as key contributors. Both studies share similar research

ideas on this issue. In contrast, (Surienty, 2019a) focused on management's safety practices and behaviors as influential factors in OSH practices. Additionally, this study suggests a need for further research to identify similar studies and clearly delineate contributing factors. Overall, it is evident that individual behavior, safety practices, and management roles are crucial in shaping OSH practices, highlighting the necessity for more comprehensive exploration of these factors.

## **2.5 Impact of Occupational safety & health (OSH)**

### **2.5.1 On workers' productivity**

The study conducted in the metal industry indicated that, workplace safety and health practices in the metal industry have a close relationship with the outcomes achieved by workers. Additionally, the study highlighted the performance of firms is also affected through implementation of OSH as well (Onawumi et al., 2016). According to recent research, data indicating approximately 1.8 trillion/year expenses due to reduce in performances. Accordingly , author predicts it requires to closely working on increasing performance in achieving the expected outcomes (Chellappa, 2023). Another study indicates that, the performance of workers is influenced by the organizational environment, accounting for 26.6% in relation with workers performance. Additionally, there are other factors which accounting 73.4% that need to be studied in order to gain a comprehensive understanding (Iskamto, 2023). Furthermore, it has been indicated that, when workers engage in training sessions, practice control methods among themselves, create injury-free areas, and develop safety-oriented personal characteristics, it leads to enhanced company performance and productivity (Rajuskar & Warule, 2020). In today's organizations, there is a growing need to prioritize and pay attention to workers' health and safety. A study conducted by Jilcha (2020), indicates that relying solely on traditional methods to address workplace safety and health issues is not yielding the expected results. Instead, adopting a modern approach that emphasizes the well-being and safety of workers in the workplace environment has been shown to generate the desired performance outcomes In addition to focusing on workers' health and safety, organizations also need to consider the performance of their employees (Pane & Kasmir,

2022). According to the author, includes a focus on both physical and non-physical aspects of the workplace in order to optimize workers' performance. Research has consistently predicted the significance of Occupational Safety and Health (OSH), in maintaining a healthy workplace environment and strengthens workers' productivity. Numerous studies have established a strong association between OSH and employees' physical and mental well-being, which directly affects their performance and efficiency (Pane & Kasmir, 2022). By addressing health issues and ensuring a safe work environment, organizations can create conditions that promote optimal productivity among their workforce (Lari, 2023). Similarly, establishing a strong Occupational Safety and Health (OSH) framework leads to the creation of a safe working environment, consequently encourages worker productivity (Kristanto & Purnamasari, 2022). By prioritizing OSH measures, organizations can ensure the well-being of their employees, reduce the occurrence of accidents and injuries, and enhance overall productivity levels. Implementing effective OSH practices not only safeguards workers' health but also contributes to a positive work culture, increase morale, job satisfaction, and ultimately, performance (Kristanto & Purnamasari, 2022).

Other research indicated that, prioritizing the well-being & security of workers could have a positive impact on productivity. When employees feel safe and their well-being is prioritized, they are motivated, engaged, and productive at workplace (Birhan & Endawoke, 2023). Likewise, when workers are satisfied with their working conditions, it leads to notable achievements in their work performance (Zhenjing et al., 2022). The study conducted by (Lelo et al., 2019) examines the relationship between worker productivity and work-related stress. it indicated by (Lelo et al., 2019), that there is a significant link between productivity levels and the level of stress experienced by workers. It is vital to address work-related stress to enhance productivity. Ensuring work safety in daily activities creates a safer working environment, positively impacting workers' performance. Another study examines the correlation between work safety and employees' daily duties, revealing that a safe working area significantly boosts workers' performance (Mustafidah Mahardhika et al., 2023). The study suggests that implementing an occupational safety and health (OSH) system including measures such as monitoring workplace accidents, managing workloads, providing training, and raising awareness can

significantly enhance workers' productivity (Millicent et al., 2023). Additionally, the use of personal protective equipment (PPE) may also influence productivity, although its specific impact requires further investigation (Millicent et al., 2023). Conversely, worker performance is closely linked to workplace safety, serving as a key metric for both the quality and quantity of output. It is a significant factor influencing organizational outcomes, as poorly organized work environments lacking safety measures can directly impact productivity and the expected results of workers (Hendiani & Wediawati, 2023). The study emphasizes that a favorable working environment significantly enhances expected productivity and achievement (Lindawati et al., 2024). According to Lari (2022), safety and health interventions play a crucial role in transforming the organizational environment, positively influencing workers' behaviors and fostering a supportive work atmosphere, which is expected to improve productivity. Additionally, Triansyah et al. (2023), found that, effectively managing workers' capacity and skills has a significant impact on productivity, performance, and overall work quality. By leveraging workers' abilities, organizations can enhance productivity and achieve better outcomes.

The primary gaps in the studies are related to the impact of personal protective equipment (PPE) on workers' productivity, which requires further investigation. Additionally, worker performance, accounting for 73.4%, needs more analysis, while organizational performance and its impacts, representing 26.6%, and also require study. Various organizational factors have not been included in existing research, highlighting another gap. Furthermore, developing methods or frameworks to assess workers' skills and capabilities in enhancing productivity is another area that needs attention.

### **2.5.2 On organizational performance**

Organizational performance is defined as the ability of an organization to effectively manage and control its resources to achieve desired goals and targets (SIMON, 2020). Investigating risks, injuries, and occupational problems is crucial for companies, as it allows them to address these issues effectively and implement necessary measures. This emphasis on worker safety and health not only protects company resources but also

promotes the overall safety and well-being of the organization (Kessy & Raymond, 2021). Occupational safety and health (OSH) is essential for improving work-related accident prevention and ensuring the safety of organizational resources. It protects workers' abilities, promotes effective communication, and fosters the development of personnel skills (Hernández et al., 2023). The primary focus of OSH is to maintain motivation, reduce associated costs, increase productivity, and establish strategies for development based on occupational safety and health principles. Ultimately, OSH aims to provide comprehensive protection to the organization as a whole. The study examines the relationship between organizational performance and various factors, including conducted trainings, the use of occupational safety and health (OSH) clothing, and the control of OSH (Muriuki & Njoroge, 2023). Additionally, the study reveals that there is a need for conducted training programs, the implementation of safety and health practices, and efforts to ensure that, workers are free from injuries and those workplace health complexities addressed. Safety leadership, safe behavior, and safety climate are crucial components of a robust occupational safety culture. They play vital roles in preventing occupational accidents and promoting a positive working environment. By emphasizing safety leadership, encouraging safe behavior, and cultivating a positive safety climate, organizations can effectively mitigate risks, reduce accidents, and create a work environment that promotes ergonomic principles (Draghici et al., 2022). According to a study, Vladenska and Permana (2023) , Occupational Health and Safety (OSH) significantly influences the performance of individuals and organizations alike. It directly and indirectly affects employee health and safety, as well as overall organizational performance. Neglecting OSH can result in financial losses, decreased productivity, and repetitive damages. Therefore, prioritizing OSH is essential for ensuring worker safety and well-being, while also protecting the overall functionality and success of the

organization.

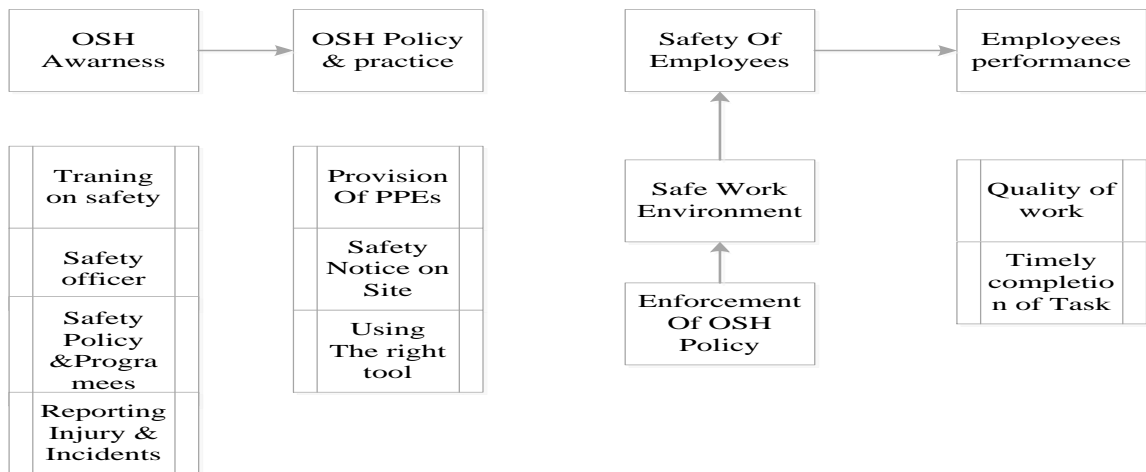


Figure 2.1 OHS on organizational performance:

(Vladenska & Permana, 2023)

On the study by Muriuki and Njoroge (2023), it indicated a close relationship between organizational performance and key factors such as training, evaluation of occupational health and safety, and the implementation of protective equipment having remarkable connection between performance of organization. Furthermore, there indicates a strong positive correlation between organizational performance and factors, including training, the utilization of personal protective equipment (PPE).

### 2.5.3 Factors influencing workers' Productivity

Recent studies have provided valuable insights into the factors that impact workers' productivity. Study by Rahman et al. (2023), highlights the significant influence of organizational support on employee performance within the work environment. Conversely, another study identifies various factors, such as the organization's management system, creativity, and key performance indicators (KPIs) that have an impact on workers' performance. These findings contribute to a better understanding of the varied nature of productivity and provide guidance for organizations to enhance employee performance (Triansyah et al., 2023).

In a study conducted by Rahman et al. (2023), indicates that, the primary factor affecting productivity is the workplace environment. The authors emphasize three key variables:

organizational support, technological innovation, and the overall workplace environment, as major influences on productivity. Additionally, organizational support, effective work arrangements, and resource allocation are significant factors impacting worker productivity. Therefore, organizations should implement practical strategies in these areas, such as grouping tasks based on key factors and fostering a conducive workplace environment, as suggested by the study's findings (Clement & Gwaltu, 2023). The study by Kahya et al. (2019), The study emphasizes that various factors, including workplace environment, noise, temperature, humidity, and illumination, can directly or indirectly affect a worker's performance, productivity, and safety. Inadequate working conditions pose significant challenges, leading to reduced overall performance, lower output quality, and increased risks. Additionally, another study in the metal industry explored the relationship between workplace injuries and education and income levels, finding that employees with higher education are less susceptible to injuries, while those with higher monthly incomes experience a lower incidence rate compared to their lower-paid counterparts (Bahrami et al., 2019). In another study by Septian (2024), conducted in the steel industry, the impact of safety on workers' performance was examined through an analysis of job safety which identified seven high-risk areas and five very high-risk areas. The results indicating 26% of the areas classified as low risk, 22% moderate risk, 30% high risk, and 22% extremely high risk. On contrary, through mitigation methods, 70% of the work types categorized as low risk, 30% as moderate risk, and none fell into the high or extremely high-risk categories. So that, author indicates, to ensure safety, health, and appropriate utilization of the work area, it is crucial to implement necessary protective measures such as using the appropriate personal protective equipment (PPE) and following the correct work procedures (Septian (2024). The studies conducted by Kahya et al. (2019) and Septian (2024), make a similar contribution to the existing knowledge regarding the factors of occupational safety and health (OSH) that impact workers' productivity and performance. However, both studies overlook the significant influence of workplace environment factors, although they explain this overlooks through different approaches. Consequently, the impact resulting from the challenges posed by different types of workplaces and their inappropriateness will have a significant effect on the overall outcomes.

On the other hand, Arrozak (2021) suggests that job satisfaction is a key factor in boosting workers' productivity. Satisfied employees tend to be more productive, and this can be enhanced by implementing various organizational measures, such as providing protective equipment, ensuring proper airflow, and installing fire protection devices. These steps create a safer and more conducive work environment, positively impacting employee productivity (Muriuki & Njoroge, 2023). Additionally, the contribution of different departments within an organization significantly influences productivity. A study by Kaloki and Ng'eno (2022) highlights, the crucial role of personnel management offices in enhancing productivity by improving the work environment and motivating workers to perform their duties effectively.

In summary, neglecting health and safety issues significantly impacts employees in workplace. There is a direct relationship between occupational safety and health (OSH) and workers' productivity. Health-related problems can negatively affect employee performance and morale, ultimately reducing productivity. Therefore, it is crucial to effectively address work-related health issues and ensure a safe working environment that allows workers to perform at their best. By providing a secure and hazard-free workplace, employees can focus more on their tasks and responsibilities, leading to improved performance outcomes.

## **2.6 Predicting occupational safety & health (OSH) Accidents**

The study by Xu and Xu (2020) employs the "Bow Tie Model" to predict the causes and consequences of fatal accidents in the metallurgical industry, aiming to identify injury causes and related problems. The authors note that traditional methods, such as linear or quadratic regression, are inadequate for predicting future accident types. Instead, they utilize "grey system theory" to forecast future characteristics of accidents in the industry. However, a limitation of the Bow Tie model is its inability to analyze the degree of injury. The authors suggest that future studies should combine this method with other prediction techniques, such as feasibility analysis, to better analyze injuries and related accidents.

The study by Sarkar et al. (2020), utilizes machine learning to predict accidents, incorporating "class imbalanced" reactive and proactive data. It employs a combination of techniques, including Synthetic Minority Over-sampling Technique (SMOTE), Borderline SMOTE (BLSMOTE), Majority Weighted Minority Oversampling Technique (MWMOTE), and k-means SMOTE. Various algorithms, such as Support Vector Machine (SVM), Artificial Neural Network (ANN), Naïve Bayes, k-Nearest Neighbor (k-NN), Classification and Regression Tree (CART), and Random Forest, are used to analyze datasets and predict injuries. Predictions derived from mixed data are considered more relevant than those based solely on investigated data. However, the study acknowledges limitations related to the quantity of available data, particularly in integrating machine learning with alternative information sources beyond traditional data combinations. The authors also highlight constraints associated with methods like time series approaches.

Based on studies Xu and Xu (2020) & Sarkar et al. (2020), the integration of methods employed for the prediction of injury accidents are one of the suggested areas for future studies. Hence, according to Sarkar et al. (2020), there is a potential opportunity to integrate different prediction methods in order to achieve a more comprehensive analysis of future incidents and elaborate on associated problems. By combining various approaches, such as machine learning, with alternative data & other related sources can leverage the strengths of each method and address the limitations of individual approaches. The study by Khairuddin et al. (2022) utilizes deep neural networks to classify accident types and identify contributing factors. However, the application of deep learning models in extracting occupational injury reports is currently limited due to slower adoption and low coverage in research within the field of occupational safety and health. A notable limitation of their study is that, it does not address the use of deep learning-based natural language processing (NLP) methods and advanced machine learning techniques for decision-making. The study conducted in the construction industry by Koc et al. (2022) employs machine learning (ML) algorithms such as Random Forest (RF), Naïve Bayes (NB), K-Nearest Neighbor (KNN), and Artificial Neural Networks (ANNs), along with sampling techniques like random under-sampling (RUS), random over-sampling (ROS), and synthetic minority over-sampling technique

(SMOTE). The results emphasized the significant impact of various factors related to historically recorded injuries, including workers' age, materials used, number of workers, accident year, and accident time. To improve prediction accuracy, Koc et al. (2022) suggest incorporating additional factors such as the specific body part affected, type of injury sustained, and the causes behind accidents. By considering these aspects alongside existing variables, the prediction model could achieve better performance and provide comprehensive insights into the occurrence and severity of injuries. However, the authors acknowledge a limitation in their methodology concerning the sampling technique known as "cluster-based under sampling," which was not incorporated into the current research and represents a research gap.

Comparing the studies by (Sarkar et al., 2020), (Khairuddin et al., 2022) and Koc et al. (2022), reveals several gaps and limitations, such as limited data availability, restricted data sources, lack of time series methods, and insufficient coverage of deep learning models. Additionally, Koc et al. (2022) did not incorporate cluster-based under sampling and highlighted the need for including more factors for comprehensive insights. In contrast, Chen et al. (2023) employed visualization, clustering, and ranking techniques in the construction industry to enhance safety prevention methods, though their results were limited by the applied techniques and the need for additional methods. The study Camliyurt et al. (2023), focused on maritime pilots, using decision tree and random forest methodologies to predict occupational injuries, but faced limitations due to the exclusion of near-miss incidents and a scarcity of data. Similarly, Maheronnaghsh et al. (2023) emphasized, the advantages of machine learning over traditional methods in predicting accidents in the OSH field, yet noted a limited focus on the metal sector within their research.

On the other hand, Debela, Azage, Deyessa and Motbainor (2022) conducted a study in Ethiopian manufacturing industries to investigate occupation-related injuries and their contributing factors, particularly focusing on predicting economic costs. The study aimed to assess the associated injury costs within the manufacturing sector but noted a limitation in not considering occupational injuries and their costs from the perspectives of workers and other stakeholder groups. Additionally, the study acknowledged the

challenge posed by the lack of similar research in the manufacturing industry regarding the prediction of related issues.

## **2.7 Development Strategy for occupational safety & health (OSH)**

The research study on the occupational safety and health (OSH) strategy developed in Malaysia indicates that implementing this strategy enhances worker safety in various environments and improves workplace culture (Rozanah Ab. Rahman et al., 2019). The country has established an OSH master plan that integrates ILO regulations, leading to positive impacts, including changes in employees' perceptions and personal behaviors, which are crucial for effective OSH practices. On the other hand, ensuring a safe and healthy working environment is a fundamental principle and right at work, highlighting the need for increased occupational safety and health (OSH) practices (ILO, 2023b). The ILO (2023b) OSH strategy discusses various types of work, their associated challenges, and opportunities, focusing on emerging alternatives in occupational safety. It specifically addresses issues in high-risk sectors, such as agriculture, construction, and mining, but may have limited consideration for other sectors. Additionally, the strategy recognizes the evolving nature of work and workplaces, taking into account factors like climate change and the continuous development of new technologies and work processes.

The study by Jilcha (2023), offers new insights into occupational injuries in the manufacturing industry, by focusing on key elements of safety, well-being, and worker productivity. The concept of zero accidents represents a novel approach, with limited research in this area, especially in manufacturing, where most studies have concentrated on car incidents. As a limitation, the study's model or strategy outcomes may need further clarification to align with the research objectives. In spite of that, the author's contribution introduces an innovative perspective to the understanding of OSH practices in the manufacturing sector, presenting a positive vision for improvement.

On the other hand, challenges related to workplace injuries and hazards in today's industry can potentially be mitigated through the integration of advanced technologies (Arana-Landín et al., 2023). The research suggests that implementing Industry 4.0 (I40)

has demonstrated promising results in minimizing safety and health issues. However, it is crucial to carefully assess these outcomes and adapt them to the specific industrial setups and methods to ensure effectiveness.

In conclusion, a research study conducted in Malaysia on the occupational safety and health (OSH) strategy indicates that its implementation would effectively ensure worker safety and improve workplace cultures (Rozanah Ab. Rahman et al. (2019). The study highlights the significance of a safe and healthy working environment as a fundamental right, emphasizing the need for robust OSH practices (ILO, 2023). While the OSH strategy addresses various types of work, challenges, and opportunities, it primarily focuses on high-risk sectors such as agriculture, construction, and mining: commonly referred to as "sectors of high-injury risks." However, a potential limitation is the lack of consideration for other sectors, suggesting a need for further investigation and improvement. In contrast, Jilcha (2023) offers new insights into the concept of zero accidents, with its strategy and model development providing a fresh perspective on OSH challenges and knowledge.

## **2.8 Suggested Strategy for occupational safety & health (OSH)**

According to a previous study conducted by the ILO (2023b), the strategy aims to reduce health problems and their impact on individuals by focusing on three pillars: enhancing national occupational safety and health (OSH) efforts, improving coordination and investment in OSH, and strengthening workplace OSH management systems. The strategy outlines four principles: adherence to ILO standards, effective communication with the community, consideration of gender and ensuring that OSH is addressed at all levels. Additionally, the findings suggest that implementing regulations and policies, along with conducting regular checks and inspections in work environment without burdening workers with associated cost can serve as an effective approach to enhancing workplace conditions and ensuring safety from hazards (Andersen et al., 2019)

The study highlights the urgent need for a new workplace safety and health strategy that adapts to the changing industry landscape. This strategy should include sustainable

solutions, effective communication with representatives, and alignment with valuable frameworks, supported by government intervention (Chia et al., 2019).

The strategy developed by (Kineber et al., 2023) utilized an Occupational Health and Safety Management System (OHSMS) intervention for accident prevention in the construction industry. The ILO's research on occupational safety and health (OSH) highlights gaps in its focus, particularly on industries beyond traditional high-risk sectors like agriculture and construction. It calls for a more inclusive OSH approach that addresses broader challenges. The study promotes the concept of zero accidents in manufacturing and acknowledges the potential of Industry 4.0 technologies to enhance safety, though it lacks exploration of their specific applications. Additionally, findings from the construction industry suggest that developed strategies could benefit other sectors as well (Kineber et al., 2023). The proposed Occupational Safety and Health (OSH) strategy aims to reduce health injuries and related issues. According to the ILO (2023), it is built on three main pillars: enhancing national OSH efforts, improving coordination and investment, and strengthening workplace safety management systems. It also includes four principles for addressing safety at all levels, emphasizing regular checks and inspections. However, there remains a need for a new strategy that adapts to the evolving industry landscape by incorporating sustainable solutions and fostering effective communication and integration with government initiatives.

In conclusion, this study identifies gaps in prior research by focusing on the strategy proposed by Kineber et al. (2023) to reduce injury rates across various sectors, including manufacturing. The authors recommend implementing the Occupational Safety and Health Management System (OSHMS) framework to enhance workplace safety. Effective implementation involves assessing current health and safety conditions, engaging stakeholders, and conducting training programs to raise worker awareness. Continuous monitoring and regular evaluations are essential for identifying improvement areas. Ultimately, reviewing OSHMS implementation is crucial for enhancing safety and reducing injury rates in the metal manufacturing sector.

## 2.9 Global Occupational safety & health in metal manufacturing Industry

Safety and health practices are vital for both workers and organizations (Dafit Feriyantoa, 2020). Key factors contributing to accidents include stress, fatigue, unsafe acts, and workplace design, highlighting the need for effective OSH practices. Nalugya et al. (2022), found a significant gap in protective equipment use, with only 37.1% compliance despite 61.4% of workers having satisfactory safety knowledge. Strong safety practices are essential in the manufacturing sector to enhance worker safety and reduce hazards (Naji et al., 2021). Enhancing safety practices involves integrating management, engineering measures, training, and worker awareness to tackle safety challenges effectively (Ala et al., 2020). A study in Spain found that operational faults, slips, and falling objects are major contributors to accidents, with smaller companies reporting more incidents than larger ones (Fuentes-Bargues et al., 2022). In Palestine, 32.3% of workers reported injuries, resulting in an average injury rate of 7,556 per 100,000 workers, highlighting inadequate health and safety practices in manufacturing (Hanan S. Tuhul et al., 2021). Reported health issues included musculoskeletal disorders (34%), gastrointestinal problems (25.8%), respiratory issues (18.1%), eye problems (59%), and skin and hearing issues (26%) (Suri & Das, 2016).

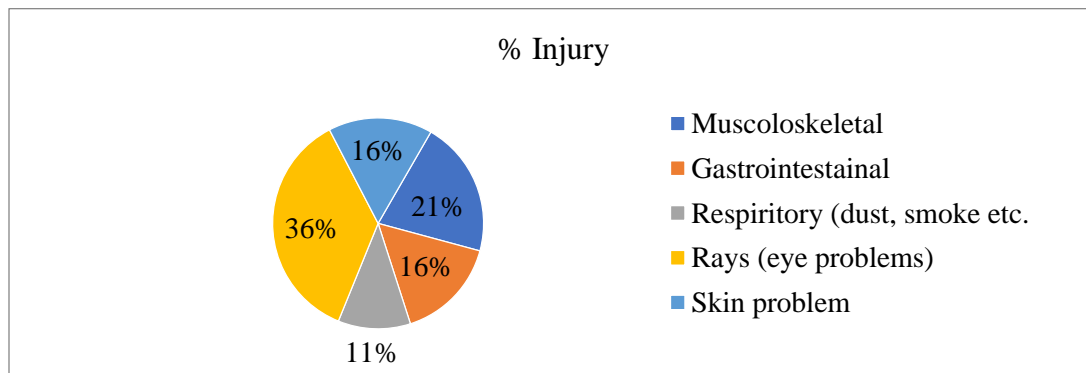


Figure 2.2 Injuries in manufacturing industry

Source (Suri & Das, 2016)

A study on work-related problems in the industry found that 40.6% of participants experienced physical disorders. The most commonly injured body parts were the neck

(26.8%), shoulder (22.8%), upper back (14.9%), and lower back (14.8%) (F. Yang et al., 2023).

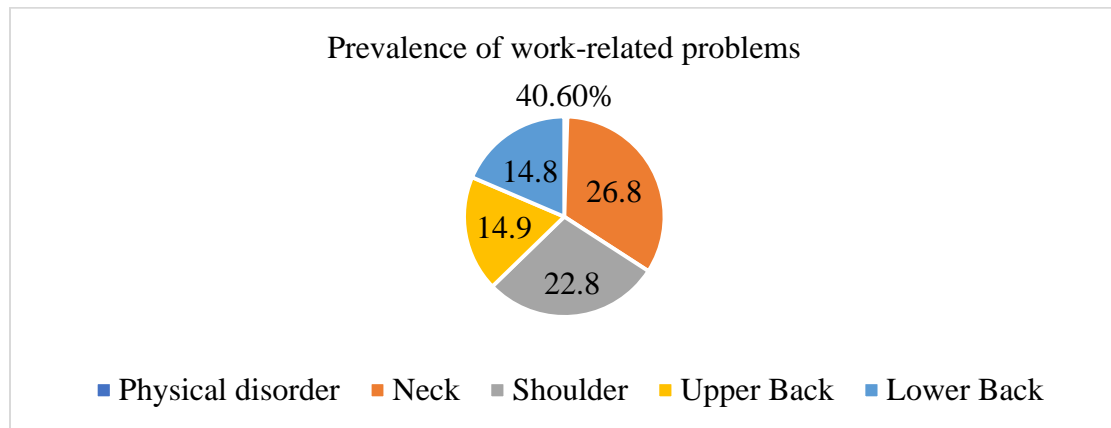


Figure 2.3 Work-related problems

Source (F. Yang et al., 2023)

The research findings highlight the prevalence of physical illnesses and health problems among workers in the manufacturing sector, revealing limited mitigation methods. Despite this, the studies conducted by (Hanan S. Tuhul et al.), Shivali Suri and Das (2016) & (F. Yang et al., 2023) underscore the significant impact of health injuries on productivity.

A study by Sari et al. (2023) in metal industry identified 14 injury incidents, including hand and foot injuries, and recommended enhancing safety practices through proper materials, adherence to safety rules, improved illumination, and machine maintenance. (Rajak et al., 2022) found that approximately 28% of employees faced health issues, mainly due to injuries from objects (37.32%), cuts (30.28%), and heating sources (19.01%), attributed to factors like lack of awareness, high-risk conditions, and alcohol-related behaviors. In other industries, 64.7% of OSH problems were linked to hand equipment (45.8%) and hot areas (14.1%), driven by workplace dissatisfaction and inadequate training (Asiedu et al., 2024). The study highlights the importance of addressing underlying causes and fostering a work environment that sustains worker motivation. Research on musculoskeletal disorders (MSDs) in the manufacturing industry found that neck disorders accounted for 15% of cases, lower back disorders for 12.5%,

shoulder disorders for 11.2%, and upper back disorders for 7.1%. The findings indicated that female worker, those working long hours, and individuals over 35 years were more significantly affected by the prevalence of MSDs. (X. Ding et al., 2023). A study on metal workers found that eye and ear injuries accounted for 98.4% of reported cases, with 97.1% of workers noting a lack of safety rules and practices, emphasizing the need for proper safety protocols and equipment (Joshi et al., 2020). Another study revealed that inadequate safety equipment contributed to 23.9% of cases among welders, with 68% experiencing accidents and 60.2% reporting health issues (Atik et al., 2024). Additionally, research identified multiple factors contributing to work-related injuries in the metal industry (Muliajati et al., 2024). The study identifies key factors contributing to workplace injuries, such as hand tools, unsafe working conditions, poor safety practices, and inadequate safety clothing. Recommendations include comprehensive training, improved management-worker integration, and effective communication (Mohd Nasrom Mohd Nawi\* et al., 2022). In India, a lack of safety knowledge among workers leads to increased injuries in the manufacturing sector, highlighting the need for safety awareness training (Bhavika Mamtani & Mahajan, 2020). The global prevalence of occupational safety and health (OSH) issues in the metal manufacturing industry is estimated at 55% (Shabani et al., 2024), with work-related injuries resulting in approximately 2 million deaths annually due to factors like extended working hours and environmental hazards (WHO, 2021b). Both studies stress that improper use of Personal Protective Equipment (PPE) is a major cause of workplace injuries. Global data shows 395 million recorded injuries and 2.6 million deaths, with work-related incidents accounting for 330,000 fatalities. The injury rate is significantly higher for men (51.4 per 100,000) than for women (17.2 per 100,000), and countries in the Asia and Pacific region contribute about 63% of the global total (ILO, 2023c). These statistics underline the urgent need for comprehensive measures to enhance workplace safety and prevent injuries.

Overall, studies have highlighted gaps in safety and health practices, particularly in the integration of safety knowledge, measures, and management. There is a pressing need for engineering solutions to enhance safety. Additionally, primary data collected within organizations indicate a lack of comprehensive research and effective strategies for developing interventions.

## 2.10 Occupational safety & health in metal manufacturing industry in Ethiopia

Work-related accidents in the iron and steel industries are influenced by factors such as night shifts, hours worked, safety training, and the use of personal protective equipment (PPE) (Sime & Worku, 2020). A study found that 57.1% of workers experienced physical injuries, primarily from hot metal contact (23.4%) and fire explosions (22.5%). In Ethiopia, 41.6% of workers cited injuries linked to inadequate equipment, training, and long hours (Girma et al., 2022). Another study reported a 51.7% prevalence of back pain associated with work conditions (Hailu et al., 2020). Additionally, a 39.4% prevalence of occupational safety and health (OSH) incidents was linked to factors like gender and lack of safety equipment (Yosef et al., 2023). Previous studies had limitations, focusing on current issues without future strategies or lacking clarity in methods. For instance, only 41.7% of workers effectively utilized PPE, while 58.3% showed poor utilization despite recognizing its importance (Tessema & Sema, 2022). A large-scale study by Benti et al. (2019) highlighted inadequate PPE availability, with 66% of workers suffering hand injuries and 51% of injured individuals not wearing PPE due to unavailability, without clarifying staff participation in data collection.

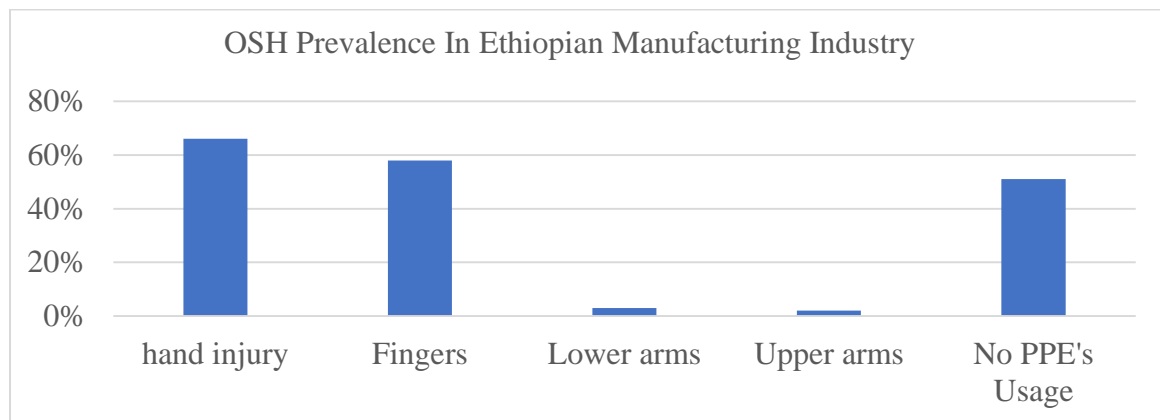


Figure 2.4 Prevalence of OSH in Manufacturing Industry

Source: (Benti et al. (2019))

Workplace injuries are common in manufacturing, primarily due to improper clothing and poor safety adherence, with an overall injury rate of 29.4%. Hand injuries account for

42.2%, followed by head (17.2%), leg (15.6%), and eye injuries (14.8%) (Tolera & Terefa, 2022b). The study also identifies low pay, inadequate use of personal protective equipment (PPE), and excessive working hours as significant contributing factors.

A study by Berhan (2020c) found a high rate of workplace accidents in Ethiopia's iron, steel, and metal manufacturing sectors, linked to a lack of Personal Protective Equipment (PPE) and a poor safety culture. It emphasizes the need for improved understanding of safety practices among workers. Comparing the studies by Tolera and Terefa (2022b) & (Berhan, 2020c) both highlight the relationship between appropriate workplace clothing and injury occurrence, stressing the importance of proper attire in preventing injuries. They also note that different types of injuries can lead to various problems for manufacturing workers, making the identification of specific injuries crucial for safety.

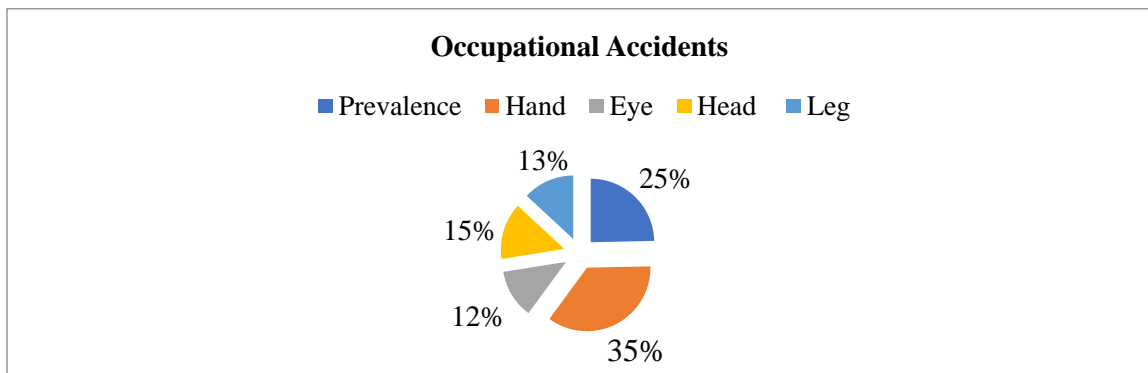


Figure 2.5 Accident Rates

Source (Tolera & Terefa, 2022b)

Figure 2.5 shows accident rates by body part, with hand injuries at 35%, leg injuries at 25%, head injuries at 15%, prevalence at 13%, and eye injuries at 12%. A study by (Benti et al. (2019) on occupational health and safety in large metal manufacturing improved data collection through clinical records but noted limitations in questionnaire-based interviews that could lead to inaccurate results. This emphasizes the importance of careful methodology in interpreting findings. Comparing the studies by Sime and Worku (2020) both share a limitation in data collection via questionnaires, yet the latter aims to build on previous research to focus on workplace health prevalence in selected metal manufacturing industries in Addis Ababa. (Benti et al., 2019; Berhan, 2020b), & their

findings to the current OSH Concern to manufacturing firms has its own positive impacts. A study in the metal industry found a 30.7% prevalence of hearing problems, attributed to smoking, age, sound level, and work experience. It recommended reducing sound levels, providing proper training, and ensuring safety clothing to address these issues (Melese, Adugna, & Mulat, 2022). A study by Afework et al. (2024) revealed that only 39.3% of workers in small-scale metal industries adhered to safety regulations, particularly among temporary workers. The authors recommend occupational safety training programs, noting that 75% of 310 analyzed injury cases resulted in workers returning to work within 90 days (Tamene et al., 2022). A key limitation of the study is the lack of statistical tools to quantify the severity of health-related problems, which significantly hinders the assessment of these issues. The research by Girma and Kebede (2019), The study focuses on steel workers in Ethiopia, assessing the impact of dust exposure through interviews with 75 workers. It reveals a significant prevalence of work-related issues linked to dust exposure in the manufacturing industry, predicting that safety clothing, training, awareness-raising, and effective regulations can help address these problems. Study by Sime et al. (2022a), focusing on work-related stress among manufacturing workers, the study found a high injury burden of 47.5% (95% CI). Key contributing factors included hazardous working environments, inadequate safety measures, insufficient training, and workers' experience.

According to Sime et al. (2022a), Lack of experience and inadequate skills are linked to a higher risk of workplace issues. The study recommends improving the working environment, providing adequate training, and raising awareness about alcohol consumption risks reducing work-related injuries and stressing among industry workers. The focus of the organization manager and their common understanding in OSH correction are very helpful. Studies conducted on workers in metal manufacturing industries also confirm that, when management has a common understanding and actively addresses OSH issues, there may result in minimizing injury risks and addressing health complexities, but it requires effective integration within the organizational structure (Berhan, 2020a).

The study conducted by Sileyew (2020), The study highlights workplace safety and health challenges both globally and within the local manufacturing industry. Results indicate a lack of adequate consideration for safety and health issues in both the global and Ethiopian manufacturing sectors, with minimal concern for occupational safety and health (OSH). The findings of the study by Sileyew (2020), specifically focus on the Ethiopian manufacturing industry, identifying various factors that contribute to this lack of consideration. These factors include knowledge gaps, challenges in knowledge diffusion and integration, the absence of OSH policies, limited technological advancements, and a general lack of awareness.

## **2.11 Prediction methods summery & Gaps**

The aforementioned research on OSH prediction models, as illustrated in Appendix 4, provides valuable insights into the subject matter and helps address the study objectives. The related papers primarily focus on predicting the severity of occupational injuries, with a stronger emphasis on the construction industry. However, there is no such coverage on the manufacturing sector, particularly the metal industry. Nevertheless, there is still an opportunity for further elaborate future research on the subject matter in other sectors, such as manufacturing areas. There is a significant lack of machine learning integration in the metal industry, as noted by Sarkar et al. (2020), who overlook time series methods. Mohamed Zul Fadhli Khairuddin et al. (2022) highlight the slow adoption of deep learning in occupational safety. Koc et al. (2022) & Chen et al. (2023) suggest that the benefits of advanced techniques remain underexplored. Similarly, Chen et al. (2023) evaluated various classification methods, while Debela, Azage, Deyessa and Motbainor (2022) focused solely on employer-related injury costs, neglecting worker and societal perspectives. Camliyurt et al. (2023) faced data constraints and omitted event and fault tree analyses for accident root causes. Although decision trees, random forests, and AI techniques offer insights into predicting occupational accidents, (Maheronnaghsh et al., 2023) did not explore machine learning applications outside mining and construction. Most studies emphasize ML for injury data analysis, yet adoption remains limited, particularly in the metal sector, which lacks clear accident prediction methods. Camliyurt

et al. highlight opportunities in the marine industry but, note insufficient focus on metal manufacturing.

## **2.12 Identified Literature Review Gaps**

This chapter's literature review covers occupational safety and health (OSH), its impacts, influencing factors, prediction models, and strategies. It analyzes global and national OSH practices in the manufacturing sector, emphasizing prediction models to enhance current research findings. Overall, it provides a thorough overview of key OSH concepts and research outcomes.

The summary emphasizes previous findings on workplace health and safety in both global and Ethiopian manufacturing contexts as summarized in appendix 4 & 5 respectively, highlighting a troubling frequency of workplace injuries and the inadequate use of personal protective equipment (PPE) as a key factor. Notably, several global studies have been conducted by Fuentes-Bargues et al. (2022), Tuhul et al. (2021), focus on the causes of workplace injuries and the magnitude of the problem, identifying major factors contributing to these incidents. Furthermore, Rajak et al. (2022), Asiedu et al. (2024); (Xiaowen Ding et al., 2023), (Joshi et al.) , Researchers conducted research focus on, the burden of workplace environment challenges in metal industry. The findings indicate that lack of awareness, inadequate PPE, long hours, insufficient training, and poor working conditions significantly contribute to workplace incidents. In contrast, a study on the Ethiopian manufacturing industry overlooks critical factors like technology and skill deficits (Afework et al., 2024). It examines the coverage of OSH practices and challenges in these contexts. The assessment of injuries and related factors is a key focus in the context of Ethiopian metal manufacturing industries, supported by various studies conducted by Aschalew Sime Megene and Yallew (2020) and Girma et al. (2022), These studies enhance the understanding of injury assessment and associated factors, with the Ethiopian study specifically focusing on the prevalence of accidents and related injuries.. Benti et al. (2019), Bekele et al. (2023), (Naol & Terefa, 2022), (Melese, Adugna, Mulat, et al., 2022), Berhan (2020a); (Berhan, 2020c), and Yosef et al. (2023). Studies indicate that injury incidents are primarily due to a lack of personal protective equipment (PPE), insufficient training, and inadequate management support. The research also explores

various assessments and challenges related to workplace health in the metal industry, alongside insights from global research Bhavika Mamtani and Mahajan (2020), Hanan S. Tuhul et al. (2021), Shivali Suri and Das (2016), as well as a study on prevalence by (Feng Yang et al., 2023) The research offers valuable insights into the impacts of occupational safety and health (OSH) and the factors associated with health and safety incidents. However, it lacks effective mitigation strategies. Additionally, it highlights that accident prediction in the manufacturing sector is less explored compared to the construction industry, presenting opportunities to integrate machine learning tools for enhanced incident prediction. Many previous studies in metal manufacturing have given little consideration to accident prediction & mitigation methods. This study aims to address existing gaps by exploring on how occupational injury incidents be predicted and the implementation of effective safety mitigation ways in the metal manufacturing sector.

## **2.13 Conceptual frame work**

The conceptual model outlines dependent variables occupational injury incident affected by independent variables related to PPE usage, Training & awareness, management support and working condition. The independent variables influence mediators like safety culture and employees engagement. Ultimately, enhancing safety culture and employee engagement which influencing dependent variable occupational injury incidents & affects the performance and overall organizational effectiveness.

Enhancing the usage of personal protective equipment (PPE) and improving training and awareness are crucial strategies that directly affect safety behavior, significantly reducing occupational injury incidents.

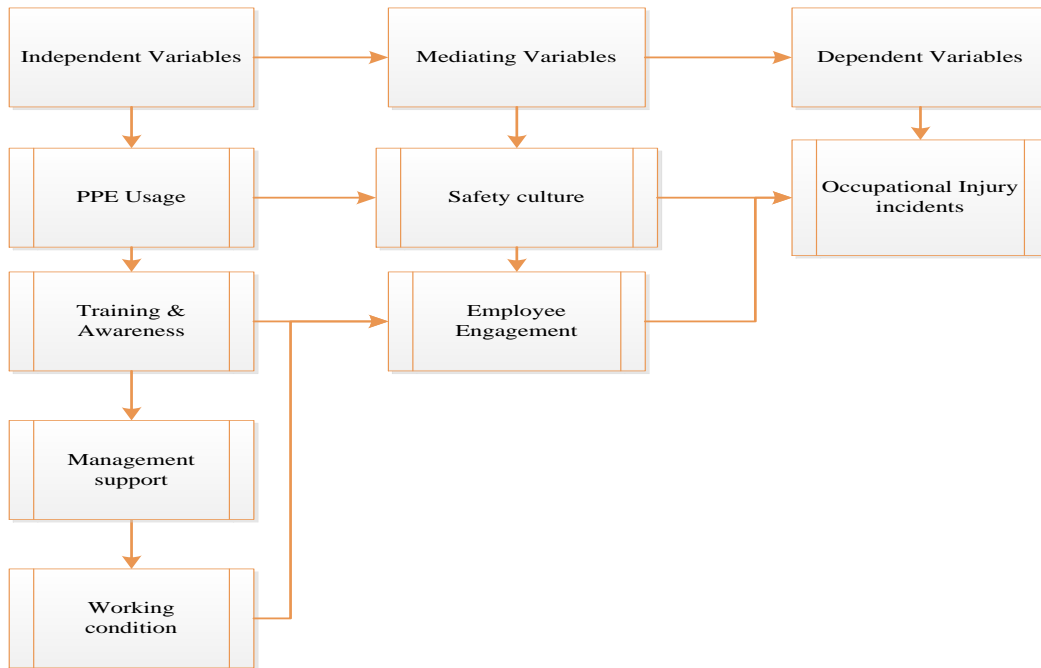


Figure 2.6 Conceptual framework variables

Source (own illustration)

By implementing comprehensive training programs focused on the correct use of PPE and conducting regular audits, organizations can strengthen their safety culture. This proactive approach not only increases safety knowledge among employees but also positively influences their safety attitudes, fostering a more vigilant workforce committed to adhering to safety protocols. Moreover, strengthening management support through active participation and feedback mechanisms further encourages safe practices among workers.

When management shows a commitment to safety, it empowers employees to engage in safety initiatives and view their concerns. Ultimately, by creating a strong safety culture and ensuring rules & regulation organizations can make working environment where safety and health incidents are minimized, leading to a safer and more productive metal manufacturing sector.

## Chapter Three

### 3 Research Methodology & Material

#### 3.1 Introduction

The research methodology employs a mixed-methods approach, integrating both qualitative and quantitative data collection and analysis techniques. The qualitative component involves interviews with management, safety officers, health center staff, and frontline workers to gain insights into safety culture, workplace conditions, and associated challenges. Additionally, site observations and discussions with focus group members will enhance the qualitative understanding. On the quantitative side, the study analyzes company records and data from the health and safety office, including incident reports and work-related injury records. By combining qualitative insights with quantitative data, the study aims to gather relevant information for further analysis, ultimately tries in addressing the study's objectives.

#### 3.2 Research design & Flow Process

Process flow of research design employs the utilization of both primary and secondary data sources, as well as a combination of quantitative and qualitative data collection methods. Previous studies have predominantly focused on quantitative approaches, with relatively less attention given to qualitative methods (like: interview, site observation, focus group discussion etc...). In recognition of this gap, the current study was incorporating both quantitative and qualitative approaches. The quantitative research primarily involves analyzing the current situation through structured questionnaires compiled and adapted from OSH-related studies in the literature by Tessema and Sema (2022), Afework et al. (2024), and Amirah et al. (2024). It employs closed-ended and partially open-ended questions along with Likert scale measurements. The questionnaire was initially organized with variables in English and then translated into Amharic to effectively address the sample population in the case company, ensuring ease of understanding and effective communication with the participants. Additionally, the qualitative research includes site visits, checklists, site discussions, reviewing company historical records, and gathering insights from experienced personnel and conducting

interview & discussions. The data collected is organized in excel spread sheet & major analysis work is done using the statistical tool SPSS V.27. Additionally, the study will utilize to analyses the data through tables, charts, graphs & scatter plots.

The major process flow emphasizes, the flow of work activities based on the research method, beginning with problem identification, literature reviews global & Ethiopian context, gaps identification, LR frame work, Define variables & method, data collection, analysis, model generation, interpretation, conclusion and Recommendations. Also, Overall design process flow utilizes primary and secondary data sources as inputs to facilitate the identification of relevant collected data output.

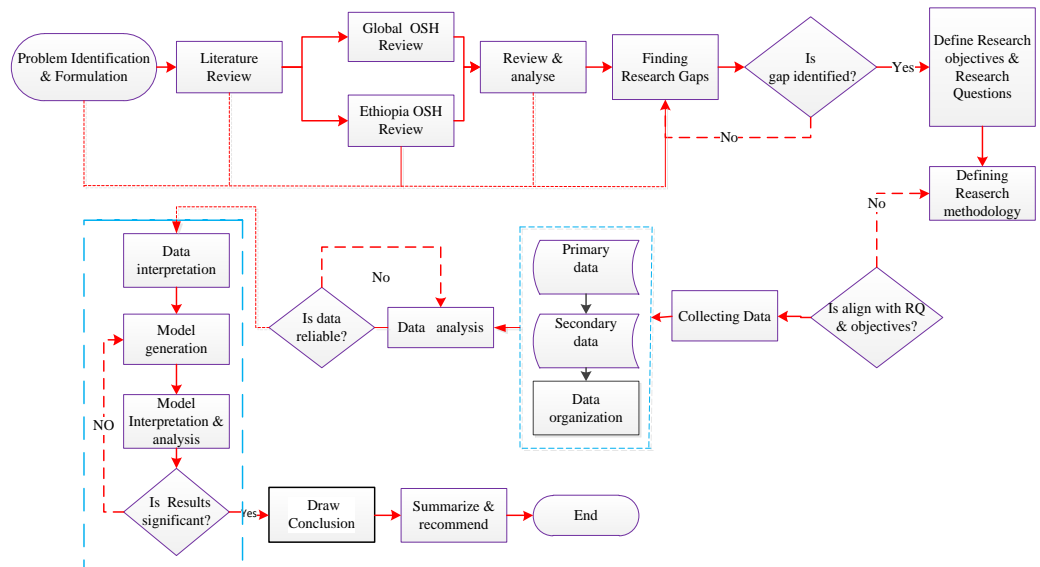


Figure 3.1 Research Methodology Frameworks

Source (Own illustration)

### 3.3 Study Area

The research was carried out in Addis Ababa, Ethiopia, with a specific focus on investigating and predicting the impact of workplace safety & health on workers & organizational performance. The study aims to investigate the OSH injury factors, and predicting the incidents affecting workers' health within metal manufacturing located around Mexico Square.

### **3.4 Data source**

The data source for the study incorporates mixed approaches including primary and secondary sources. Primary data obtained through well-structured questionnaires, which will serve as a key source of information. Basically, the source of primary data in case company falls on collecting through interviews, site observation by check lists & discussion with experienced workers as well. Interviewing method was taken in case company focus groups as obtained from information through experienced workers. The site observation was supported by a checklist to assess the working environment conditions, safety practices, and challenges in the workplace, ensuring that the data collected was factual rather than self-reported, the discussion with experienced workers offers valuable insight obtained from their experience. In addition, study incorporating & adopting the study conducted by (Fening et al., 2023). Secondary data sources will primarily consist of literature reviews. Similarly, study was reviewing relevant company industrial safety manuals, safety procedures, history logbook records, and health center recorded data were incorporated as secondary data source. The data recorded in industrial safety manuals & health center was analyzed to understand the impact of workplace condition on workers as well. Furthermore, data sources related to workplace health & safety, such as: International Labor Organization (ILO) and the World Health Organization (WHO) were providing supportive information and serve as additional sources. The primary data sources aimed to gather relevant information to meet the specific objectives of the study. This data was collected through questionnaires, interviews, site visits, and discussions with selected groups, thereby addressing specific objective number one of the study. The secondary data sources focused on company documents related to safety and health issues from health centers, as well as reports from the industrial safety office. Thus, the study aims to achieve specific objective number two of the established objectives. Additionally, the literature review included Occupational Safety and Health (OSH) issues from the International Labor Organization (ILO) and the World Health Organization (WHO). Thus, study aims to achieve specific objectives of study no.3 & 4 by conducting a comprehensive analysis of OSH incidents in company's working environment.

### 3.5 Population, sample size & sampling technique

The case study company population includes all employees involved in daily operations relevant to the research objectives. Two approaches were used to incorporate this population into the study. First, a representative sample was selected through a pre-test conducted with ten employees, utilizing questionnaires to gather and analyze results. This method intentionally targeted individuals directly involved in the research focus areas. Second, random sampling was employed to ensure broader participation by utilizing existing data, which aimed to include a diverse range of employees from various departments and working areas within the company. To achieve the study objectives, data were gathered from key working areas or production units, specifically focusing on the industrial safety and health department, the medical health center, human resources, marketing, and the production and planning department. This included frontline workers from five major production units, ensuring that the necessary data for the study were obtained. Hence, study planned to collect questioner data from total targeted factory workers as described below Therefore, the total number of workers in five (5) manufacturing units & support departments were incorporated to estimate the appropriate sample size to achieve the study's objectives & in addressing expected population sizes in study.

Sample design is a specific strategy devised to acquire a representative subset from a particular population. It incorporates, method or approach that a researcher would employ to choose elements for inclusion in the sample (Avinante et al., 2021).

The sampling formula is:  $n = \frac{N}{1 + N(e^2)}$  Where: n=required sample size, N=is population, e= level of precision

Hence, study tries to adopt & assume some of the parameters in the formula, to indicate the estimated sample size for data collection in case company. Taking, (147 total workers. A 95% confidence level & Acceptable error level ( $\pm 5$ ), i.e level of interval= 0.05. Therefore, estimated sample size equals

$$\text{Sample size: } n = \frac{(147)}{1 + 147 (0.05^2)} = \underline{107.4} = \underline{110}$$

## **3.6 Data Collection Method**

### **3.6.1 Primary Data source & Collection**

The primary data source focus on collecting information through structured questioner. The data collection through questioner mainly focuses on, manufacturing industry workers who are direct involvement in production units. Study includes in data collection, workers who have a direct involvement in working areas. The exclusion criteria would be workers who have issues of health problems, outside the normal working hours. The major focus of the data collection through questioner incorporates major five (5) production units & support department aiming to explore health & safety issues & challenges on workers' productivity.

Site visits allow for obtaining important information regarding occupational safety and health (OSH) challenges within a company. Site visits are believed to be one of the better sources of information for understanding the specific safety and health concerns in a given workplace. Study emphasized that, about 74% of responses from questioner choose to reach feed backs through site observations (Martic, 2023). Hence, study focuses on workplace environmental assessment, workers health & safety issues, injury incidents, overall industry situation & understanding & ensuring the ground truth. It helps more understand existing situation & allows us to discuss to focus groups in the case company & gives us a way for valuable data collection. The structure or standard questioner developed to predicts existing challenges & aims to obtain data from manufacturing industry workers as sample population. It emphasizes the socio-demographic characteristics, age, education, work experience, employment condition & year of experience. Furthermore, addressing, work place condition, behavioral characteristics, injury & availability of PPE as main variables, rules & regulation & PPE control. Additionally, data collected through a type of closed ended & partially open ended considering, interview Questionnaire for factory selected groups & Likert scale measurement contents containing four (4) variables with a total of 21 questions as well. Overall, major data are gathered from company workers including, machine operators, maintenance crews, health officers, safety personnel, supervisors, team leaders, support departments & other focus groups. Hence, the data sources, aims to answer research

questions through addressing investigation of the overall company & overlooking challenges during the study period.

### **3.6.2 Secondary data source & collection**

Secondary data for the study was collected from multiple sources. This will include data from company clinical history records, industrial safety records, logbooks, observational checklists, and other relevant records maintained by the case company. Additionally, data gathered from related studies, books, articles, brochures, and case company manuals were incorporated.

Furthermore, the examination of occupational safety issues will involve reviewing the records history of safety officers. This will entail reviewing safety-training documents, record sheets, and gathering feedback from experienced personnel within the company. Moreover, data collection will also involve reviewing journals, articles, reports, student research papers, and related articles from major web pages such as Google Scholar, Science Direct, Emerald, as well as non-governmental organizations. Furthermore, International Labor Organization (ILO) and the World Health Organization (WHO) among the major sources of secondary data for the study.

Therefore, data analyzed in questioner, interview, site visits, and company history record analysis & provided improvement strategy model all together tried to answer study research questions & met study specific objectives.

## **3.7 Data analysis & tools**

The study gathered information from primary and secondary sources, needs to undergo proper filtering, organization, and analysis. Firstly, questioner data were gathered and recorded in an MS Excel spreadsheet, ensuring filtered and organized in a structured manner.

In second place, data collected were filled into SPSS software in accordance with variables names. It incorporates data analyzing and interpreting using various tools including: graphs, tables, and charts based on data outputs. Hence, study utilizes IBM SPSS V.27 software to perform data analysis and interpretation. Similarly, study

comprise of regression model test of: R, R<sup>2</sup>, adjusted R square, and P-value <0.05 with the inclusion of bivariate regression analysis.

Dependent & independent variables are considered & analyzed through regression analysis to predict dependent variable health & safety (HS) in workplace. In addition, improvement strategies were employed aiming to meet the study objective & to improve workplace safety & health in case company.

As well, emphasize a strategy of occupational health & safety management system (OHSMS) in previous study, which aims to enhance & minimize work area injury risks faced by employees, which will ultimately contribute to the creation of targeted measures for preventing and managing workplace exposures.

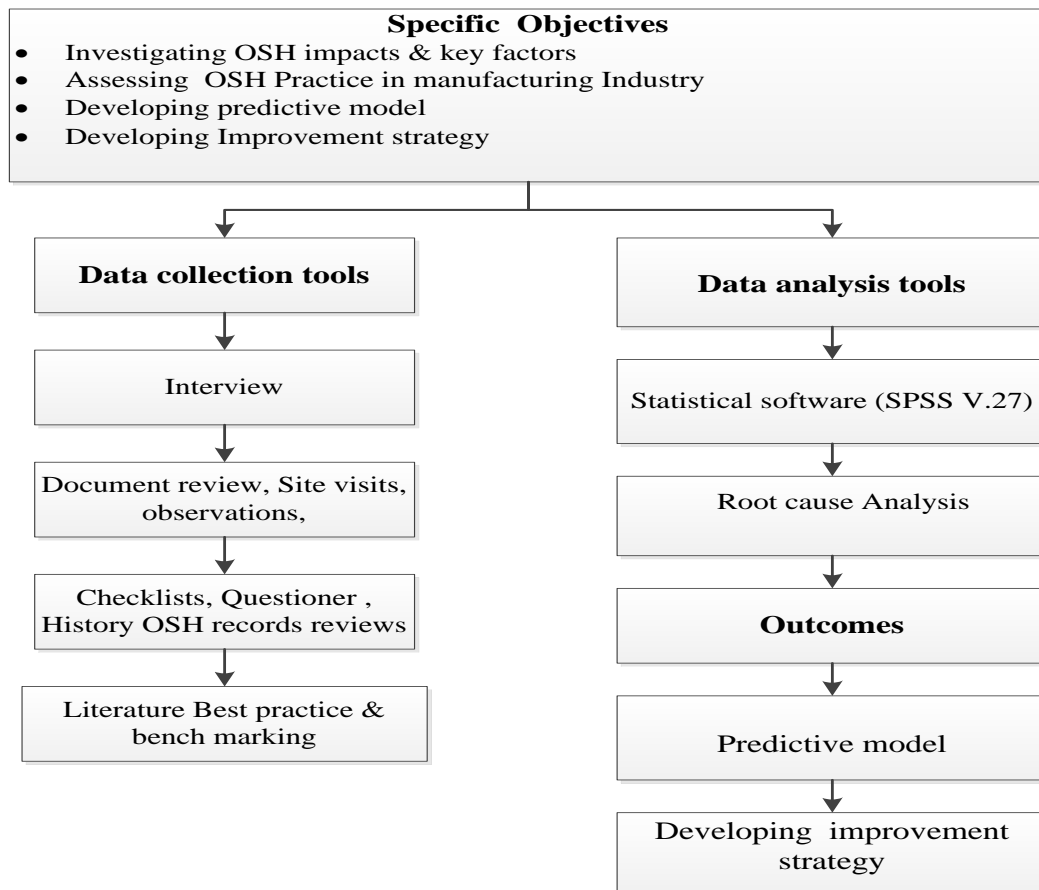


Figure 3.2 Data Analysis Tools

Source (own analysis)

### 3.8 Reliability & Validity of the study

The concept of validity refers the process at which meeting its expected objective in research analysis & reliability on the other hand referring the dependability & strength of the research outcome obtained (William, 2024). Hence, study develops the questioner by obtaining feed backs from co-advisor, case company individuals through pre-test of sample respondents and incorporating feedbacks from close colleagues.

Based on case company population, a sample size of 110 questionnaires was distributed. Meanwhile, the research used pre-testing for a sample of 10 individuals before distributing the full questionnaire. This pre-testing was conducted to address the objectives of the study prior to the major data gathering.

Consequently, after getting the pre-test results and inputs, the researcher distributed 110 questionnaires, targeting manufacturing industry workers and obtained results seen in table 3.1.

Table 3.1 Reliability Test Result of Questioner Data

s/n	Variables	Number of items	Cranach's alpha " $\alpha$ "
1	Workplace health problem	12	0.831
2	environment rate	5	0.763
3	Health & safety rate	7	0.729
4	Human resource management factor rate	5	0.876
5	Workplace culture & practice rate	4	0.836
6	Overall Reliability	33	0.805

Source: surveying results

As indicated in Table 3.1, the reliability test result meets the Cranach's alpha recommended standard value of  $\alpha > 0.7$  as indicated by (Taber, 2018). Hence, the analysis test results in table 3.1 indicating, its internal consistency of the questionnaire items is within the range of standard values.

### **3.9 Research Ethical Consideration**

The study addresses ethical concerns pertaining to case study Company keeping the rules and regulations set by Addis Ababa Institute of Technology (AAIT), as the educational institution. In order to ensure ethical practices, the study aims to reach out to the entire population of the case company through with details about the study's objectives.

The data collection process involves using official letter and providing with study objectives and purpose to prevent any misrepresentation of ethical issues. Furthermore, during face-to-face communication with company representatives, the ethical considerations of the study and the avoidance of any misleading information, personnel information & data handling to protect participant confidentiality considered during the study period.

### **3.10 Dissemination of Research Findings**

The research study findings disseminated first through the presentation on workshops, conferences which might help to address the study objectives, employing sharing of information through websites, official library of Addis Ababa Institute of technology (AAiT), case company and relevant stakeholders.

The final output intended to be printed and laminated at a printing press. The valuable literature then, taken to publishing agents for publication, making it available to individuals involved in future development and research in the field.

## **Chapter Four**

### **4 Result and Data Discussion**

#### **4.1 Introduction**

The data presentation & analysis in this chapter incorporating, various methods, including structured questionnaires, interview, site observations, history records & document reviews in metal manufacturing industry. The primary focus of the data analysis was on the conditions of the workplace, workplace safety and health practices, injury cases, and types of injuries recorded & environmental condition. The Likert scale measurement variables used in the study emphasize the work environment, health and safety issues, human resource management, and workplace culture and practices. Additionally, the analysis incorporates data obtained through interviews with support departments including, management groups, industrial safety officers, and health center technicians, leaders & focus groups, site observation through checklists, history records & structured questioner as well.

The overall aim of study focused in exploring & enhancing health and safety concerns in the workplace, which have a direct impact on worker in the manufacturing industry. The findings result based on collected data provides insights into the current situation of occupational safety and health in manufacturing industry and identify areas for improvement to promote a safer and healthier work environment for the employees.

#### **4.2 Questioner Data SPSS Analysis**

##### **4.2.1 Rate of responses**

Study distributed a total of 110 questionnaires to respondents from the target population. Out of these, 95 respondents (87%) properly completed the questionnaire and provided regular feedback, which were then included in analysis. However, the remaining 15 responses (13% of the total) were not considered in the study due to issues with the data provided, such as irregularities in data filling and difficulties in handling the information. Therefore, the analysis in this chapter focuses on the following main parts, based on the data collected from the 95 valid responses: Demographic background of the respondents,

Workplace health conditions and related health problems, Work environment & Health and safety issues Additionally, the analysis covers the scale-measured variables and their corresponding output results, which are presented under the respective subheadings within the chapter. In essence, this chapter provides a detailed analysis of the key data points collected through the questionnaire survey, with a focus on understanding the current condition of workplace health, safety, and environmental factors within the manufacturing industry context.

## 4.2.2 Demographic background analysis

This part of the analysis incorporates the respondents participated in data collection during the questionnaire survey. The analysis output includes the distribution of respondents by gender, age, educational level, employment condition, and years of experience. The primary goal of demographic background review is, to explore the health & safety incidents among workers in metal industry depending on the variables. Alternatively, examining the effects during the assessment phase of the study by analyzing health injury records can provide a comparative and detailed analysis of injury rates, specifically in relation to factors such as gender, age, and education level. This approach allows for a deeper discussion and focus on workplace health and safety challenges.

Table 4.1 Demographic Characteristics of participant

Variable	Characteristics	Frequency	Percentage
Gender	Male	59	62.1
	Female	36	37.9
Age	Less than 30 years	33	34.7
	30-40 years	43	45.3
	40-50years	16	16.8
	Above 50 years	3	3.2
Educational level	Not educated	24	25.3
	Grade 1-6	32	33.7
	Grade7-12	26	27.4

	Diploma	6	6.3
	Degree & above	7	7.4
Employment condition	Permanent	69	72.6
	Contract	24	25.3
	Others	2	2.1
Year of Experience	Less than 5 years	34	35.8
	5-10years	24	25.3
	15-20years	28	29.5
	25-30 years	6	6.3
	Above 30 years	3	3.2

According to Table 4.1, key demographic characteristics of the survey participant were as follows: Gender: The respondents were predominantly male, accounting for 62.1% of the sample, while female respondents make up 37.9%. from which, male dominated in metal manufacturing working environment related with the study findings by Berhan (2020c), Girma et al. (2022), Duguma (2018), Mengistu et al. (2021) & Tolera and Terefa (2022a).

The largest age group represented is 30-40 years old, comprising 45.3% (N=43) of the respondents. Education: The majority of respondents have an educational level between grades 1-12, with a significant proportion having no formal education (25.3%). Those with education levels of 7-12 grades account for 26%, while those with a diploma or degree and above make up a comparatively lower proportion at 6.3% and 7.4%, respectively. Employment: Most respondents hold permanent positions (69%), while a notable portion was on contract (24%). Work Experience:

The workforce has a mix of experience levels, with the largest group having less than 5 years of experience (35.8%), followed by 5-10 years (25.3%), 15-20 years (29.5%), 25-30 years (6.3%), and more than 30 years (3.2%, N=3), indicating a relatively low

prevalence.

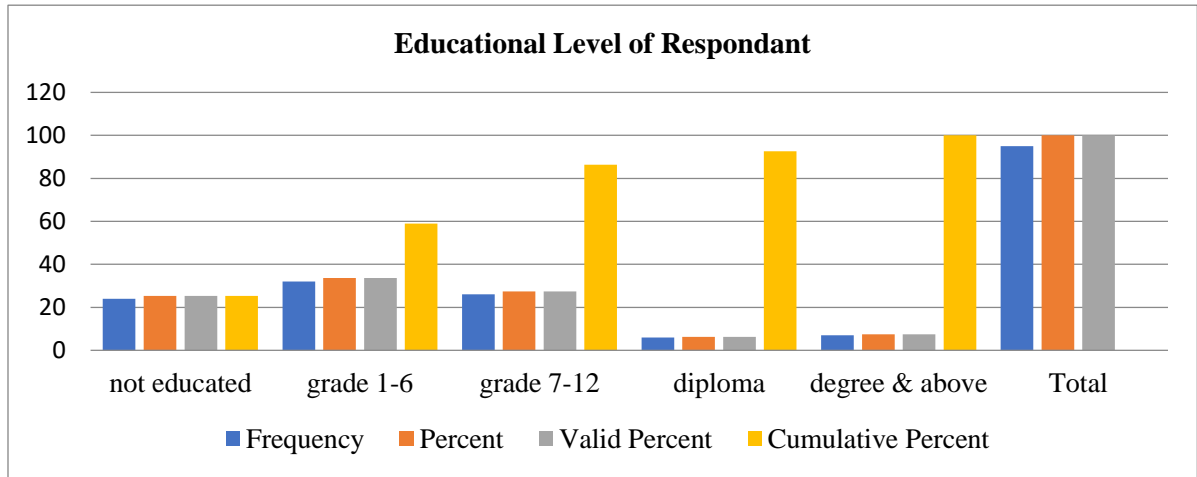


Figure 4.1 Educational levels of respondents

According to Figure 4.1, the survey reveals a concerning educational profile within the manufacturing workforce. Only 7.4% of participants have a degree or higher, while 6.3% hold a diploma. Most participants, 32%, only completed grades 1-6, and 26% finished grades 7-12. Alarming, 25.3% reported having no formal education at all. These findings highlight a significant gap in educational attainment that cannot be ignored. The high number of uneducated workers is particularly troubling, as it exceeds the findings of other studies, such as those by Tamene et al. (2022) , Sime et al. (2022b) & Kaur et al. (2019) which also noted educational deficiencies in similar contexts. This emphasizes the urgent need for the manufacturing sector to focus on educational development and training initiatives. Without a strong effort to improve the workforce's educational qualifications, the case company challenge increasing and becoming less competitive. Additionally, the work experience among survey participants complicates the situation. A significant 35.8% of workers have less than five years of experience, indicating that, many are relatively inexperienced. In contrast, only 6.3% have between 25-30 years of experience, and just 3.2% have over 30 years. This trend suggests that, the case company may be missing out on the benefits of experienced professionals who could guide newer employees. As various writings indicate, less experienced workers are often the first to encounter operational risks and inefficiencies. Similarly, site observations reveal that workers lacking experience and knowledge in the case company's work environments are

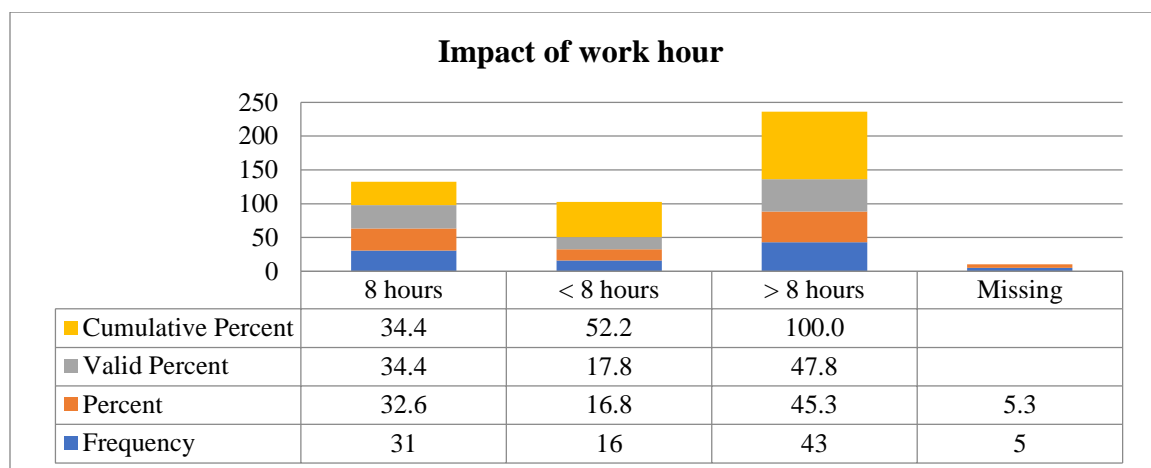
more susceptible to various health risks. For instance, the study shows that workplace health challenges in the company's operational areas arise from issues such as improper material handling (tools, machines, etc.), operational faults, and misuse. These factors have been identified as significant contributors to difficulties observed in the manufacturing processes. Therefore, it is crucial for industry leaders to invest in comprehensive training programs that not only aim to raise current educational levels but also support inexperienced employees.

In conclusion, the survey results highlight an urgent need for the manufacturing industry to address educational and experiential gaps within its workforce. By doing so, the sector can improve overall productivity, safety, and innovation, ultimately leading to a stronger and more competitive industrial landscape.

### 4.2.3 Workplace health condition & characteristics

#### 4.2.3.1 Workplace health condition

Figure 4.2 indicates that 32.6% of the workforce works a standard 8-hour shift, while 16.8% work less than 8 hours. Notably, 45.3% of participants reported working more than 8 hours. This suggests a significant portion of employees is engaged in extended working hours. Therefore, the findings indicate that the percentage of workers working more than 8 hours is higher than the results reported in the research by Afework et al. (2024), Daba et al. (2022) & Belete et al. (2023). This data suggests that, the manufacturing industry is utilizing shift or extra work arrangements, with a large number of employees (45.3%) working more than the standard 8-hour shift & its consequences.



#### Figure 4.2 working hours' response analysis

Based on the information provided in Figure 4.2, the key points are: 32.6% of the workforce is working a standard 8-hour shift. However, a larger proportion of 45.3% are working more than 8 hours. Hence, majority of the workforce was working greater than 8 hours, as compared to the 32.6% working the standard 8-hour shift. The result then states that, the response analysis is very much in line with the study by Girma et al. (2022) & Daba et al. (2022) which found that, working hours significantly impact occupational health. Similarly, a study by the WHO (2021a) Explores how working more than the standard hours per week poses challenges to health-related issues and increases the risk of various diseases and complications. The document review of the health center at the case company, which serves as a logbook, highlights an important detail: it records the shift periods that workers are assigned. This information was not included in the study findings because the researchers believed it would complicate the content. However, the study confirms that, shift workers experience serious injuries, including complications in the legs, hands, back pain, and stress. These issues, already noted in the logbook, provide evidence that working more than 8 hours contributes to these health problems. In the same way, the findings indicate that the results are higher than those of Larsen et al. (2017), this showed fewer work hours compared to standard hours, along with a significantly larger number of hours within the normal work schedule. Accordingly, study overlooks the manufacturing industry should work on reducing health risks associated with working hours through incorporating appropriate mitigation methods.

According to Figure 4.3, the survey focuses at the workplace health and safety aspects in manufacturing industry indicating, 62.1% of the responses "Yes", suggesting, there are health problems and challenges present in the manufacturing workplace. In contrast, 34.7% of the responses "No", suggesting that, there were no significant health related problems reported in working area.

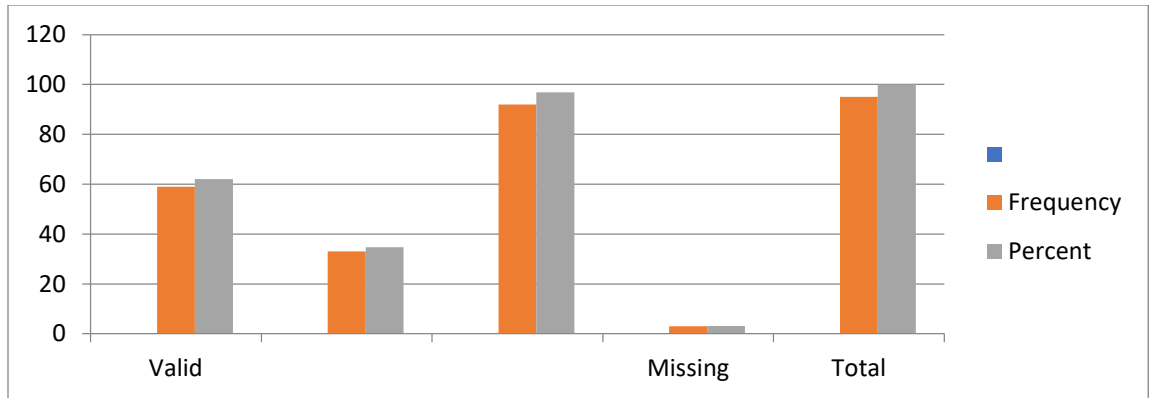


Figure 4.3 Workplace health problems

The information in Figure 4.3 and the survey responses regarding the current condition of the manufacturing work environment appear to be challenging. Notably, a cumulative response of 64.1% indicated 'Yes,' highlighting significant issues or concerns with the current working conditions of the case company. This distribution of responses highlights that, the manufacturing work environment requires substantial attention and improvement. Additionally, the findings overlook the impact of worker well-being and workplace safety on employees, as well as the positive effects these factors can have (Juba, 2024). Hence, the high percentage (64.1%) of "Yes" responses indicates a major health and safety concern within the industry. This was a significant finding that, the organization needs to address these issues.

The analysis of job satisfaction in Figure 4.4, among the survey respondents in the manufacturing industry shows the following: 42.1% (40 respondents) expressed satisfaction with the working conditions. 57.7% (52 respondents) indicated dissatisfaction with the working conditions. The findings of this study indicate a higher level of job dissatisfaction compared to the research outcomes reported by (Daba et al., 2022). In other words, the majority (57.7%) of respondents reported being dissatisfied with the working conditions in the manufacturing industry, while 42.1% expressed satisfaction. Calculated as a percentage of the total responses (100%), the data shows that 56.5% of the total responses indicate no satisfaction with workplace environment.

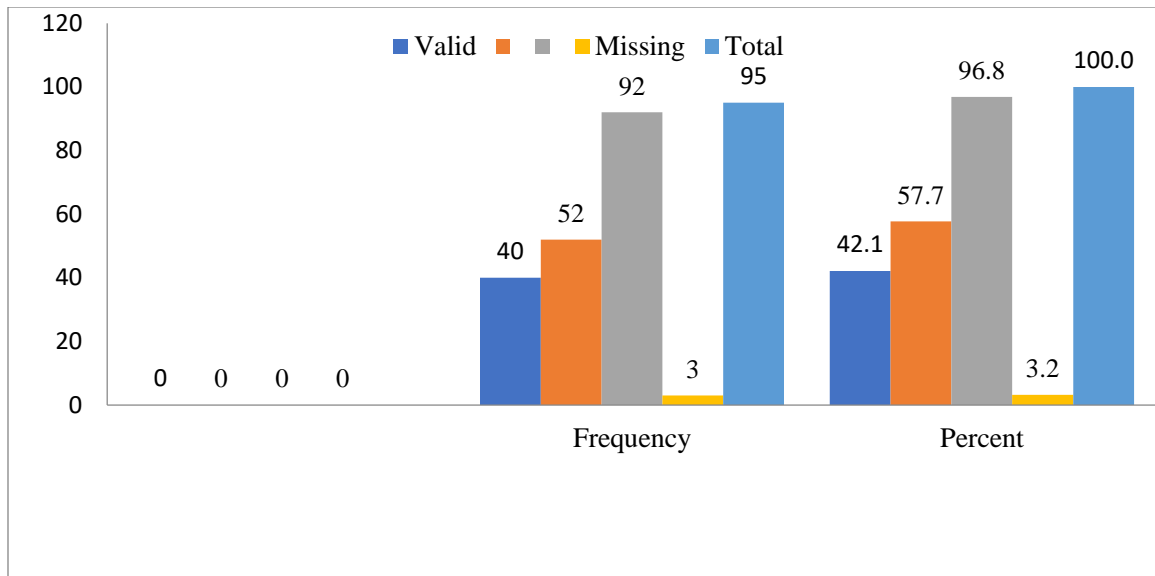


Figure 4.4 Analysis of job satisfaction

Figure 4.4 shows that over 50 respondents, or 56.5% of participants, reported general job dissatisfaction, while 43.5% expressed satisfaction. On the other hand, when comparing the study findings with those related to job satisfaction and workload, it appears that satisfaction levels are lower (Montuori et al., 2022). This may indicate a need to consider other variables or factors in the study. However, this findings highlights significant challenges in the work environment requiring attention.. Addressing these issues may require collaboration with relevant stakeholders. Likewise, survey results regarding workplace health exposure and issues with machines and equipment in the manufacturing industry in Figure 4.5 shows, 66.3% of workers reported being affected by problems related to workplace machines and equipment. In contrast, 28.4% of the responses indicate, there were no challenges faced with the machines and equipment in the workplace. The data reveals that, the majority of workers of 66.3% are experiencing issues and problems related to the machines and equipment present in the manufacturing work environment.

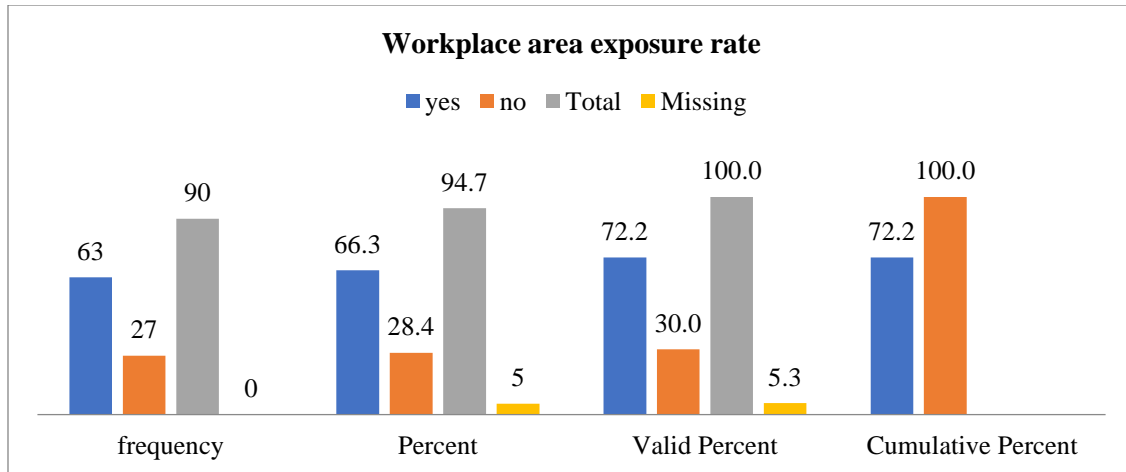


Figure 4.5 Exposure rate of workplace condition

On contrary, results in Figure 4.5, regarding challenges with workplace machines and equipment in the manufacturing industry shows, 72.2% of respondents answered "Yes" when asked about facing challenges with the machines and equipment. In contrast, only 30% of respondents answered "No" depend on facing such challenges. The data shows that, "Yes" response rate of 72.2%, is considerably higher than the "No" response rate of 30%. Therefore, the majority of survey participants perceive there were significant problems with the machines, tools and equipment present in manufacturing work environment. Hence, the result of this study is comparatively higher than the study findings regarding machine , tools & other source of injury by Meleko et al. (2017) requiring interventions in safety & health in working environment.

#### 4.2.3.2 Workplace health characteristics

The results presented in Figure 4.6, provide insights into the use of personal protective equipment (PPE) in manufacturing workplace. According to the data, 27.4% (26 respondents) indicated that, PPE is being used consistently in their work environment. Also, 44.2% (42 respondents) reported that, PPE is not being used frequently. 28.4% (27 respondents) stated that, PPE is not used at all in work environment. These suggested, a mixed picture regarding the use of PPE in the manufacturing industry. While, significant proportions (27.4%) of workers were using the necessary protective equipment and there were also notable percentages (44.2%) that were not consistently utilizing the required PPE. Hence, there is room for improvement in ensuring the proper and consistent use of

personal protective equipment among workers in the manufacturing work environment. Addressing the gaps in PPE utilization could help enhance the overall occupational safety and health conditions. The lower usage of PPE in manufacturing industry, as indicated by the survey results in Figure 4.6, is consistent with the findings from previous studies conducted by Berhan (2020c) , Yosef et al. (2023) & Duguma (2018) Creating focused areas for the use of PPE in today's manufacturing industry.

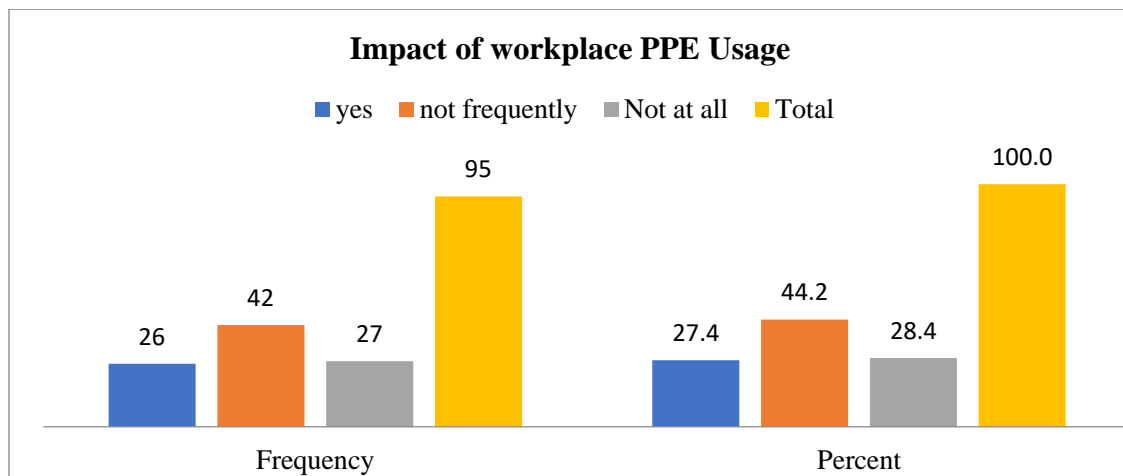


Figure 4.6 Work areas PPE usage rate

The output results in Figure 4.6, with a 28.4% of respondents never use any PPE, and 44.2% use it only infrequently were also concerning. However, the cumulative PPE usage rate, including both frequent and infrequent usage, was significantly higher at 71.6%. Despite this relatively high overall usage rate, the survey reveals that, the proper or consistent usage of PPE was only 27.4% also one of the challenges for organization. This discrepancy between the high cumulative usage rate and the relatively low proper usage rate suggests that, there are issues with the effective implementation and utilization of PPE among workers in manufacturing industry. Also, findings indicate, a need to focus on improving the mitigation measures and ensuring the proper and consistent use of personal protective equipment in manufacturing workplace. This would help enhance the overall occupational safety and health conditions for workers. Hence, the study analysis result on PPE usage is consistent with previous study by Umugwaneza et al. (2019) & Gebremeskel and Yimer (2019), towards the workplace PPE usage rate & practice as well. In contrast, the responses regarding workplace health and safety rules and regulations indicated in Figure 4.7 were relatively low. This implies that, there are

deficiencies or shortcomings in the application and enforcement of health and safety guidelines and policies within the manufacturing industry setups.

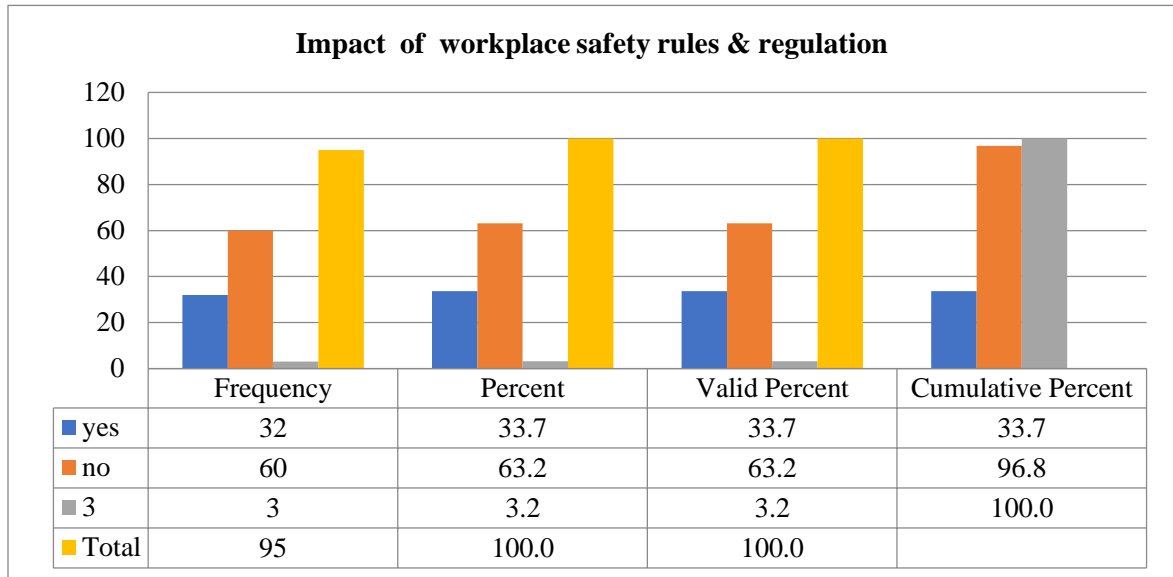


Figure 4.7 Workplace safety rule & regulation

The outputs from Figure 4.7 and Figure 4.6 are closely tied to the issues highlighted regarding, the use of proper personal protective equipment (PPE) in manufacturing industry. The result of safety rules & regulations response rate of 33.7%, compared with 63.2% no safety rules & regulation response rate showing, significantly higher result which consistence with other study by (Gebremeskel & Yimer, 2019) . It indicating, there was a gap between the availability of safety rules, regulations and practice in the manufacturing industry. In other words, there appears to be a lack of clear and comprehensive safety policies, particularly when it comes to mandating the required usage of PPE by workers. In other ways, the output data presented in Figure 4.8 shows, the usage rates of different types of safety equipment in the workplace. It indicates, the usage of safety helmets (42.1%) finding higher than study by Hunegnaw et al. (2021) and Girma et al. (2022). The result of safety gloves (21.1%) is relatively lower in results. However, the usage of safety shoes (9.5%) is higher than Girma et al. (2022) and safety clothing (14.7%) findings were relatively lower. The overall result suggested, while certain safety measures are more widely implemented, there are still areas where the utilization of necessary protective equipment needs to be improved. In particular, the

lower usage rates of safety shoes, masks, and safety clothing indicating, further efforts requiring enhancing the overall occupational safety and health conditions in workplace.

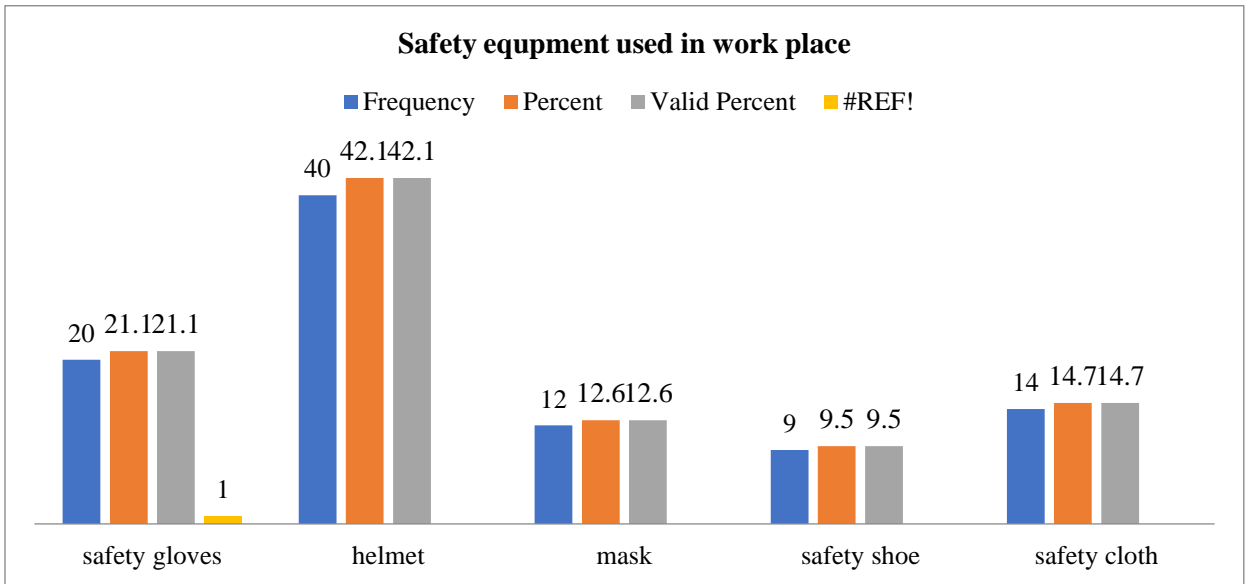


Figure 4.8 Impacts of safety equipment used

The output results shown in Figure 4.8, Figure 4.6 and Figure 4.7 suggest that, manufacturing industry needs to focus on several key areas related to delivery, usage, and safety rules & regulations in accordance with personal protective equipment (PPE) in the workplace. Specifically, the issue of control and enforcement around the usage of safety clothing appears to be a significant factor affecting worker behavior and compliance in the manufacturing environment. On the contrary, referring data presented in Figure 4.9 requiring, further insights into the issue of safety clothing control in manufacturing workplace. Accordingly, 39 respondents (41.1%) reported as there are safety clothing control measures in place, 45 respondents (47.4%) stated, there is a lack of control over the usage of safety clothing. Regarding impact of workplace PPE control, a relatively balanced perception among the participants in the existence of safety clothing control mechanisms. Nearly, as many respondents (47.4%) perceive a lack of control over safety clothing usage, comparing the outputs of control measures of (41.1%).

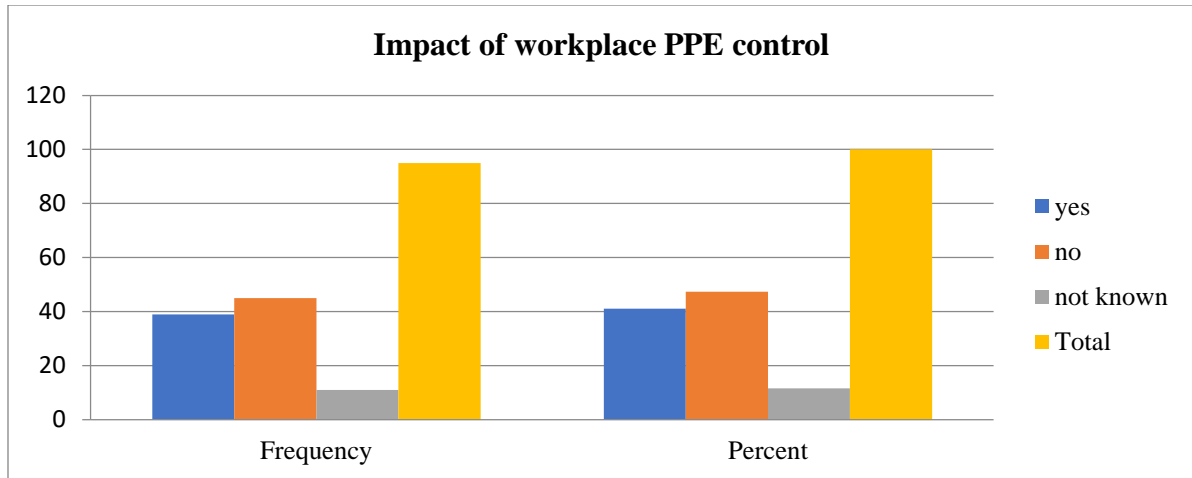


Figure 4.9 Workplace PPE control

Conversely, output result in Figure 4.9 indicating, 11 (11.6%) of them have no idea about areas of controlling safety clothing at workplace. The fact that, 11.6% of respondents have no knowledge or understanding of safety clothing control measures were quite concerning & which can relate with safety rules & regulation lacks in industry workplace. The combined gaps in health and safety controls observed in the workplace are a significant problem for manufacturing industry. These issues directly affect the overall health and safety conditions in workplace. To address this, manufacturing industry should take appropriate controlling measures to rectify the identified gaps and weaknesses in the health and safety practices.

In other ways, the result on part of body affected shown in Figure 4.10, resulted in 18.9%, 31.6%, 18.9%, 22.1% & 8.4% injury cases on the hand, ear, leg, shoulder, and no accident respectively. As can be noted, the two major parts of the body the ear and shoulder have significantly high rates of injury records according to the responses given. Also, the cumulative analysis results of 69.5% & 91.6 % for leg & shoulder part respectively were one of the concerning finding. Similarly, These findings are consistent with the higher injury rates reported in the study by (Tolera & Terefa, 2022c). Or else, the relatively high incidence of hand and leg injuries in the manufacturing setting indicates a need for enhanced safety measures and training to protect workers' extremities. However, the manufacturing industry requires finding out the root causes of these injury incidents and implementing appropriate mitigation methods.

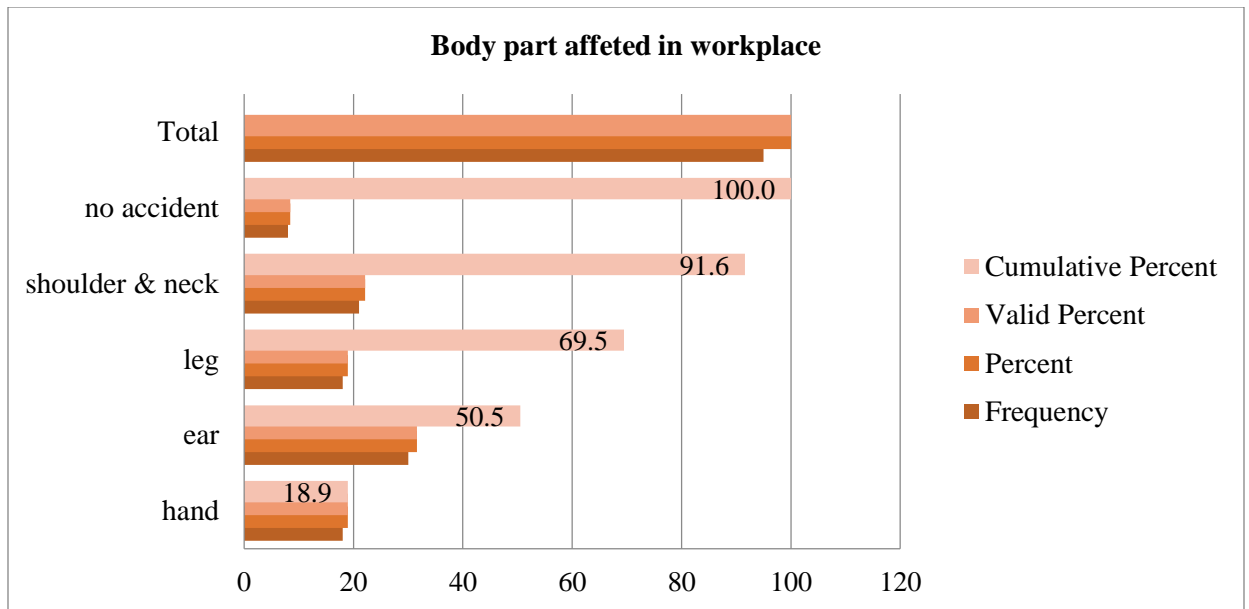


Figure 4.10 Body affected analysis result

Result suggested a concerning relationship between the use of personal protective equipment (PPE) and body part injuries in manufacturing workplace. Accordingly, Figure 4.6, only 27.4% of participant indicated that PPE was being used consistently in their work environment. In other ways, in the analysis of Figure 4.9, 41.1% reported the presence of safety clothing control measures while 47.4% stated a lack of control over safety clothing usage. Similarly, study finding in the lower rate of PPE usage rate very much in line with study by (Alemu et al., 2020). Hence, it concluded that, effect on body injuries were directly related to the provision of PPE & the control of the appropriate personal protective equipment (PPE) and the lack of effective control measures in the workplace of manufacturing industry.

#### 4.2.4 Analysis of workplace health problems

The data in Table 4.2 shows, the degree of occurrence of the health problems in manufacturing industry depend on measure scales of: always, sometimes, rarely & not at all). It is recall that, the most health problems occurred is recorded as 50%, 50.5% & 49.5% for respiratory problem, stress & ear problem respectively.

Consequently, health problems like head ache 47.4% always occurred & 42.1 % sometimes, Back pain 45.3% always & 44.2% sometimes, Leg pain 45.3% always &

48.4% sometimes, Muscle pain 46.3% always & 45.3% sometimes. Also, hand/finger problems 45.3% always occurred & 41.1% sometimes, Infection diseases 45.3% as always occurred & 40% sometimes.

Table 4.2 Workplace health problems analysis

s/n	Health Problems	Degree Of occurrence				Missed
		always	sometimes	Rarely	Not at all	
1	Head ache	45(47.4%)	40(42.1%)	9(9.5%)	1(1.1%)	
2	Back pain	43(45.3%)	42(44.2%)	9(9.5%)	1(1.1%)	
3	Leg pain	43(45.3%)	46(48.4%)	5(5.3%)	1(1.1%)	
4	Shoulder & neck	37(38.4%)	44(46.3%)	12(12.6%)	2(2.1%)	1(1.1%)
5	Muscle pain	44(46.3%)	43(45.3%)	7(7.4%)	1(1.1%)	
6	Eye Problem	39(41.1%)	45(47.4%)	10(10.5%)	1(1.1%)	2(2.1%)
7	Ear Problem	47(49.5%)	39(41.1%)	5(5.3%)	4(4.2%)	
8	Pain in joints	39(41.1%)	44(46.3%)	9(9.5%)	3(3.2%)	1(1.1%)
9	Respiratory problems	48(50.5%)	36(37.9%)	8(8.4%)	3(3.2%)	
10	Hand, finger etc	43(45.3%)	39(41.1%)	12(12.6%)	1(1.1%)	
11	Infection diseases	43(45.3%)	38(40%)	13(13.7%)	1(1.1%)	
12	Stress	48(50.5%)	34(35.8%)	13(13.7%)	0%	

Conversely, data output of Table 4.2, the health problems with the highest recorded were respiratory problems (50.5%), ear problems (49.5%), and stress (50.5%) with always occurrence. Also, the health problems with the highest "sometimes" occurrence are leg pain (48.4%), shoulder and neck issues (46.3%), and eye problems (47.4%). Similarly, the highest "rarely" occurrence is seen in infection diseases (13.7%), stress (13.7%), and shoulder and neck issues (12.6%). For the "not at all" occurrence, the highest percentages is stress accounted (0%), shoulder and neck issues (2.1%), and joint pain (3.2%).

As a result, the most prevalent health incidents among participant were respiratory problems, ear problems, and stress, which are reported as "always" and "sometimes" occurrences. While the "rarely" and "not at all" occurrences are relatively low for most health problems and there is still a significant number of workers affected by these issues

on a regular basis. Similarly, data suggested, manufacturing environment poses significant health risks to workers with respiratory problems, stress, and musculoskeletal issues being the most prevalent. It indicating, needs for industry to prioritize worker health and safety measures in mitigate these problems.

#### 4.2.5 Analysis of cause of injuries in workplace

The analysis results in Figure 4.11 shows, machine fault (57%), falling (57%) & hot metals (55%) are the major causes of workplace injury with high percentage. This finding result, is higher than a recent study findings by Weldearegay et al. (2024), Dapari et al. (2023) & Asiedu et al. (2024) which requiring a big attention in manufacturing workplace health & safety issues. Additionally, issues such as poor ventilation (58%) and improper material handling (53%) also a high rate of injury record in this study findings compared with study findings in manufacturing sector by (Fatemi et al., 2020).

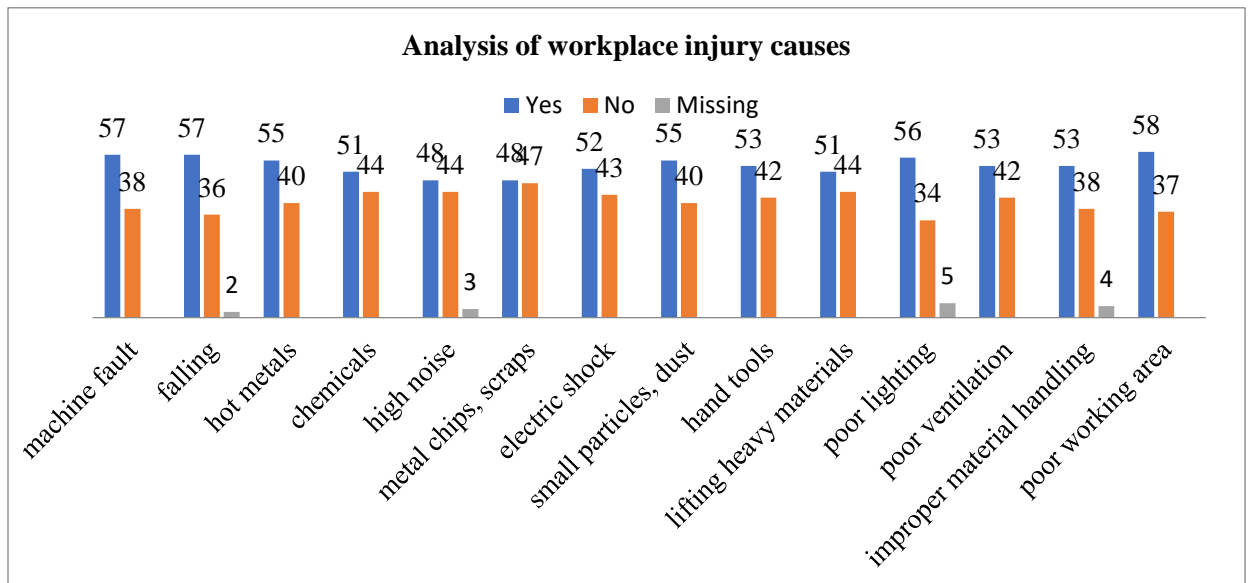


Figure 4.11 Cause of workplace injury rate

Similarly, data in Figure 4.11 shows, the most prevalent hazards like, machine fault and falling which both accounted for 60%. A significant number of respondents indicated, hand tools (55.8%), poor ventilation (55.8%), and electric shock (54.7%) safety concerns in the workplace. Also, reveals, some moderately frequent hazards including, chemicals (53.7% of respondents), high noise (53.7% of respondents), and lifting heavy materials

(53.7% of respondents). Notably, comparing others, the least frequent hazard reported is metal chips/scraps, with only 50.5% identifying it as a concern. Hence, Generally, data analysis suggested, the workplace requires significant improvements with a major focus needed on addressing the top hazards of poor lighting, poor work area, mechanical issues, and slips/falls. These appear to be the most crucial safety concerns that need to be addressed.

#### 4.2.6 Analysis of body part injured

This part of the data analysis addressing injury incidents that mostly occurred in the workplace. So that, Figure 4.12 shows, the frequency of respondents who reported "Yes" or "No" for different parts of the body affected being highest recorded rate. It includes, the chest body part accounted for 59 (62.1%). finger part 41 (43.2%), which also taken as one of the lowest values among the study analysis.

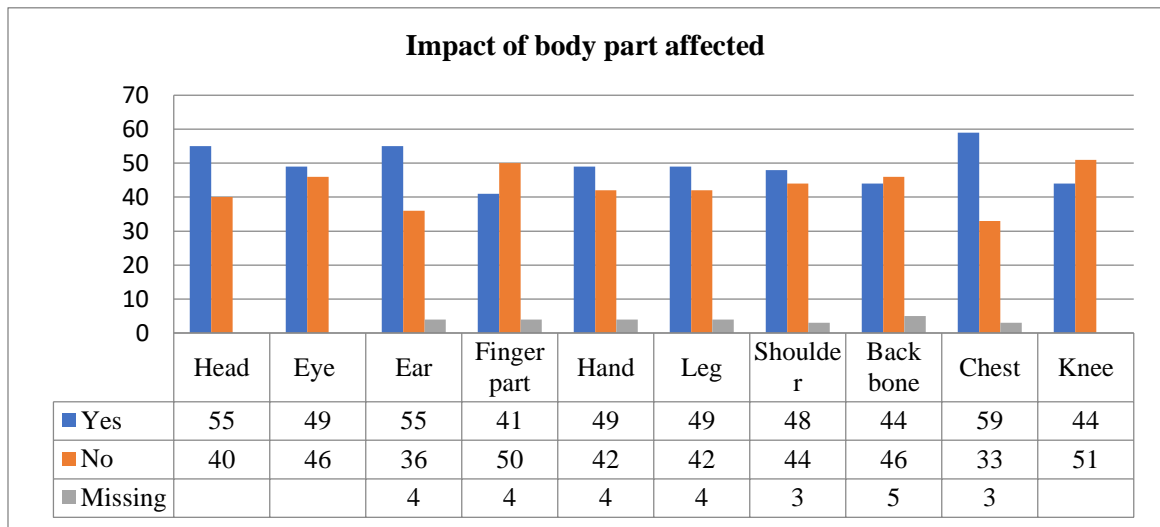


Figure 4.12 Analysis of body injury

Similarly, Figure 4.12 emphasizing; the most commonly affected body parts among the participant include the chest, ears, head, legs, and hands. Specifically: 62.1% of respondents reported issues with the chest, 57.9% experienced problems with the ears and head, 51.6% had concerns related to the legs, hands, and eyes, 50.5% reported shoulder-related issues, 48.4% had backbone problems, 46.3% faced knee-related injuries & 43.2% experienced finger-related health concerns. Hence, the findings of the study specifically on the chest (62.1%), leg, hand & eyes each 51.6% result are higher than the study

finding by (Wondimneh et al., 2022) & (Chercos & Berhanu, 2017). Therefore, it can be said that, a significant prevalence of various health and safety problems currently observed in the working environment which requires big attention.

#### 4.2.7 Impact of work place environment

This part of study uses a scale measurement approach to analyze the workplace environment. It consists of 5 alternative response options that allowed participants to indicate their level of agreement or disagreement with the various workplace-related factors affecting workplace environment. The 5-point scale ranged from 1 (Strongly Disagree) to 5 (Strongly Agree), with intermediate options such as Disagree, Neutral, and Agree. The workplace-related questions in Table 4.3 of the first analysis shows, participants strongly disagree on the working area conditions or poor work area movement with 48 Participants (50.5%) response. However, the response of strongly agree shows a relatively higher contribution for room lighting 15 (15.8%) respondents and workspace area 17 respondents (17.9%).

Table 4.3 Impact of the workplace environment

s/n	Factors	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Missed
<b>Workplace environment</b>							
1	The working area allows me to perform tasks efficiently with minimal unnecessary movement	48(50.5%)	26(27.4%)	5(5.3%)	9(9.5%)	4(4.2%)	3(3.2%)
2	The ventilation in my Work area provides sufficient air circulation.	23(24.2%)	29(30.5%)	20(20.1%)	15(15.8%)	8(8.4%)	
3	The lightening in my work area is adequate for the task I perform	19(20%)	26(27.4%)	26(27.4%)	9(9.5%)	15(15.8%)	
4	My work area is free of dust, chemicals & maintains a clean environment	12(12.6%)	26(27.4%)	29(30.5%)	15(15.8%)	10(10.5%)	3(3.2%)
5	I have enough space in my work area to move around & complete task comfortably.	13(13.7%)	30(31.6%)	24(25.3%)	11(11.6%)	17(17.9%)	

On the other hand, a significant portion of (50.5%) strongly disagrees on working area allows them to perform tasks efficiently is in line with study by (Kiconco et al., 2019). Also, concerns on ventilation and lighting in the working area is crucial with 24.2% and 20% of participants reflecting strongly disagree in workplace ventilation & proper lightning respectively. Also, this is an important concern regarding workplace ventilation and lighting which can directly impact worker motivation, comfort, and ultimately affecting the performance. On a more positive note result indicating, cleanliness and space allocation in the work areas appear to be relatively better, though still room for improvement. However, a concerning 30.5% of respondents are neutral about the cleanliness of the work area, and another 25.3% disagree about enough space to move around comfortably might indicating requirements for improvements.

The overall responses highlighted, manufacturing industry needs to closely evaluate and address the issues related to the physical work environment, including ventilation, lighting, and space allocation. Implementing improvements in these areas could significantly enhance worker satisfaction and performance.

#### **4.2.8 Impact of Health & safety concerns**

The primary focus of this section was on workplace safety and health issues, which can significantly impact worker and overall organizational performance. According to the data in Table 4.4, there are health & safety concerns regarding workplace safety and health incidents.

The result of Table 4.4 indicating, 23.2% strongly disagree, and 30.5% disagree about existence safety protocols & procedures in workplace. It indicates a need for the organization to review and strengthen its safety policies and practices. Similarly, the adequacy of emergency exits appears to be challenging with 15.8% of respondents strongly disagreeing and 36.5% disagreeing about work area inadequate emergency exits. Hence, this is a crucial safety issue that requires attention from manufacturing industry.

Table 4.4 Workplace safety & health impact investigation

s/n	Factor	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Missed
<b>Health &amp; safety Issues</b>							
1	My workplace follows appropriate safety & health protocols	22(23.2%)	29(30.5%)	30(31.6%)	10(10.5%)	4(4.2%)	
2	My work area has adequate emergency exits	15(15.8%)	35(36.5%)	25(26.3%)	12(12.6%)	8(8.4%)	
3	First aid kits & supplies are available in my workplace.	11(11.6%)	38(40%)	36(37.9%)	7(7.4%)	3(3.2%)	
4	I receive Regular occupational safety & health training.	12(12.6%)	31(32.6%)	37(38.9%)	8(8.4%)	5(5.3%)	2(2.1%)
5	The Organization provides me with proper Personnel protective equipment	14(14.7%)	37(38.9%)	31(32.6%)	6(6.3%)	5(5.3%)	2(2.1%)
6	Fire extinguisher & other safety equipment are available in my Work area.	14(14.7%)	26(27.4%)	41(43.2%)	8(8.4%)	6(6.3%)	
7	The organization conducts regular health checks for workers.	11(11.6%)	29(30.5%)	35(36.8%)	9(9.5%)	5(5.3%)	5(5.3)

Conversely, the availability of key safety-related provisions appears to be an area requiring notice and improvement measures. Approximately 40% of participants expressed disagree on availability of first aid kit. Similarly, more than 30% participants disagree regarding the safety training, personal protective equipment, and regular health checks for workers. The availability of fire extinguishers and other safety equipment appears another subject with 43.2% of participants neutrally responding & 27.4% disagreed on the issue. In consequence, even in areas where safety equipment is provided, there are still concerns about its adequacy or accessibility safety equipment. Also, adequacy of emergency exits also challenging with 15.8% of participants reflecting as

strongly disagreeing and 36.5% disagreeing about adequate emergency exits in working area.

Generally, the response analysis indicates that, organization requires to more attentively prioritizing the practice of safety and health protocols & regulations in the manufacturing industry. Addressing the safety-related issues and minimizing injury risks should be a key focus area for the organization.

#### 4.2.9 Investigation of human resource management concerns

The human resource management assessment in the questionnaire was aimed at examining the relationship between health & safety aspects and their impact on worker performance. The questions were designed to address the general factors relevant to the study area. The Investigated results show, a general lack of skill development opportunities & performance feedback mechanisms which accounted 40% each with disagree & neutral responses respectively. Consequently, the health and safety systems within the organization were also rated as disagreeable or neutral by the participant. Furthermore, a significant level of uncertainty exists, as indicated by the 42.1% of neutral responses regarding the availability of structured training and skill development programs.

Table 4.5 Human resource management investigation results

s/n	Factors	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Missed
<b>Human resource management</b>							
1	My work is regularly reviewed & received constructive feedbacks	7(7.4%)	38(40%)	38(40%)	5(5.3%)	7(7.4%)	
2	My Organization leaders encourage me to develop my skills & abilities.	15(15.8%)	35(36.8%)	28(29.5%)	10(10.5%)	7(7.4%)	
3	There are systems in organization to monitor worker safety & health in workplace.	8(8.4%)	37(38.9%)	36(37.9%)	8(8.4%)	6(6.3%)	
4	My organization provides a structured training & skill development program.	7(7.4%)	33(34.7%)	40(42.1%)	7(7.4%)	4(4.2%)	4(4.2%)

5	I am afforded sufficient opportunity for skill development & training.	8(8.4%)	38(40%)	34(35.8%)	6(6.3%)	9(9.5%)	
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As a consequence results in Table 4.5 shows, the encouragement and motivation practices within the organization are very low, with only 7.4% of participants expressing positive attitude. It suggested the need for organization to work on improving employee motivation and engagement. Similarly, it shows, significant lack in the safety and health control measures for workers, with only 8.4% of participants giving positive reflections. This aligns with the findings shown in Figure 4.5 regarding personal protective equipment (PPE) usage, which appears to be improved.

In general result reflecting, the organization requires taking measures to address in areas of skill development opportunities for employees, employee motivation and engagement & strengthening of health and safety controls for workers in working environment.

#### **4.2.10 Investigation of workplace culture & practice issues**

The main focus of this section is to investigate the overall workplace environment and understand the participant’s perspectives on various aspects. Also, majority of participants expressed neutral (43.2%) or disagree in (24.2%) regarding the organization's fostering culture of collaboration, teamwork, and mutual respect. Hence, indicating a significant lack of close collaboration and teamwork within the workplace.

A large number shows, disagreed (35.8%) or neutral (31.6%) about quality organization services facility setups including cafeteria, rest room etc. and suitability of these facilities in working environment.

Table 4.6 Investigation of workplace culture & practice

s/n	Factors	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Missed
<b>Workplace Culture &amp; Practice</b>							
1	My organization foster a culture of collaboration, team work & mutual respect	12(12.6%)	23(24.2%)	41(43.2%)	13(13.7%)	6(6.3%)	
2	My organization provides excellent facilitates like a good cafeteria, clean rest rooms & well equipped recreation areas	11(11.6%)	34(35.8%)	30(31.6%)	14(14.7%)	5(5.3%)	1(1.1%)
3	Organization has well-defined system in place to maintain a positive work environment	10(10.5%)	17(17.9%)	47(49.5%)	15(15.8%)	6(6.3%)	
4	I have a clear understanding of my job duties & responsibilities.	5(5.3%)	37(38.9%)	33(34.7%)	10(10.5%)	8(8.4%)	2(2.1%)

In other ways, Table 4.6 shows, organization faces challenges in creating a positive and supportive work environment. It overlooks the need for the organization to focus on strengthening overall working conditions and practices related to work environment culture. Improving the organization's facility setups, such as the cafeteria, restrooms, and recreation areas, can have a higher impact on workers' daily performance, productivity, and overall satisfaction. Hence, addressing the availability & provision of these facilities is crucial, as it can contribute to enhancing the overall well-being and engagement of the workforce. By addressing these key issues, organization can create a more conducive and engaging work environment & leading to an improved performance and efficiency of workers as well.

### 4.3 Regression model analysis

The study seeks to investigate the effect of independent variables work environment, body injury, health problems, workplace characteristics, workplace condition & injury causes on the dependent variable health & safety (HS) as tabulated in Table 4.7.

Table 4.7 Regression coefficients

Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.268	.134		1.996	.049
	Work environment	.312	.068	.338	4.599	.000
	Injury cause	.078	.101	.082	.773	.441
	Health problem	.079	.177	.087	.448	.655
	Work place condition	.125	.177	.144	.704	.483
	Work place character	.262	.175	.262	1.493	.139
	Body injury	.061	.208	.069	.292	.771

a. Dependent Variable: HS

The results as indicated in Table 4.7 shows, work environment variable has a statistically significant or positive impact on dependent variable, health and safety (HS) with a p-value of 0.000. However, other independent variables are not significantly or uniquely contributing to the model & p-values are greater than the commonly used threshold of  $p < 0.05$ . In other ways, ANOVA Table 4.8 suggested, the regression model explaining the significance level of  $P = 0.000$ .

Table 4.8 ANOVA Summary

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	32.454	6	5.409	61.282	.000 <sup>b</sup>
	Residual	7.767	88	.088		
	Total	40.221	94			

a. Dependent Variable: HS

b. Predictors: (Constant), Body injury, Work environment, Injury cause, Work place character, Health problems, Work place condition

On the contrary, analysis data in table 4.8 was statically significant, with:  $F(6, 88) = 61.282$ . It shows, set of independent variables (work environment, body injury, health problems, workplace characteristics, workplace condition & injury causes) collectively have a significant impact on the dependent variable health & safety (HS) issues. Similarly, the result of F-statistics ( $F=61.282$ ) indicating, overall model is a god fit for the data & the independent variables are able to explain a significant portion of the variation in the dependent variable. Therefore, the result from the ANOVA analysis indicating, the regression model is appropriate & the independent variables are collectively important in predicting the dependent variable.

The model summery in table 4.9 shows that, multiple correlation coefficients (R) is 0.898, indicating, a strong positive correlation between the set of independent variables.

Table 4.9 Model Summery

<b>Model Summary<sup>b</sup></b>				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.898 <sup>a</sup>	.807	.794	.29709
a. Predictors: (Constant), Body injury, Work environment, Injury cause, Work place character, Health problems, Workplace condition				
b. Dependent Variable: HS				

Conversely, regression coefficient  $R^2$  value 0.807 in table 4.9 emphasizing, approximately 80.7% of the variation in health & safety issues can be determined through independent variables in the model. Also, adjusted R-square Value 0.794 gives out the number of independent variables in the model providing an explanatory estimate to the model. Hence, the analysis suggested, set of independent variables accounted for approximately 79.4 % of the variation in health & safety issues, after adjusting the number of predictors in the model.

## 4.4 Prediction of health & safety (HS)

Based on the results from the regression model analysis, predicted values were generated for the dependent variable of health and safety (HS) in relation to the independent variables. As detailed in Table 4.10, the observed data of health and safety (HS) injury rates indicate that, the lowest predicted injury rate was 1.5420. This suggests a minimal estimate per observed sample of the population. This suggests that, under certain conditions defined by the independent variables, the anticipated level of health and safety incidents was relatively low. Conversely, the highest predicted value rate was 3.8055. Additionally, the range indicates that the outcomes reflect different conditions in the workplace. This indicates that, in this condition the independent variables contributed to significantly better outcomes for health and safety (HS) incident rates. Overall, the analysis highlights a range of predicted values, illustrating how different conditions can impact health and safety results.

In other ways, an examination of the residual values presented in Table 4.10 suggests that, the model was reasonably capturing the variation in the dependent variable. Specifically, the minimum and maximum values, as well as the mean and standard deviation of the residuals, indicate that, the model is performing adequately in representing the data of predicted values. The mean residual value of 0.000 suggesting, with a standard deviation of .28746 indicating, on average the model's predicted values are nearly aligned with the actual observed values, with a relatively closer to the mean. Furthermore, standard residuals exhibit a similar distribution with a mean of 0.00 and a standard deviation of 0.968, showing that, the majority of predicted values fall within acceptable range of actual observations.

Table 4.10 Summary of Residual Statistics Values

<b>Residuals Statistics<sup>a</sup></b>					
	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	1.5420	3.8055	2.5903	.58759	95
Residual	-.86251	1.69567	.00000	.28746	95
Std. Predicted Value	-1.784	2.068	.000	1.000	95
Std. Residual	-2.903	5.708	.000	.968	95

a. Dependent Variable: HS

At last, information provided in Table 4.10 suggested, model assumptions are likely to have been met. Specifically, the standard deviation of standardized residuals was reported as 0.968 & the residual value of 0.000.

#### **4.4.1 Interpretation of predicted values**

The results from the regression model provide valuable insights into health and safety considerations within metal manufacturing industry. These findings are closely tied to performance and can inform decision-making regarding safety interventions and policies. Understanding the limits of the predicted values enables organizations to recognize situations where safety outcomes may fall below acceptable thresholds. For instance, depend on regression results of Table 4.10; one of the predicted minimum injury rate values was 1.5420, while a more favorable performance level was represented by the value of 3.8055. The mean predicted value of 2.59 indicates a moderate level of health and safety (HS) conditions. Values below 2.59 require attention and urgent action, while values above 2.59 suggest effective health and safety practices are in place. On the Likert scale, which ranges from 1 to 5, a value of 1.5420 indicates a negative perception, suggesting a potential for higher injury rates. This reflects significant concerns about health and safety practices in the workplace. Conversely, the predicted value of 3.8055 indicates a more positive viewpoint, suggesting a lower injury rate. This implies that, workers feel relatively confident about the health and safety conditions in the metal manufacturing industry.

In summary, the range of predicted injury rate values from 1.5420 to 3.8055 illustrates the potential outcomes for the dependent variable, offering critical insights into expected health and safety levels within manufacturing industry. Similarly, regression model appears to provide reliable prediction as indicated by the low standard deviation of residuals. This reliability helps decision makers in developing safety protocols & interventions. Also, manufacturing industry can identify specific area or condition leads to higher or lower safety issues outcomes. Additionally, these results help in

understanding the current situation and identifying areas that require improvement by focusing on the practical implication derived from the residual statistics which improves workplace safety concerns.

#### 4.4.2 Relationship between dependent variable & predicted values

Based on the analysis of the regression model in Figure 4.13, scatter plot shows a linear relationship between the predicted values and the dependent variable, which is identified as HS (health and safety). The data points on the scatter plot appear to follow a linear pattern, with the majority of the data falling in close proximity to the regression line.

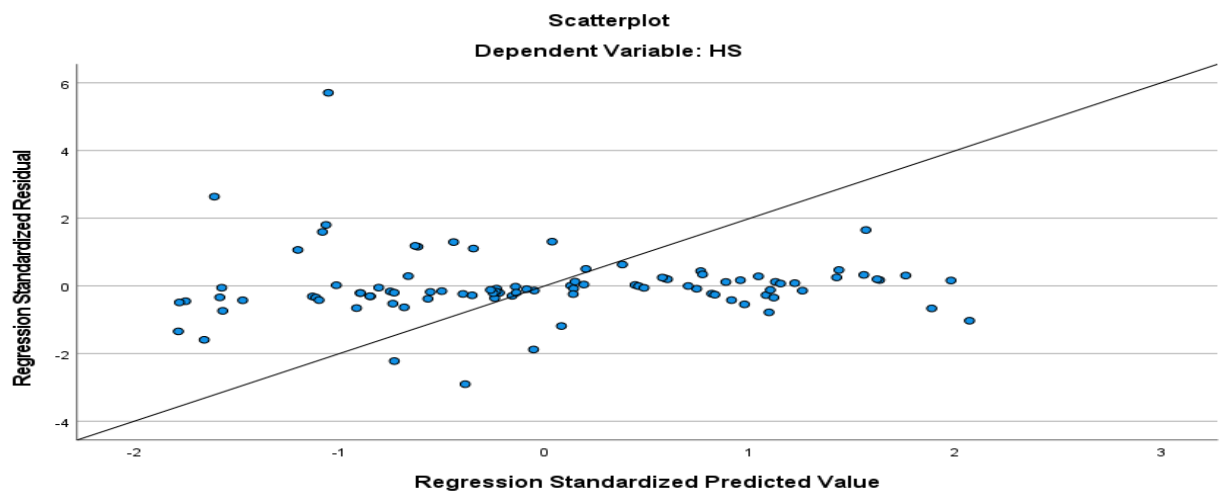


Figure 4.13 Relationship between dependent variables & predicted values

(Source: SPSS output)

Furthermore, the data points illustrated in Figure 4.13 are distributed along the regression line, showing a notable degree of variability in health and safety (HS) values corresponding to the predicted values. This variability suggests that, while there are identifiable trends, other influencing factors also play a significant role in shaping the health and safety outcomes.

The scatter plot serves as a critical tool for interpreting these results, allowing stakeholders to visualize the relationship between the predicted values and health and safety metrics. By simplifying complex data, the scatter plot enhances the ability to refine the regression model, informing decision-making processes. It also facilitates effective

communication among team members and stakeholders, ensuring that everyone is aligned on the perception drawn from the data. Moreover, the scatter plot can aid in monitoring and improving organizational culture by highlighting specific issues that require attention. For instance, it can tell areas where health and safety practices may be minimal, prompting targeted interventions to address these challenges.

In summary, the practical implications of the scatter plot are significant. By enhancing organizational performance, it supports informed decision-making, optimizes resource allocation, and identifies training needs. Ultimately, exploiting these insights can lead to a safer and more efficient working environment, benefiting both employees and the organization as a whole.

### 4.4.3 Dependent variable & P-P plot

The Normal P-P Plot in Figure 4.14 indicates that, regression model follows a reasonably normal distribution. Hence, finding implies, regression model's assumptions were satisfactorily met, allowing for reliable statistical inferences and interpretations. The closeness of the data points to the reference line particularly in the central portion of the plot provides confidence in the appropriateness and validity of the regression analysis and its ability to accurately capture the relationships in the data. Essentially, the findings suggest that, the regression model was appropriately specified, allowing organizations to focus on the results of the analysis to enhance safety and health outcomes.

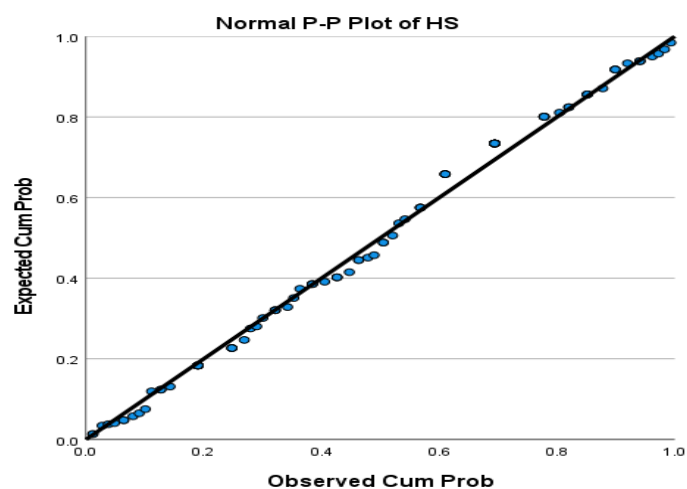


Figure 4.14 P-P plot of observed & expected cumulative probability

Furthermore, plot in Figure 4.14 shows dependent variable in the regression model specifying and is aligned to the assumption of normal distribution & interpretation of the real results. Overall, the practical implications of the findings suggest that, the organization can utilize the results from the regression analysis to establish a safer work environment, which will ultimately benefit both its employees and the organization as a whole.

## **4.5 Chapter Summery**

This chapter presents the primary data analysis, which was based on standard questionnaires developed in closed, partially open and Likert scale forms. These questionnaires were administered and analyzed using SPSS software. Additionally, structured interviews and site visit checklists were utilized to further elaborate and analyze the results. The major focus areas in this analysis include the demographic characteristics of the workforce, workplace conditions, health-related problems, body injuries, the work environment, health and safety issues, and the workplace culture and practices. These aspects were extensively analyzed using SPSS, with the results presented through various charts, graphs, and interpretations to provide a comprehensive understanding of the key findings.

In the first place, the analysis of the workplace health conditions primarily focused on working hours, revealing that 49.5% of participant work regular 8-hour shifts, while 43.2% work less than 8 hours. Regarding health problems, 49.5% responses indicated the presence of health issues in the workplace, while 47.4% reported no challenges. Conversely, the analysis of job satisfaction showed that, 55.8% of responses expressed satisfaction, while 41.1% indicated no job satisfaction. In examining health exposure in the work area, the responses were 66.3% indicating workplace health exposure, while 28.4% representing no occupational incidents.

In analyzing the current situation of the manufacturing industry, it is important to note that some of the collected data may lack consistency and could have been intentionally misreported. However, this study aims to examine the factors that may be affecting these potentially misleading results. We acknowledge the need for a careful investigation of the data collection process to identify any biases or inconsistencies that may have influenced

the findings. This approach will help present more reliable and refined results, enhancing our understanding of conditions in the manufacturing workplace.

Regarding the use of personal protective equipment (PPE) in the workplace, the data indicating, only 27.4% of responses indicate regular use, while 44.2% of respondents report not using PPE frequently, and 28.4% state they do not use it at all. Similarly, the rules & regulation of health & safety was directly related with significant figure of 63.2% indicating with no safety rules in metal manufacturing industry is one of the issues point out from the analysis. The safety equipment uses & control practice in metal manufacturing industry obtained was nearly similarly to the workplace equipment usage. This low rate of safety control & usage affecting workers overall health & affecting the performance of the organization as well

On the other hand, the analysis of the workplace environment, health and safety incidents, human resource management, and workplace culture based on the survey responses reveals significant areas of concern. The survey results show, a strong disagreement from the respondents regarding the appropriateness of the working conditions, with a response rate of 50.5%, which is very high. The analysis of workplace safety issues indicates high rates, ranging from 40-50%, with concerns over safety training, personal protective equipment (PPE), and availability of first aid kits in the workplace. Additionally, the aspects of human resource management and the overall safety culture and practices within manufacturing industry also require significant notice.

One of the result from regression analysis indicating, independent variables of the work environment had a statistically significant or positive impact on the dependent variable health and safety (HS) with p-value ( $p < 0.05$ ). Besides, the overall regression model was found to be significant with ( $F(6, 88) = 61.282, p = 0.000$ ), indicating the set of independent variables collectively have an important influence in predicting the health and safety dependent variable. The R-squared value of 0.807 suggests the model explains about 80.7% of the variation in health and safety, representing a moderate degree of model fit. Since, the model explains 80.7% of the variation; stakeholders can focus on the identification of independent variables, that influencing health & safety. In essence, organization can allocate resource efficiently & also serve as the benchmarks for ongoing

monitoring of health & safety practice. Hence, the finding result highlight, the organization can effectively utilizes these independent variables to enhance safety measures and health outcomes in the workplace. It can be achieved through applying practical implication of targeted intervention, training & development & monitoring leading to improve outcome and safer working environment.

The scatterplot of predicted values versus dependent variable health and safety showed a linear relationship, further supporting appropriateness of the regression model. While the work environment appears to be a key driver, the analysis indicates other unaccounted for factors may also be influencing health and safety outcomes.

In summary, the analysis results and findings discussed in this chapter address the major focus areas that were set out to meet the study's objectives. The key findings aim to relate to the situational conditions within metal manufacturing industry and the concerns faced by the production units in their respective industry setups. Therefore, based on the presented findings and results, study has identified the major problems that relate to the ground truth in the working environment. These findings may ultimately require the development of mitigation methods to overcome the challenges present in work environment.

## **4.6 Data analysis of Interview, Site visits & Company history records**

### **4.6.1 Interview data analysis**

The part of interview data analysis employed a total of 13 questionnaires, consisting general questions addressing the impact of metal manufacturing industry workplace safety concerns and working environment. The interview conducted focus on production units & support departments of the manufacturing industry. Out of the 13 forwarded interviews, study uses 11 (85%) of the collected data and within the questionnaire administered, management group responded to 10 out of the 13 questions, resulting in a 75% response rate. Also, health center responded to 12 out of the 13 questions, achieving a 92.3% response rate. The production unit & industrial safety office provided a 100% response to all the questions forwarded during the data analysis period. Hence, it

highlights, the importance of addressing workplace safety in the manufacturing industry and its direct impact on workers performance and the overall work environment. The varying response rates across the different sections suggest that, there exists opportunities for the organization to improve communication and engagement with the management group, while the industry health center and the industrial safety office appear to be more responsive to the questionnaire.

Conversely, the analysis revealed several gaps in organization's approach to addressing the impact of working environment and performance. While the management groups, including human resources and production planning, have not clearly addressed this issue, there is a separate point between the industrial safety and health center and the workers. The safety rules, regulations, and awareness efforts have not effectively reached the workers, resulting in significant gaps in safety practices, particularly regarding the provision of proper personal protective equipment (PPE). The survey results further highlight this issue, revealing that 63.2% of respondents indicated the absence of safety rules and regulations within the company. This lack of effective safety measures underscores the need for improved communication and implementation of safety protocols. Furthermore, the responses reveal a significant gap between workers and top management regarding safety and health matters, despite the existence of safety offices. Similarly, the findings show that only 8.4% of workers have a positive outlook on safety control measures, highlighting a concerning issue in the overall assessment of safety and health practices. Additionally, there are inconsistencies in safety and health awareness and training, with immediate leaders and top management requiring more attention in this area. To address these gaps, the organization needs to improve communication, strengthen safety policies and procedures, ensure timely provision of safety equipment, and provide comprehensive safety and health training across all levels of the manufacturing workforce.

Conversely, a significant gap in timely based provision of personal protective equipment (PPE) observed in working environment. A large number of responses indicated a lack of access to safety clothing, which poses significant challenges for workers, especially those in heavy-duty work areas. Similarly, the survey results regarding the provision of appropriate personal protective equipment (PPE) revealed concerning issues.

Specifically, 28.4% of workers reported never using any PPE, while 44.2% used it only infrequently. These findings highlight significant problems in the working environment of the case company. Similarly, some respondents acknowledged that, the culture of using improper clothing and unsafe practices in the workplace also contributes to the problem & very large consent points to the organization's failure to ensure the reliable and timely supply of necessary PPE. In addition, some participants expressed concerns about the lack of support from top management for overall safety and health controls in the manufacturing industry. This issue is reflected in the survey results, which show that only 5.3% of respondents indicated the existence of safety controls. This lack of regular safety and health checks presents a significant concern. Also, study emphasizes, the existence of major gaps between the top management and the industry's safety concerns, as reflected by the responses of five participants. Hence, organization must prioritize the consistent and timely provision of PPE, while also creating a stronger safety culture and securing greater commitment from the top management to enhance the overall safety and well-being of the manufacturing workforce.

There are huge gaps in the safety and health training provided to manufacturing industry workforce. Even though, some training was conducted on a regular basis usually on an annual interval, training programs are not well-supported or followed up with the necessary materials and resources. The survey results regarding skill development and training in the organization indicate that 38 respondents (40%) expressed disagreement with the training provisions, while only 9 respondents (9.5%) agreed that the training provided in the workplace was adequate. Moreover, participants have highlighted a lack of close support from the top management for these training initiatives. This lack of commitment from top leadership was also reflected in the lower rate of responses regarding the industry safety office's ability to fulfill the necessary materials and inputs required for effective safety and health programs. Similarly, training initiatives are largely ineffective in addressing their intended objectives. The majority of respondents highlighted a significant lack of proper safety and health training practices within the industry. Additionally, the study's analysis of training skills and development programs revealed that only 4 respondents (4.2%) reported the existence of a training development program. In contrast, 33 respondents (34.7%) expressed disagreement regarding the

presence of training and skill development opportunities in their organization's working environment. The finding regarding health control and treatment presents a mixed figure. Few numbers of the respondents indicate, the health center provides good treatment and care for the workers. However, most number has highlighted a lack of certain treatment materials and resources at the health center. Specifically, some of the responses suggest that, lack of proper personnel involvement in the health center has contributed to the unavailability of some necessary treatment materials. This has led to gaps in the comprehensive care provided to the workers.

The review regarding the health center treatment facility and material availability suggested, there are problems in providing an adequate supply of necessary items. However, the health center appears to be making efforts to provide the best possible service despite these challenges. In the views of few cases, the health center's treatment procedures and methods are generally good, with the exception of concerns around the appropriate providing of sick leaves and rest time for the workers. On contrary, a few other issues were raised by the participants. Besides the availability of important materials, the capacity of the treatment center and the personnel's ability to address the needs also have an impact on the overall challenges in enhancing health and safety in the industry.

The review result indicates that, while the health center is trying to deliver the best possible care, it faces constraints in terms of material availability and treatment capacity that seem to be impacting its ability to fully address the health and safety needs of the workers. Addressing these resource and capability gaps could be important for improving the overall health and safety situation in the manufacturing industry.

Conversely, health center attempt to provide good treatment, while the responses highlight gaps in the availability of essential materials and resources, as well as concerns about the treatment center's capacity and personnel to effectively address the health needs of the manufacturing workforce.

On the other hand, two key issues regarding health and safety concerns in the manufacturing industry were exploited. Firstly, there are significant gaps in the workers'

personal behavior and practices around use of personal protective equipment (PPE). Almost all responses indicate that workplace culture needs to be changed to ensure that workers use the right personal protective equipment (PPE), do not sell the equipment, and wear appropriate clothing. Conversely, the survey results regarding PPE control in the organization's working environment show that 47.4% of respondents reported a lack of control, while 11.6% indicated they have no knowledge or understanding of safety clothing control measures. This lack of awareness is also one of the significant challenges identified in the results. Secondly, the responses highlight a lack of close support and commitment from top management and immediate supervisors in fostering a strong safety and health culture. Similarly, the survey results indicate that only 6.3% of respondents feel that effective systems for monitoring and controlling worker safety and health are in place. In contrast, 38.9% expressed disagreement with this assessment, while 37.9% remained neutral, reflecting a significant challenge in addressing these issues. This lack of leadership-level engagement has hindered effective implementation and practice of safety measures, contributing to challenging injury incidents. To address these challenges, the organization needs to implement targeted interventions that address both worker-level behavior changes as well as strengthen the leadership's accountability and support for comprehensive health and safety initiatives across the manufacturing industry setups.

The interview participant regarding improving worker performance reflects its requirement with close collaboration between the workers and top management as well. Besides, it indicates requirements of adequate motivation, training, and capacity building initiatives being a major concern. However, responses suggest that, many workers do not receive equal services, motivation, or support from the organization, leading to improper treatment in the work environment. Over 90% of the reflections indicating, the top management needs to create more opportunities for workers to be motivated & productive in manufacturing industry. Additionally, the responses highlight the need for better management and leadership support. At this stage, addressing issues of idle management and improperly assigned leaders is crucial for improving overall competitiveness and enhancing the workforce's performance.

In conclusion, the analysis of interview data revealed, several findings regarding workplace health & safety in metal manufacturing industry. It highlights significant gaps in communication & engagement between management particularly in providing personnel protective equipment (PPE). The resource constraints, lack of trainings & support from management groups were noted in contributing to inadequate safety practice of workers. Hence, fostering stronger safety culture & securing greater commitment from leadership are essential to address these gaps & enhance the overall workers safety & health. Implementing targeted interventions that promote accountability, equitable treatment, and collaboration between workers and management will be crucial for improving health and safety outcomes in metal manufacturing industry.

#### **4.6.2 Site visits analysis**

The site visits of study use checklist aiming to gather information regarding workplace health & safety issues in case company. As attached in Appendix 3, the checklists covered 22 key focus areas on health & safety, providing a thorough assessment of the critical aspects related to health and safety in manufacturing industry. The checklist content focus on evaluating the safety and health training provided to workers, the usage and practices related to personal protective equipment (PPE), adherence to safety rules and regulations, the availability and condition of safety exits and emergency provisions, the documentation of injury records, as well as the standards and practices of health treatment facilities.

This data-driven approach enabled the study to gather detailed information from metal manufacturing sites, facilitating a comprehensive analysis of the health and safety challenges and improvement opportunities within the industry. First, the study addresses specific areas of concern and employees' perceptions before collecting site data. This involved conducting interviews immediately after site observations to discuss key points identified during the observation periods. Second, focus groups were organized following the site observations to gather feedback and validate the results, providing additional insights. Third, the study included assessments of the working environment through discussions with workers in their respective areas, aimed at understanding baseline

conditions. By verifying the ground truth and comparing it with pre-site visit data, the study effectively highlights the working environments, making the analysis more straightforward.

The general findings highlighted several areas for improvement, including the need for more consistent provision of PPE, better maintenance of emergency exits, mitigation of hazardous environmental conditions in certain production units and strengthening of safety training and awareness programs. The hazardous area encompasses the manufacturing industry production units of: chrome plating with improper handling of chemicals, poor working area, poor ventilation, and fabrication & heat treatment rooms. Besides, these factors collectively contribute to unsafe working condition, highlighting the need for improved safety measures. The detailed data collected through these structured checklists enabled a comprehensive assessment of the health and safety challenges facing metal manufacturing industry.

In the first part of the observation, the study aims to assess safety procedures, regulations, and policies in the manufacturing working place. Additionally, site visit overlooks analysis of safety training for workers being conducted & frequency and effectiveness of trainings. However, the most concerning issues appear to be related to the provision and use of personal protective equipment (PPE). Also, PPE is not regularly provided to workers and many workers complain about the lack of proper PPE. This lack of consistent PPE usage puts workers at high risk of injuries and exposure to workplace hazards.

In the second part, the existence of emergency exits and safety equipment was observed. It was found, some of the emergency exits in production areas were found closed or not easily accessible. This poses a serious safety risk in the event of an emergency situation. The working environment conditions also require attention, with issues like high noise levels, high temperatures, and chemical exposures identified in specific production units such as the fabrication, chrome plating, bolt & nut production, and heat treatment areas. These environmental factors can contribute to worker health issues and accidents if not properly addressed. Besides, the accident and injury records indicate that, there is room

for improvement in overall industry setups. Also, observation noted high accident rates and injury recorded in certain manufacturing areas, suggesting the need for more robust safety measures and closer monitoring of incident trends.

In summary, organization should focus on strengthening its safety culture through enhanced worker training; improving the provision and use of PPE, proper maintenance and accessibility of emergency facilities/designs, and implementing targeted interventions to mitigate the hazardous environmental conditions in specific production units. A holistic approach that addresses both worker behavior and management-level accountability will be crucial in driving sustainable improvements in health and safety within the manufacturing industry setup.

### **4.6.3 Company history record analysis**

The analysis of the company's historical records relies on the available industrial safety records and reports, as well as health center documentation. It incorporates health and safety challenges within the recorded period from 2020 to 2022, as previously mentioned in the background of the study, which indicates that injury incident records show a decreasing trend over the years. However, the current situation still reveals ongoing challenges in manufacturing workplace. This suggests that, records maintained by the industry safety office and health center may not be entirely consistent or comprehensive. Upon further analysis of the health center records, some data gaps were observed between the years 2020 and 2022. Conversely, records of sick leave show that, significant issues with worker sick leave and absenteeism. The challenges identified in the findings relate to several key issues: shift work hours, frequent machine breakdowns, inadequate use of personal protective equipment (PPE), worker reluctance, and insufficient health and safety controls. These factors contribute significantly to the problems faced. During the specified period, there were a total of 405 instances of sick leave (168 male and 237 female) and 434 records of absenteeism (112 male and 322 female). This high level of sick leave and absenteeism is a significant concern.

Conversely, historical health and safety records appear to be inconsistent, likely due to lack of permanent personnel in the industry safety and health offices. However, there is a

positive sign that, the health office is making an effort to reorganize and reorganizing the historical data, which can be considered a good starting point. Analyzing the major illness records based on the standardized formats currently used in the workplaces, the data reveals that 28% are related to machine faults, 20% to falling incidents, 16% to improper material handling, and 32% to unsafe working practices, indicating that a significant portion of the health and safety challenges.

The overall findings highlight, the need for organization to strengthen its health and safety data management practices. Improving the consistency, completeness, and accuracy of the relevant records and reports will be important point in order to gain a clear understanding of the right health and safety challenges faced by the manufacturing operations. This in turn, will enable the development of more targeted and effective interventions to address the identified issues and drive sustained improvements in the overall health and safety performance of organization.

#### **4.7 Identified Problems**

Based on the investigation made and the findings in metal manufacturing, the following key problems have been identified that can provide opportunities for developing strategies to reduce workplace Safety and Health issues. The metal manufacturing faces significant challenges related to worker well-being and workplace health & safety. Based on the survey responses, 45.3% of workers reported working more than 8 hours per day, which can contribute to fatigue and increased health risks. Furthermore, 62.1% of respondents reflected the existence of substantial health and safety issues within the industry. Moreover, the respondents reported a high workplace exposure rate of 66.3%, which also has a significant impact on the well-being of workers in the metal manufacturing industry.

The analysis of job satisfaction revealed that 56.5% of workers were dissatisfied with their jobs. This dissatisfaction may resulted from poor workplace safety and health regulations, inadequate control of personal protective equipment (PPE), infrequent safety and health checks, and a lack of support from leadership and management. These factors significantly contribute to the occurrence of challenges in the workplace. Indicating a

need to identify the root causes and develop effective mitigation methods. The usage and availability of personal protective equipment (PPE) were found to be inadequate. Only 27.4% of respondents indicated the provision of PPE at the workplace, while 44.2% reported inconsistent use of safety materials and 28.4% cited a lack of safety equipment. Related with workplace safety rules and regulations, 63.2% of participants reported that, there were no such rules and regulations in place, which is a major contributing factor to the workplace challenges. Additionally, the use of essential safety equipment was alarmingly lower, with only 9.5% of participants indicating the availability of safety shoes and 14.7% for safety clothing, which directly impact worker health and safety. These findings underscore the urgent need for metal manufacturing to prioritize worker well-being, enhance safety measures, and implement comprehensive safety policies and procedures to create a safer and more productive work environment.

A lack of control over workplace safety clothing in metal manufacturing industry leads to a high rate of workplace injuries. Similarly, 64.1 % of the responses indicating, there exists workplace health issues which directly related with workplace environment challenges & human resources system problem response of 50.5% & 38.9% respectively. Specifically, 69.5% of respondents reported leg injuries, and an alarming 91.6% reported shoulder injuries, highlighting this as a major focus and contributing factor to the broader safety issues in the working environment. Additionally, a lack of protection for workers' heads and ears further affecting the occupational health and safety challenges faced by manufacturing industry.

The industry analysis from site observational records reveals several significant issues related to occupational safety and health (OSH) in metal manufacturing industry. The key problems identified include a lack of safety controls, inadequate workplace emergency readiness, insufficient safety rules and regulations, limited worker awareness and training, inconsistent use of personal protective equipment (PPE), poor safety procedure, exposure to injury incidents, poor working environments, and a general lack of management commitment to workplace safety.

Taking into account, the major safety & health incidents in manufacturing industry face major safety and health challenges, including machine faults, falling, improper material

handling, and injuries to the hand, leg, and back. The most commonly reported body parts injured were the ear, eyes, legs, shoulders, and workers experiencing stress. The primary causes of these incidents includes, improper handling of tools and materials, high noise levels, long working hours, improper use of safety equipment, and confined rooms with poor ventilation.

The finding results from the liker scale questioner consisting of analyzing the workplace environment, health & safety issues, culture & practice of the health & safety in manufacturing industry. Most of the result analyzed indicating in the range of strongly disagree, disagree & neutral. Few reflecting on agrees & strongly agree on some issues. However, coming into the situational analysis of the case company, it can be said that, the manufacturing industry requires a big attention regarding workplace condition, safety of workers & improving the safety culture & practice as well. For instance, 30.5 % respondent were neutral about the working place environment cleanness, 25.3% of the respondent also disagree about working place free space & allows for appropriate movements. Similarly, human resource management aspects & the workplace culture analysis responses have also required big attention which the respondent reflects more than 40% neutral & disagree responses. In contrast, the result from the regression analysis suggests, work environment was a key factor influencing the outcomes based on the data collected through the questionnaire. This insight could be a crucial point for addressing the challenges in the metal manufacturing industry. By focusing on improving the work environment, organizations may be able to enhance the overall safety and health culture as well as practices in the workplace.

In summary, in order to mitigate manufacturing industry health & safety challenges, the study tries to overlooks major causes for the incidents in the fish bone diagram as illustrated in figure 4.15.

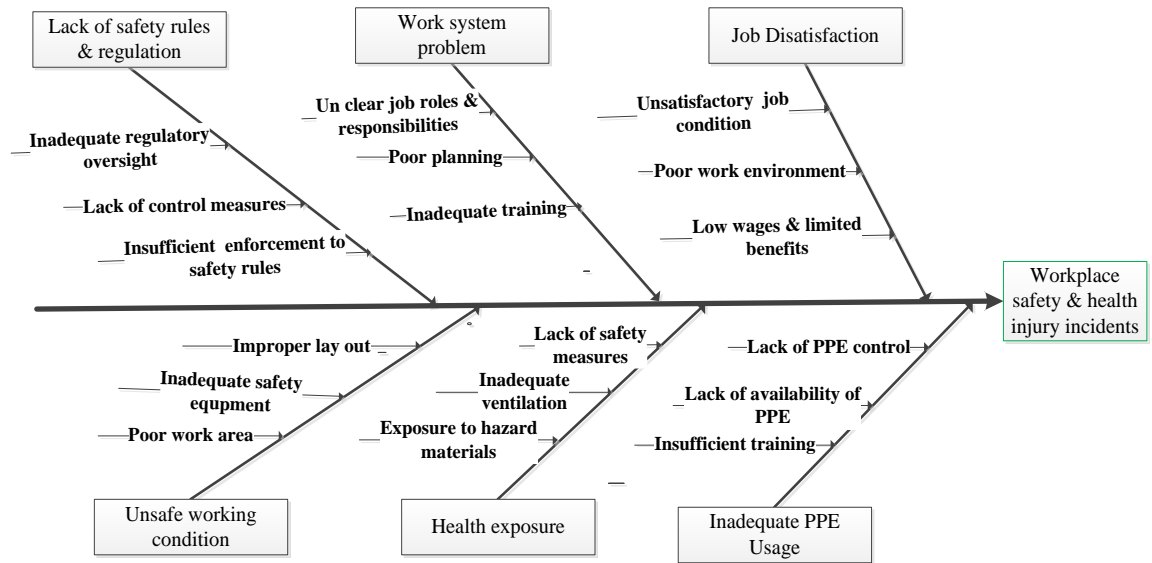


Figure 4.15 Fish-bone diagram illustrating workplace safety & health incidents

(Source: own survey)

Based on the fishbone diagram in Figure 4.15, study emphasizes in identifying the causes and factors by reviewing study findings. The study findings exploring the major challenge areas & related to workplace working condition. The main objective of surveying safety and health incidents in this study was to explore the factors that can be categorized as main and sub main, as illustrated in Figure 4.15. The Fishbone Diagram serves as a valuable tool for identifying and distinguishing the root causes of issues within a system. By analyzing the major causes outlined in the diagram, organizations can pinpoint specific factors that may impact health and safety. This identification process allows for a clearer understanding of potential risks. Addressing the factors identified in the Fishbone Diagram enables organizations to tackle challenges effectively. By focusing on continuous improvement, this approach encourages the development of strategies to mitigate the underlying problems faced in the manufacturing industry. Overall, utilizing this diagram enhances the organization's ability to implement proactive measures for ensuring a safer work environment. On contrary, the development of an action plan in metal manufacturing is crucial for addressing significant issues, identifying their root causes, and involving regulatory bodies that may necessitate government intervention. Additionally, it is essential to focus on factors that directly impact

workplace conditions, such as the use of personal protective equipment (PPE), adherence to safety rules and regulations, and the presence of unsafe working environments, all of which contribute to job dissatisfaction. In other words, integrating these elements into a comprehensive strategy, which includes several key steps regardless of the occupational health & safety management system (OHSMS), enables organizations to effectively enhance safety and improve overall working conditions. Hence, study looking manufacturing industry to effectively address the root causes of the OSH issues & mitigate the source of the problems in creating opportunities for improving health and safety incident in the working places.

## **4.8 Improvement Strategy**

The improvement strategy based on the analysis results in metal manufacturing industry needs to be developed to overcome the challenges in the workplace. Study emphasizing, implementation of OSHMS minimizes the workplace health & safety injury concerns (Kessy & Raymond, 2021). This study aims to connect the findings from the investigation and assessment of metal manufacturing industry to the strategies of the Occupational Safety and Health Management System (OSHMS). The identification of key issues in the study highlights several critical problems, including working more than standard hours, inadequate use of personal protective equipment (PPE), and a lack of safety rules and regulations, Lack of PPE control, Job dissatisfaction, higher exposure rate, & poor working environment. These issues should necessitate organizations to conduct injury analyses. Additionally, enhancing training and awareness is crucial for identifying gaps in safety training and the provision of necessary materials, which should be a primary focus of the strategy. Furthermore, the connection between safety rules and regulations in the implementation of the Occupational Health and Safety Management System (OHSMS) is evident, particularly in light of participants' reflections on the inadequacy of existing safety protocols.

On the other hand, the findings regarding top management commitment raise concerns that should be addressed systematically throughout the strategic implementation process. According to the study by Felknor et al. (2023), regarding the workplace safety and

health problems mitigation strategy, it requires closely working and planning for the future. Besides, the study findings overlooks major problems & challenges of job related problems which mainly addressing poor working place culture & requires developing protecting measures for workplace safety & health challenges in manufacturing industry.

As an initial step, the strategy could start with identifying problem areas & factors which requires intervention which needs systematic planning & coordinating. On contrary, as previously overlooked study were investigated, the work environment as one of a key factor influencing organization OSH performance, from which enhancing the physical, ergonomic, and psychosocial aspects should be considered. This includes, ensuring proper workstation design, adequate lighting, ventilation, and providing the necessary equipment which then be overlooked through organized & closed collaboration.

In the second part, the strategy should address lack in PPE usage, PPE control, lower safety rules & regulation, unsafe working condition & job dissatisfaction as previously described. In same way, the strategy should also focus on upgrading and maintaining the physical workplace conditions, ensuring compliance with relevant OSH rules and regulations, implementing regular safety inspections and intervention and providing appropriate personal protective equipment (PPE). So that, through the development of targeted interventions, implementation of injury prevention programs, and the provision of comprehensive health and wellness services for workers might requires effort to build robust planning & coordination works in carrying out the proposed strategy.

According to Fridrich et al. (2015) predicting the true impact of intervention is challenging dependent on its nature of work & characteristics. However, comparing the arguments presented by Felknor et al. (2023) and Fridrich et al. (2015) reveals contrasting perspectives on the effectiveness of interventions in workplace safety. On contrary, Fridrich et al. (2015) argue that, accurately predicting intervention outcomes is inherently complex and challenging due to the specific characteristics of different work environments. In contrast, Felknor et al. emphasize the importance of proactive collaboration and strategic planning to effectively address workplace safety issues. This inconsistency highlights a gap in understanding how to implement effective strategies.

Nevertheless, both studies suggest a positive outlook, indicating that enhancing understanding, communication, and planning can lead to more effective interventions in workplace safety.

Conversely, study on OSH strategy indicating, it protects workers from injury & improve work culture (Rahman et al., 2019). Similarly, the basic concept regarding the strategic development ensuring zero accidents or vision zero implementation keeping in mind safety, workers well-being & health (Jilcha, 2023). Similarly, implementing the safety & health intervention is taken as an important part of concern today (Vitrano et al., 2024). Study in construction industry exploring that, the strategy itself is important not only for the construction sector but also for other sectors, such as manufacturing (Kineber et al., 2023). It emphasizes the need to work on the organization's current situational assessment and to follow the strategic stages as well. Hence, related with existing problems encounter in manufacturing industry working environment, study by (Kineber et al., 2023) is adopted & incorporated in OSH Improvement strategy aiming to reduce workplace health & safety challenges in today's industry as indicated in Figure 4.16.

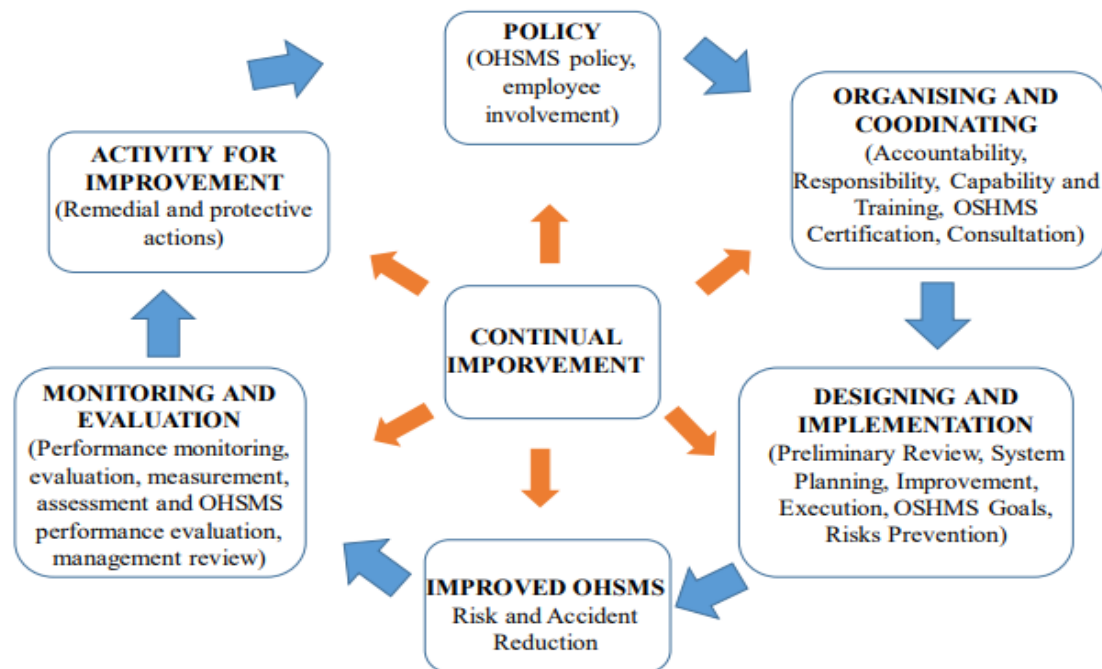


Figure 4.16 A frame work for OHSMS,

Source: (Kineber et al., 2023)

The framework consists of seven (7) major stages to implement the improvement strategy. The first stage is the occupational safety & health management system (OSHMS) policy, which involves establishing the policy and ensuring employee involvement. This is then followed by the organizing and coordinating stage, which focuses on accountability, responsibility, capability and training, OSHMS certification, and consultation. The next stage is designing and implementation, which encompasses preliminary review, system planning, improvement, execution, setting OSHMS goals, and addressing risks and prevention. This is followed by the continual improvement stage, where the OSHMS is continuously monitored, evaluated, and refined (Kineber et al., 2023)

Referring OHSMS in figure 4.16, the following major Improvement strategies are discussed in line with the challenges encounter in metal manufacturing industry:

#### **4.8.1 OHSMS Policy (Stage-1)**

At first stage, the manufacturing industry requires the development of a comprehensive workplace Safety and Health Management System (OSHMS) policy which is crucial and as described it requires national policy (Pramono et al., 2023). The study found a lack of safety rules & regulation with 63.2 % participants reporting no such policy in workplace. Hence this high lights the needs for compressive OSHMS policy. To illustrate, the OSHMS policy should be created through a collaborative effort involving management groups through assigning dedicated personnel, active participation, responsible bodies' involvement and industry focus groups from the metal manufacturing sector and representatives in developing effective strategy. So that, the collaborative approach Of OHSMS required for workplace related challenges in ensuring basic causes of harms allows to protect workers from health related issues (Marhavilas et al., 2022). Hence, the policy addresses the challenges and concerns of the entire metal industry rather than being limited to a single organization or sector. However, policy may be developed without sufficient inputs from focus groups; industry workers might leads to ownership & compliance. Similarly, policy might be unclear, or lack of specific objectives, which making it difficult for workers to understand roles & responsibilities.

The policy should clearly define the objectives, scope, and responsibilities for implementing and maintaining the OSHMS, and it should also incorporate the meaningful employee involvement as depicted in the framework & in supporting the development and implementation stages (Kineber et al., 2023).

#### **4.8.2 Organizing & coordinating (stage-2)**

The organizing and coordinating stage of the OSHMS improvement framework is critical, as it focuses on establishing clear accountability, responsibility, capability, and training requirements for all stakeholders within the organization (Kineber et al., 2023). This stage ensures that, the organizational management and workers satisfaction will then be key area of focus for creating health & safety of workers aiming to minimize risks (Bayram, 2018). The lack of management commitment, inadequate workers awareness & training was one of the issues. This can then lead to clear lines of accountability & responsibility which the organization should define to ensure effective OSHMS implementation. However, there may be unclear lines of accountability may result in confusion about who is responsible for safety initiatives. Regarding training, there might be an inadequate training in meeting effective coordination. Hence, the organization should provide the necessary training to employees on the basis of addressing program to enable them to perform their OSHMS-related duties effectively. Furthermore, the organization also seeks certification to demonstrate its compliance with relevant standards through providing health & safety services & regular safety inspection for continuous improvements as described by (Kineber et al., 2023).

To achieve this, the manufacturing industry should actively consult with metal manufacturing sectors, industry owners, government bodies and research centers to gather input and ensure the effective implementation and improvement of the OSHMS across the entire industry.

#### **4.8.3 Designing & Implementation (Stage-3)**

The implementation of an Occupational Health and Safety Management System (OHSMS) plays a crucial role in reducing workplace injuries. The author also explains that, the new ISO 45001:2018 standard can be regarded as one of the mechanisms for

decreasing incidents related to health and safety in the workplace (Abidin et al., 2021). The design & implementation stage of an occupational safety & health management system (OSHMS) in the manufacturing industry should begin by conducting an extensive initial review of its existing safety and health system, working environment, identifying challenges, and performing a comprehensive situational analysis. To justify, the study identified various safety & health issues, including lack of safety control, inadequate workplace emergency exists, high rate of workplace injuries. This assures, for a compressive design & implementation of OSHMS to address these problems.

This initial review should engage direct participation of company workers, focus groups, top management, team leaders, and safety officers to ensure a well-defined investigation of the current situation on basis of the OHSMS. By conducting this compressive situational analysis, the organization can pinpoint specific area that requires attention, enabling the development of a clear & structure approach to enhance workplace safety. The findings from this initial review, should allow the organization to develop a robust coordination system, as outlined in stage-2 of the improvement framework. At part of this process, the organization can prioritize action based on their potential impact employee safety & health, ensuring resource allocated effectively to areas of concern. The planning process should then lead to the implementation of various OHSMS elements, such as injury identification & assessment, and the development of appropriate control measures. At this stage, the manufacturing industry must ensure the continuous improvement in regular reviews and updates to the system to maintain its effectiveness and relevance.

#### **4.8.4 Improved OHSMS (Stage-4)**

The successful implementation of the various OHSMS elements, such as injury identification, risk assessment, and the establishment of appropriate control measures, should be the key focus for manufacturing industry. Conversely, study emphasizing , the involvement of management & workers were extremely important components for OSHMS implementation (Mahmmud et al., 2023). By effectively implementing these OHSMS components, the industry can work towards its primary objective of creating a safer and healthier work environment for its workers. Specifically, the manufacturing

industry should pay special attention to the work areas that have experienced higher rates of occupational injuries and incidents. This stage of OSHMS should incorporate workplace environment, necessary equipment provision & injury reduction methods. Basically, occupational injury assessment can positively affect employee safety, enhance company profits, and help minimize or reduce material and financial losses of the organization (Kuzior & Kopij, 2024). Therefore, based on this, it should aim to identify the root causes and contributing factors behind the higher injury rates in specific areas of the manufacturing industry where there are elevated incident rates. Likewise, based on the findings of this targeted analysis, the industry can then develop and implement risk mitigation strategies to address the challenges faced by these high-risky manufacturing units. This focused approach will enable the industry to make significant changes towards its goal of reducing work-related injuries and incidents across the entire manufacturing sector.

#### **4.8.5 Monitoring & evaluation (Stage-5)**

The manufacturing industry must implement monitoring and evaluation process that addresses the ongoing measured, assessment, and continuous improvement of the OHSMS activities. Performance monitoring and evaluation of Occupational Safety and Health (OSH) systems are essential for maintaining and improving safety standards within organizations. As noted in Zulkarnaen (2018), a systematic approach to collecting and analyzing data such as accident rates, regulatory compliance, and employee feedback provides a comprehensive view of the OHSMS's effectiveness. To justify, the study highlighted, the need for better monitoring & evaluation for safety & health performance, as evidenced by the high workplace exposure rate, inconsistency use of PPE & lack of essential safety equipment. This data-driven evaluation allows organizations to identify trends, assess current practices, and implement corrective actions to address any shortcomings in safety and health measures. The ongoing cycle of monitoring and evaluation enables organizations to adapt and enhance their OHSMS continuously. Regular reviews of performance data and employee input ensure that safety measures remain relevant and effective, ultimately leading to a safer workplace. By prioritizing this process, companies can make informed decisions that lower risks and promote overall

employee well-being. The study emphasizes that, in ensuring the implementation of the OHSMS, government bodies are also required to be involved in monitoring and evaluation to ensure that these processes are carried out effectively (Atarah et al., 2023). This joint effort will ensure that, the findings and reviews are discussed and addressed through a collaborative approach, leading to the identification of appropriate corrective measures and opportunities for continuous improvement. The management and workers should come together to review the data and analysis, and then collectively discuss and decide on the necessary steps for improving the OHSMS. This continuous improvement process should focus on addressing any gaps or deficiencies, as well as reinforcing the successful elements of the system, to ensure that the company's occupational health and safety goals are consistently met (Kineber et al., 2023).

#### **4.8.6 Activity for improvement (Stage-6)**

Based on the findings from the monitoring and evaluation (Stage-5), the company should establish a comprehensive framework that encompasses both corrective and preventive measures to address the identified OSH-related problems and issues. This approach should focus on identifying and addressing the root causes of these problems, rather than just addressing the symptoms. On the contrary, a study emphasizing the need for effective injury investigations requires the identification of appropriate corrective measures as well (Joe-Asare & Stemn, 2024). The implementation of protective measures, such as engineering controls, administrative controls, and personal protective equipment (PPE), should be a key component of this prevention-focused strategy. By addressing the underlying causes of OSH problems, the company can take proactive steps to tackle challenges and prevent the occurrence of similar issues then be one of the future improvement stages.

To address occupational safety and health challenges in the manufacturing industry, a collaborative strategy involving various stakeholders is essential. This includes close coordination and team discussions to identify root causes, leading to targeted improvements. Effective communication with policymakers, governmental agencies, unions, and industry sectors is crucial for maintaining and strengthening collaborative efforts. Additionally, prioritizing the development and enforcement of comprehensive

safety regulations will enhance occupational safety and health practices across manufacturing workplaces. Ensuring the widespread availability and proper use of essential protective equipment is crucial for improving occupational safety in the metal industry. Addressing human resource management challenges, such as enhancing training programs and fostering a culture of safety awareness, is vital for mitigating ongoing health and safety issues. The study advocates for a strategy that actively engages stakeholders, including policymakers, regulatory bodies, industry representatives, and the workforce. This collaborative approach can lead to meaningful and sustainable improvements in overall occupational safety and health within the industrial sector.

In summary, the overall proposed strategy is aiming to address the existing OSH challenges in the manufacturing industry setups. At first, performing existing analysis and inspections is the most effective method in evaluating the health and safety management system (Effivity, 2024). Accordingly, it allows for the monitoring of essential safety signs, addressing safety rules & regulations and rates of injury as well. Identifying factors which affecting the implementation stage might be the second part which requires attention. A study highlights that both internal factors: such as management commitment, worker participation, and safety culture and external factors like government support and policy changes influence the effective implementation of Occupational Safety and Health Management Systems (OSHMS) (Rahmi & Ramdhan, 2021).

On the other hand, focusing on the frame work & literature conceptual model developed, both have objective which aims to improve safety performances. Examining the independent variables in the literature review (LR) conceptual framework reveals that, continuous improvement in the proposed strategy framework aligns with the need to enhance the use of personal protective equipment (PPE) and improve training and awareness. These elements are crucial, as they can significantly reduce occupational injury incidents. Similarly, the mediating variables identified in the LR framework, such as safety culture and employee engagement, are also addressed in the proposed strategy. By analyzing these relationships together, we can develop a comprehensive safety management approach that emphasizes the importance of structured policies,

organization, and continuous improvement. Upon reviewing the strategy and its key components, it becomes evident that there are gaps that are not fully addressed in the current conditions of the manufacturing industry. For instance, while the proposed strategy emphasizes the importance of PPE and training, it may overlook specific challenges faced by different departments or production units. Identifying and addressing these gaps is essential for creating an effective safety management system that meets the diverse needs of the workforce.

By developing corrective measures and focusing on organization and coordination over time, along with adequate resource allocation, the implementation of an Occupational Safety and Health Management System (OSHMS) could positively transform the overall organizational environment. This proactive approach not only aims to mitigate existing challenges but also fosters a culture of safety that encourages employee participation and commitment to safety practices, ultimately leading to a safer and more efficient workplace.

## Chapter Five

### 5. Conclusion and Recommendation

#### 5.1 Conclusion

The overall safety and health aspects in metal manufacturing industry face significant challenges related to worker well-being and workplace safety. The study aims to cover the work-related issues in manufacturing industry through the use of various methods and to identify the major areas of concern. The study utilizes both primary and secondary data sources to evaluate the collected data and to assess the situational condition. The global and Ethiopian workplace Safety and Health context and research findings were analyzed and tried to incorporate gaps into in the study.

The major investigation indicating, a high percentage of workers reported long working hours, substantial health and safety issues, and a high workplace exposure rate, all of which contribute to increased health risks and fatigue. Key findings reveal that, 62.1% of participant result indicating, the existing health & safety issues with significant concerns regarding job satisfaction and workplace exposure. Notably, only 27.4% of workers regularly use personal protective equipment (PPE) & 72.6% inconsistency use of PPE & lack of safety equipment and 63.2% report the absence of safety rules, highlighting critical gaps in safety practices. Injury incidents due to machine faults and falls accounted for 60%, while hand tool incidents represented 55.8%. Poor ventilation also contributed to 55.8% of incidents, and electrical shock problems accounted for 54.7%. These are significant reflections of the respondents' concerns in the study. Regarding safety and human resource management, 30.5% of participants disagreed with the safety protocols and procedures, while only 7.4% expressed positive views on human resource management concerns. Additionally, 50.5% of participants reported concerns about the poor working environment in the manufacturing industry, with 43.3% remaining neutral about aspects of work culture, such as teamwork and collaboration. Furthermore, 24.2% disagreed with these cultural concerns. Similarly, 35.8% of participants disagreed with the quality of service in the organization, and 31.6% expressed disagreement regarding

related issues. The availability of essential safety equipment, such as safety shoes and clothing, also alarmingly low which directly impacting worker health and safety. Incidents of work-related challenges were observed during the site visit and assessment, add up to 405 sick leaves (168 male, 237 female) and 434 absences (112 male, 322 female) & this also presents another significant issue highlighted in the findings.

Conversely, lack of safety controls, inadequate workplace emergency exits, and insufficient ventilations, walkways were additional incidents. Consequently, major causes of the problems are analyzed through a fishbone diagram, and the degree of incidents in manufacturing industry is elaborated. The limitation in the use of safety clothing in the industry working areas, considered a very low response rate, which is taken as one of the major challenges. On contrary, one of the major findings from the regression analysis model was the significance of work environment in relation to other variables, which was identified as a concern area in addition to the practical situational analysis. In other ways, analysis indicates, a strong correlation between workplace conditions and health outcomes supported by regression analysis showing that, independent variables significantly influence health and safety. The predicted outcomes from the regression analysis indicate an acceptable range of actual values, providing critical insights into expected health and safety outcomes by highlighting areas that require improvement in other ways, the model explains 80.7% of the variation in health and safety outcomes, underscoring the importance of targeted interventions and resource allocation to enhance safety measures. As well, study identifies a strong disagreement among respondents regarding working conditions and safety training, indicating a need for significant improvements in workplace culture and human resource management. Hence, the findings emphasize, the urgent need for developing mitigation strategies to address the identified challenges, ultimately aiming to create a safer and healthier working environment in metal manufacturing industry. Likewise, finding overlooks, key elements include training, employee involvement, and awareness as mediating variables that contribute to comprehensive safety management. Despite existing gaps in current practices, developing corrective measures and focusing on organization and coordination can effectively implement an Occupational Safety and Health Management System

(OSHMS), ultimately transforming the organizational environment and reducing challenges over time. Observing these relationships collectively underscores the need for structured policies, organization, and continuous improvement in safety practices. Furthermore, finding overlooks the current strategy gaps in developing corrective measures and focusing on organization and coordination can facilitate the effective implementation of an Occupational Safety and Health Management System (OSHMS). However, through time, this approach could positively transform the organizational environment and reduce existing challenges in the manufacturing industry.

As conclusion, the health and safety challenges in metal manufacturing industry, requires adequate measures to be taken to improve the rate of injury and incidents. It might incorporating safety training & practice through emphasizing urgent policy & improvement strategy in enhancing safety management. To effectively implement controlling measures in the manufacturing industry, it is essential to foster a culture of focus and collaboration among all team members. This involves engaging everyone, from management to frontline workers, in the commitment to safety and health protocols. Therefore, manufacturing industry should pay attention to the workplace working environment and take proactive measures to prevent work-related injuries as this is a crucial aspect of enhancing overall safety & health performance in metal manufacturing industry working environment.

## **5.2 Recommendation**

To some extent, study identified and discussed major areas of work-related health and safety problems in metal manufacturing industry, with the aim of enhancing safety and health in the working environment. Based on the findings, the following key recommendations are provided to manufacturing industry:

The first and most important focus area is improving work environment and working conditions, which were identified as the most concerning issues in the study. This involves addressing the various challenges and concerns related to work environment, such as ensuring proper ventilation, lighting, and temperature control to create a comfortable and safe working atmosphere.

The second most important part is strengthening the workplace safety systems and control measures. This includes enhancing implementation and monitoring of safety systems, providing regular planned training programs for workers on safety rules, procedures, and the proper use of safety equipment, and improving overall safety practices within the industry. Furthermore, the study recommends addressing the availability and proper use of personal protective equipment (PPE) by all workers.

This would require close collaboration between manufacturing industry, safety officers, health centers, and industry leaders to overcome the challenges in providing essential safety equipment. Regularly addressing the availability of necessary safety equipment can help reduce workplace injuries and maintain a robust control system within manufacturing environment. To address the significant findings related to stress and job satisfaction in the metal manufacturing industry, it is crucial to implement comprehensive strategies aimed at improving workplace conditions. First, organizations should prioritize reducing long working hours and enhancing work-life balance, as excessive hours contribute to fatigue and job dissatisfaction. Second, increasing the availability and consistent use of personal protective equipment (PPE) is vital.

Finally, the study emphasizes the importance of establishing a comprehensive monitoring and evaluation system to review the implementation of safety rules, regulations, and control measures. This will help identify areas for further improvement and ensure the continuous enhancement of safety and health practices within manufacturing industry.

These key recommendations allow manufacturing industry can effectively address the work-related safety and health challenges identified in the study. Also, establishing a good workplace health & safety practice & ultimately creating a safer and more productive work environment for its employees as well.

### **5.3 Future Research areas**

The study emphasized the following future research areas which can elaborate more on the issues on workplace health & safety in metal manufacturing industry.

- Evaluating the effectiveness of safety equipment in enhancing workplace safety
- Impact of an integrated OSH management system on organizational safety culture
- Assessment of OSH incidents considering multiple dependent variables

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## Appendices

### Appendix: 1

English Version Questioner

ADDIS ABABA UNIVERSITY

ADDIS ABABA INSITITUTE OF TECHNOLOGY



**Research Title:** - Investigating impact & predicting occupational safety on the productivity of the workers and the performance of manufacturing industry (Addis Machine and spare parts manufacturing industry)

**Objective of the study:** - The objective of this questioner is only for MSc degree research at Addis Ababa University Institute of Technology Mechanical and Industrial Education Department. It highlights the problems and makes recommendations based on the findings of the study for our country and the manufacturing industry where the study is conducted is one of its objectives. I would like to say that, within this questionnaire the answers you give will be kept confidential: You can make a tick marks ( ) or circle to complete the questionnaire.

• If you have more information & questions, you can contact  
+251911470688/+251913490353

Best Regards!

Woubeshet Kebede (Mail:wube12kebe@gmail.com)



4.1) yes

4.2) not frequently used

4.3) Not at all

5. Which one of the safety equipment mostly used at workplace?

5.1 safety gloves  
safety shoe

5.2 helmet

5.3) mask

5.4)

5.5) Safety cloth

✓ Please write if any other used : 1, -----2, -----3,-----  
-----

6. Is there any control or supervision to the proper use of PPE at your workplace?

6.1) yes

6.2) No

7. Is there safety rule & regulation at your workplace? 7. 1) yes

7.2) No

8. Specify body part affected at your workplace?

8.1) hand

8.2) Ear

8.3) Leg)

8.4) shoulder & Neck

8.5) no accidents

#### Part 4: Workplace safety & health related problems

4.1 The degree of workplace problems occurrence

s/n	Health Problems	Degree Of occurrence			
		always	sometimes	Rarely	Not at all
1	Head ache				
2	Back pain				
3	Leg pain				
4	Shoulder & neck				
5	Muscle pain				
6	Eye Problem				
7	Ear Problem				
8	Pain in joints				
9	Respiratory problems				
10	Hand, finger etc				
11	Infection diseases				
12	Stress				

#### 4.2. The main cause of injuries encountering problems in workplace

s/n	Cause of injuries	Yes	No
1	Machine fault		
2	Falling		
3	Hot metals		
4	Chemicals		
5	High noise		
6	Metal Chips, scraps		
7	Electric shock		
8	Small particles , dust		
9	Hand tools		
10	Lifting heavy materials		
11	Poor lighting		
12	Poor ventilation		
13	Improper material handling		
14	Poor Working area		

#### 4.3 body parts mostly affected in relation to working places

s/n	body part Injured	Yes	No
1	Head		
2	Eye		
3	Ear		
4	Finger part		
5	Hand		
6	Leg		
7	Shoulder		
8	Back bone		
9	Chest		
10	Knee		

#### Part 5: Likert scale question which address the impact of workers' productivity & performance of organization

✓ Likert scale ratings : Strongly disagree: (SD), Disagree (DA), Neutral (N), Agree (A) & Strongly Agree (SA):

##### 5.1 Factors affecting workers' productivity & performance

s/n	Factors	SD	DA	N	A	SA
<b>1</b>	<b>Workplace environment</b>					
1.1	The working area allows me to perform tasks efficiently with minimal unnecessary movement					
1.2	The ventilation in my Work area provides sufficient air circulation.					
1.3	The lightening in my work area is adequate for the task i perform					

1.4	My work area is free of dust, ,chemicals & maintains a clean environment					
1.5	I have enough space in my work area to move around & complete task comfortably.					
<b>2.</b>	<b>Health &amp; safety Issues</b>					
2.1	My workplace follows appropriate safety & health protocols					
2.2	My work area has adequate emergency exits					
2.3	First aid kits & supplies are available in my workplace.					
2.4	I receive Regular occupational safety & health training.					
2.5	The Organization provides me with proper Personnel protective equipment					
2.6	Fire extinguisher & other safety equipment are available in my Work area.					
2.7	The organization conducts regular health checks for workers.					
<b>3</b>	<b>Human resource management</b>					
3.1	My work is regularly reviewed & received constructive feedbacks					
3.2	My Organization leaders encourage me to develop my skills & abilities.					
3.3	There are systems in organization to monitor worker safety & health in workplace.					
3.4	My organization provides a structured training & skill development program.					
3.5	I am afforded sufficient opportunity for skill development & training.					
<b>4</b>	<b>Workplace Culture &amp; Practice</b>					
4.1	My Organization foster a culture of collaboration, team work & mutual respect					
4.2	My organization provides excellent facilitates like a good cafeteria, clean rest rooms &					

	well equipped recreation areas					
4.3	Organization has well-defined system in place to maintain a positive work environment					
4.4	I have a clear understanding of my job duties & responsibilities.					

Thank you very much for your reply!!

## **Appendix: 2**

### **Interview Questions prepared for: management groups, industrial safety offices & Industry health center.**

The following survey questions generally include issues that affect the employee's productivity and working conditions in the workplace and the overall manufacturing industry environment.

- 1.1 Please specify, any ideas regarding the workplace and environment that affect the productivity and performance of the organization?
- 1.2 Are there health & safety rules & regulation as well as control within the manufacturing industry?
- 1.3 Do you believe that, the right personal protective equipment (PPE.s) addressed regularly to industry workers?
- 1.4 Can we say industry workers get relevant awareness about the workplace health & safety in manufacturing industry?
- 1.5 Do you believe top management address & gets supports in health & safety materials provisions?
- 1.6 Is the industrial safety & health office supported by necessary inputs materials?
- 1.7 Is there a practice of giving regular training for workers in reducing accidents & injuries in manufacturing industry?
- 1.8 How often your employees did gets threatened in hospital & how do you rate it?
- 1.9 Does your health center obtain appropriate treatment materials to overcome health related challenges?
- 1.10 Is there a practice of analyzing & reporting for health records obtained & gives mitigation measures?

1.11 What do you think, the main problems of not taking care of the safety and health of the workers focusing on the work place environment?

1.12 In your opinion, what kind of issues do you believe should be met, in order to maintain the productivity of workers and the competitiveness of the organization?

1.13 In order to establish a working system in the organization environment, what do you think to be done by the workers and the top management in general:

Thank you very much for your reply!!

### Appendix: 3

#### Site observational Check lists

s/n	General Check Areas	Recorded level Options					Remarks
		Yes	No	High	Low	Medium	
1	Existence of safety & health problems			✓			Observed in less experienced, lower education workers.
2	Is there Safety procedures, regulation & policy?		✓				
3	Is there Implementation safety trainings?				✓		
4	Is there provision of PPE's to workers regularly				✓		PPE not regularly provided in the company
5	Existence of emergency exists, emergency control equipment, safety signs etc				✓		Some emergency exist in production areas are closed, not properly accessed
6	Is there Safety rules & regulations procedures applied?		✓				
7	Is there high Noise level & temperature in working environment	✓					Observed in fabrication unit
8	Regular use of safety equipment at work places		✓				Most works complaining about PPE provisions
9	Workplace Safety Trainings & awareness is conducted regularly				✓		
10	Working environment walkways, free of danger & accidents		✓				Observed in working areas ( bolt & nut manufacturing, chrome plating,

							fabrication )
11	Accident rate in working areas			✓			Due ,most of the manufacturing units (bolt& nut, chrome plating, fabrication & heat treatments ) requires improvement works
12	Injury recorded in working areas			✓			
13	Workers absenteeism & bad records				✓		
14	Chemical exposure & affected levels			✓			Observed in chrome plating production unit
15	High heat, confined rooms, lack of ventilation, dust exposure etc			✓			Observed in heat treatment unit
16	Is there proper material handling in working areas?				✓		Fabrication, bolt & nut requires proper material handling procedures
17	Proper working areas exit & entrance allows for free movements				✓		
18	Are there proper working area arrangement?					✓	
19	Is there practice of use & control of fire extinguishers?				✓		
20	health center treatment standards & levels etc					✓	
21	Frequency of health treatment by works in health center					✓	
22	Is the overall working environment free of accidents?		✓				

#### Appendix: 4

##### Occupational safety & health (OSH) studies in Global metal manufacturing industries Summery

Author & Year	Study Area	Methodology	Major Findings	Gaps Identified
Dafit Feriyantoa (2020)	Manufacturing	A Literature & journals	Safety and health practices in the workplace are important for workers and the organization as a	Lack of specific study area and method details.

			whole. Factors causing accidents include stress, fatigue, unsafe acts, and workplace design. Good OSH practices ensure safe procedures and training. Safety issues still require attention and improvement.	
(Nalugya et al., 2022)	Metal workshop	Cross-sectional study which uses structured questioner & observational checklists	Result indicating practicing & individuals knowledge towards usage of protective clothing dependent on: work experience, educational level & knowledge, type of training & way of thinking	Limited data source bedside education, experience of workers. The inexperienced population not compared with the study
Naji et al. (2021)	Manufacturing sector	Integrated modeling approach	Strengthening safety practices leads to a reduction in the impact of hazards, benefiting workers and improving performance. Management participation, engineering measures, training, and awareness rising are suggested for improving safety practices.	Limited on specific population which not addressing vast data set, requires validation of data results to obtain accuracy, limited on data collection system.
(Ala et al., 2020)	Manufacturing Industry	Reviewing literature regarding safety culture in industry	Result indicates that, creating positive safety practice, awareness makes change to the overall working environment to be safe. It requires making change through boosting a positive safety	Management participation & exposure in safety practice in industry setups requires & limited.

			culture.	
Fuentes-Bargues et al. (2022)	Metal manufacturing	Descriptive analysis	Operational faults in machines and slips/object drops contribute to a higher level of accidents. Smaller companies have relatively more frequent accidents and are focusing on training, awareness, and technological advancements to reduce risks.	Source of data, limitation on specific data which related with objective
Shivali Suri & Das (2016)	Manufacturing sector	Comprehensive Literature Review	Musculoskeletal disorders, gastrointestinal problems, respiratory problems, eye problems, skin problems, and hearing problems were prevalent among workers.	Lack of specific method details.
Feng Yang et al. (2023)	Manufacturing	Cross sectional Analytical study	40.6% of participants experienced physical disorders, with the neck, shoulder, upper back, and lower back being commonly injured body parts.	Lack of study method which not able to describe cause & effects of the events. Accuracy of the result not achieved through the method employed (rather it requires to use group of individuals in certain period of time) .
Hanan S. Tuhul et al. (2021)	Manufacturing sector	Thematic Analysis Approach	High prevalence of injuries (32.3% of workers) and average injury rate 7556 per 100,000workers. Low level of health and safety practices.	Result shows, exist low involvement & resistance to change
Rajak et al. (2022)	Metal industry	Cross sectional study	28% of employees faced health-related problems, including	Lack of study on severity of nature, data

			injuries caused by objects, cutting, heating sources, head injuries, and problems in the hands and upper shoulder. Lack of awareness, training, risky working situations, and alcohol consumption identified as contributing factors.	inconsistency which not considering all groups of members.
Asiedu et al. (2024)	Industry city in Ghana	Community based correctional study	Prevalence of OSH problems (64.7%), with hand equipment being a major reason (45.8%) along with hot areas and other sources. Unhappiness in the working environment and lack of training provisions identified as main causes and associated factors.	Not able to estimate injury risk in long terms. Limitation on time lost in injury, variables missing data, lack in vast data source,
(Xiaowen Ding et al., 2023)	Manufacturing Industry	assessment based on Questioner	Indicating the higher prevalence of 15% (Neck Injury), specifically female workers & workers age > 35 years are among a higher rate of prevalence	Lack of the right method to analyze the work-related disorders which identified as one of the bigger gaps identified
Joshi et al. (2020)	Metal workers	Descriptive cross-sectional study	Eye and ear injuries accounted for 98.4% of reported cases among metal workers. Lack of safety rules, regulations, and practices reported by 97.1% of workers. Emphasis on adherence to safety rules and utilization of appropriate safety equipment.	Lack of instrument measuring metal workers problem, data collection limited only on respondents one way communication (self-report)
Atik et al.	Metal industry	Descriptive study	Lack of appropriate	Limited number

(2024)			safety equipment and provisions in 23.9% of cases (21 welders). 68% of welders experienced accidents, while 60.2% reported other health-related problems.	of population in the study,
Mulijajati et al. (2024)	Metal industry	Descriptive survey	Work-related injuries attributed to factors such as hand tools, working place conditions, improper working areas, poor safety practices, and inadequate use of appropriate safety clothing.	-
Bhavika Mamtani & Mahajan (2020)	Manufacturing industry	Combination of primary and secondary research	Lack of safety knowledge and awareness among workers leading to increased injuries. Emphasis on safety awareness training.	Primary data collection limitations within the manufacturing industry.
Shabani et al. (2024)	Metal manufacturing industry	Conducting systematic L review & Meta-analysis	Worldwide prevalence of OSH issues estimated at 55%. Workplace clothing identified as a significant factor in occupational injuries.	Limitation in having data for the study, most data found are types of self-reporting & taken us unclear data set.
(Sari et al., 2023)	Metal manufacturing industry	Conducting research using failure mode & AHP analysis	Identify 14risk types in industry with specific focus on hand & feet injury with a recommendation of the right use of clothing, working area illumination, practicing of working procedures etc	Limitation of using qualitative & quantitative approaches to view expected results
(Mohd Nasrom Mohd Nawi* et al., 2022)	Manufacturing Industry	Cross sectional study	Finding out that, companies require working on safety awareness trainings	Lack of study in considering workers attitude towards the

			enhancing, workers motivation, interaction & close collaboration of management as well.	safety culture in working environment.
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## Appendix: 5

### Occupational safety & health (OSH) studies in Ethiopian metal manufacturing industries Summery

Author & Year	Study Objective	Methodology	Findings	Identified gaps
(Aschalew Sime Megene & Yallew, 2020)	Assessment Of Injuries & factors in metal industry	Observational study with sample population	Identifying injury part & its causes by addressing lack of the right workplace clothing, safety training & related sleeping complexity are among the major study findings	The study is limited in its scope and focuses on a one-year timeframe. One of the challenges encountered from a study perspective is the presence of missing data and unclear information, which may be of deliberate withholding of information.
(Girma et al., 2022)	Assessing occupational injury & its associated factors in worker fond in industry	Cross sectional study	The finding results, the prevalence of conducted study within a year indicates 41.6%. the factors include using of PPE & work experience	
(Hailu et al., 2020)	Assessing the prevalence of back pain problems	Cross sectional study	An assessment result shows the prevalence of back pain indicating 51.7% which is very high & requires attention towards safety.	One limitation of the study is the clarity and ambiguity of the collected data, which necessitates further analysis using different approaches.
(Yosef et al., 2023)	Assessing the magnitude & factors related to OSH	Cross sectional study	The finding indicates, prevalence of 39.4%, 95%CI. It indicated obtaining gender, no usage of safety clothing, lack of training on OSH & job satisfaction found to be factors related to injury incidents.	Limited on one year recorded information makes it unclear. Also; study challenges in obtaining relevant outcomes using methods employed which requires using alternative method design (e.g. Cohort study).
(Benti et al., 2019)	Assessing the Prevalence of injury & factors large	Cross sectional study based on population size, using questioner	Workers affected in different problems due, there exists	The questioner-based interview methods gap not clearly identified in

	metal manufacturing in Addis Ababa,	& data reviews	problems of using safety clothes, level of education & working experience. The study finding indicates PPEs is the primary reason.	study.
(Naol & Terefa, 2022)	Assessing the prevalence of OSH Injury in industry	Institutional cross-sectional study	Finding entails, the prevalence of injury among industry workers reaches 29.4%. Due, the problems of PPE, longer working hours & payment issues.	The high rate of injury incidents not related with the impact on cost related issues which requires to be determined based on findings.
(Berhan, 2020c)	Investigating prevalence of accidents & associated factors in iron, steel & metal manufacturing.	Uses primary & questioner data collection on selected workers	Identifying major cause indicating low availability & usage of PPEs, high level of injury records in metal industry in Ethiopia.	The study is exclusively focused on the metal industries located in Addis Ababa and the surrounding area. It does not encompass other similar industries that may exhibit similar characteristics.
(Melese, Adugna, & Mulat, 2022)	Assessing prevalence & associated factors of hearing problem in metal industry	Cross sectional study using interview & stratified - sampling	The study results reveal a high prevalence of hearing problems, with a rate of 30.7% in the manufacturing industry. Several factors have been identified as contributors to this issue, including cigarette smoking, age, and high sound levels.	One limitation of this study is the difficulty in addressing additional challenges and exploring the causal relationships between OSH and its consequences due to limited data availability.
(Afework et al., 2024)	Assessing workers Adherence, associated factors towards safety & health practice	A structured interview & simple random sampling method	Finding shows the dedication of industry workers & indicating a low compliance level of 39.3%.	One of the limitations of this study is the challenge in obtaining comprehensive and confidential data through interviews

(Tamene et al., 2022)	Investigating & predicting injuries on workers of metal manufacturing	Through selecting group of individual & using data collection & analysis	Identify factors related to health showing, injury & its severity in Ethiopia becomes problem	Coding of disease incident were not appropriate & clear tools, no missing information not incorporated in the study.
(Girma & Kebede, 2019)	Evaluating exposure & related factors on workers working in steel industry	Cross-sectional study & interviewing	Finding indicates, steel factory exposed to high amount of particle, materials, due to low PPE's usage.	Study limits only on workers involved in production unit & not considering workers who have health related cases.
(Sime et al., 2022a)	Assessment of work-related stress & factors	Institutional based cross sectional study using questioner	Indicates an amount of bigger overall prevalence, due working condition, experience, lower supports from management	Limited on population size, study not incorporating workers who are on sick leave & being hospitalized
(Berhan, 2020a)	Investigating the role of organization management on OSH development	Primary data source using questioner	The contribution of management support not developed or integrated in organization system	Limits in data collection which not able to address large group of population
(Sileyew, 2020)	Assessing the OSH practice in global & Ethiopian manufacturing industry context	An approach of Primary & secondary data collection	Finding indicates that, OSH related problems in Ethiopian manufacturing industry caused due to knowledge, integration works, policy, management focus & problems related to technology advancement.	Study not able to explore additional variables relating to Osh, due limited resource availability. However, author predicts that, future analysis opportunities & incorporating knowledge & awareness, system development & integration, technology etc.

## Appendix: 6 Model Summery

Authors	Sector	Objective	Models	Findings	Limitations
(Qingwei Xu & Xu, 2020)	Metallurgical Industry	To Establish a composite risk	grey system theory	insufficient safety	Did not discuss the integration

		analysis method.	GM(1,1) model for prediction & uses bow tie model to identify the causes and consequences of fatal accidents	training, lack of inspection in fieldwork, incomplete safe operation guidelines and lack of accident prevention measures are the main causes in findings	of the GM (1, 1) model with other prediction techniques. severity and probability of an accident not analyzed using qualitative method
(Sarkar et al., 2020)	Metal manufacturing	prediction & analyzing of injury severity using ML techniques	SMOTE, BLSMOTE, MWMOTE, and KMSMOTE	Author predicts, KMSMOTE performs better than others in balancing datasets and therefore, helps in achieving higher prediction in terms of average recall, F1-score and geometric mean  Indicated that, higher prediction can be obtained by mixed data set than investigation reports (reactive data set)	Limited amount of data for better generalizability of the results lack of time series approach for accident prediction
(Shirali et al., 2018)	Metal Industry	Predicting the outcome of the accidents		The authors found that based on the	The authors noted that their study had

		through using CART & CHAID algorithms		predicted variables, both algorithms, CART and CHAID, achieved a performance of 81.78% and 80.73%, respectively. Concluded that these algorithms can be effectively utilized in the steel industry.	limitations in terms of the available dataset and the exclusion of other data analysis methods
(Y. Yang et al., 2023)	Automotive	Analyzing CHAID algorithms & its prediction efficiency in the given data set	Uses CHAID algorithms comparing with other algorithms such as: CART & ID3	The study's results indicate that when evaluated on a large dataset, CHAID achieved a performance of 92.3%, while CART achieved a performance of 85.7%.	The authors acknowledged that the limited dataset used in their study might not provide a comprehensive assessment of the efficiency of the algorithms. They recognized the need for further elaboration and study with a larger and more diverse dataset.
(Khairuddin et al., 2022)	Systematic Literature Reviewing on OSH predicting Tools	Examined or predicting occupational injury using text data analysis	NLP models : K-means, NB, SVM, D T, and K-NN	Explaining there is huge potential to explore the application of NLP and text-based	Decision making using computers, deep learning-based NLP models not covered &

				analytics in this occupational injury	limitation of using the methods
(Koc et al., 2022)	Construction	To predict occupational accident outcomes.	Uses Machine learning algorithms like: (RF), (NB), (KNN) (ANNs) RUS, ROS and SMOTE	Author highlights the use of (RF) , bigger through indicating factors which contribute for results (like: recorded accidents data, age, materials etc.	performances of other under-sampling methods, such as cluster-based under-sampling and CCUS not covered use of SMOTE algorithm L-SMOTE, KM-SMOTE, SVM-SMOTE and SMOTE-NC explored in study
(Chen et al., 2023)	construction	Consequence prediction through comprehensive evaluation and comparison of diverse classification methods	Author uses, visualization, clustering and ranking techniques	Study Predicts, critical factors that significantly influence the consequence of construction accidents	Focuses/ Specific to existing methods & methodology not configured with other classification methods
(Debela, Azage, Deyessa, & Motbainor, 2022)	manufacturing	Economic costs and predictors of occupation-related injury from employers' perspectives in Ethiopia.	top-down approach	Obtain the total cost variation; long-term absence from work, unsafe acts of the workers, having a sleeping disorder, and severity (type) of injury	Costs of occupational injury from workers' perspectives and societal levels were not considered & didn't consider occupational diseases indirect costs and direct non-medical costs –

					incurred by employers were not covered
(Camliyurt et al., 2023)	Marine industry	To determine the situation of occupational accident factors in maritime industry using data from diverse sources	Uses decision tree, RF (Random Forest), and detail elaboration of ML & AI methods	Research Finding indicates, the accident in workplace is more than environmental impacts. Give insight into the base for Predicting accident in more detail for future studies	Limitations on large data set & scarcity of data Event tree & Fault Tree analysis for root causes of accident not employed
(Maheronnaghsh et al., 2023)	Systematic Literature review Approach	Reviewing or Assessing the ML approaches in the study papers through figuring out problems & challenges	Using data splitting & testing methods	Identifies ML Approaches is more better than traditional approaches in OSH prediction	Limitation of Using ML in regarding OSH in different industry / sectors with limited coverage of mining & construction industry

**Keys:**

Logistic Regression = LR, Decision Tree = DT, Random Forest = RF, Support Vector Machine = SVM, Naïve Bayes = NB, K-Nearest Neighbor = KNN, Artificial Neural Network = ANN, Principal Component Analysis = PCA, Multilayer Perceptron = MLP, Auto ML = Automated Machine Learning. Random under-sampling= RUS, random over-sampling =ROS and synthetic minority oversampling technique = SMOTE, K-Means SMOTE= KMSMOTE, Majority Weighted Minority Over-sampling Technique= MWMOTE, Borderline SMOTE = BLSMOTE, Localized Synthetic Minority Over-sampling Technique=L-SMOTE, Neighborhood Cleaning =NC, Cluster Centroids-based

Under-sampling =CCUS, AI=Artificial intelligence, CART= classification & regression Trees, CHAID= chi square automatic interaction detection.

## Appendix: 7 Company health center accident registration format



Ethio - engineering Group  
Addis machine and spare part manufacturing industry  
Health Center  
Accident Registration

Doc.No  
AMSPMI/OF/IQ/2603

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የስራ ላይ አደጋ ለደረሰበት ሰራተኛ የሚሞላ ቅጽ (ቅጽ ቁጥር AMSPMI/QMS/WF/09-10.1)

1. አደጋ የደረሰበት ሰራተኛ ስም ከነአያት -----
2. ያታ ----- ዕድሜ ----- የትምህርት ደረጃ ----- ደመወዝ -----
3. አደጋ የደረሰበት ሰራተኛ የሚሰራበት ትርጉሚያፍ መምሪያ/አገልግሎት/ -----  
የስራ ዩኒት /ዋና ክፍል/ ----- የስራ መደብ -----
4. አደጋ የደረሰበት ቦታ -----
5. አደጋ የደረሰበት የማሸን /የመሳሪያ/ዓይነት -----
6. አደጋ የደረሰበት የሰውነት ክፍል -----
7. አደጋ የደረሰበት ቀን ----- ሰዓት -----
8. የስራ ክፍል ኃላፊ በአጭሩ አስተያየት የሚሰጠው -----

ሀ/ የጉዳዩ ዓይነትና ይዘት -----

ለ/ አደጋው ሊከሰት የቻለበት ምክንያት -----

9. አደጋው ሲደርስ በአካባቢው የነበሩ
  - 9.1 ስም ----- የስራ መደብ ----- ፊርማ -----
  - 9.2 ስም ----- የስራ መደብ ----- ፊርማ -----
  - 9.3 ስም ----- የስራ መደብ ----- ፊርማ -----
10. ሪፖርቱን ያቀረበው አደጋው የደረሰበት ሰራተኛ የቅርብ ኃላፊ ስም -----
11. የጤና ጣቢያው ባለሙያ አስተያየት -----

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12. ስለአደጋው መንስኤና የወደፊት ክትትል የሴኩቲ ባለሙያ አስተያየት -----

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**ማሳሰቢያ**

13. አደጋው ከባድ ከሆነ ክፍሎቹ ይህን ቅጽ ወዲያውኑ ሞልተው ኢንሹራንስም ሆነ የህክምና አገልግሎት ለማግኘት እንዲቻል መላክ ይኖርባቸዋል።
14. ይህ ቅጽ በ4 ኮፒ
  - 1ኛ ኮፒ ለሴኩቲ ክፍል 2ኛ ኮፒ ኃይል አስተዳደር 3ኛ ኮፒ ለጤና ጣቢያ 4ኛ ኮፒ አደጋው ለደረሰበት የሰራተኛው ኃላፊ ይሰጣል