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## Exploratory study on human factors affecting safety in the shipyard of Pakistan

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# **EXPLORATORY STUDY ON HUMAN FACTORS AFFECTING SAFETY IN THE SHIPYARD OF PAKISTAN**

**BISMA KHAN**

A dissertation submitted to the World Maritime University in partial fulfilment  
of the requirements for the award of the degree of Master of Science in  
Maritime Affairs

2023

## Declaration

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature):



(Date):

**26.09.2023**

Supervised by:

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Supervisor's affiliation:

**Professor, Nippon Foundation Chair,  
Director of Maritime Research,  
Head of Maritime Energy Management**

## *Dedication*

*This dissertation is dedicated to my mother. Thank you for your boundless love, care, support and sacrifices for making me who I am.*

یہ مقالہ میری والدہ کے لیے وقف ہے۔ آپ کی بے پناہ محبت،  
دیکھ بھال، حمایت اور قربانیوں کے لیے اور مجھے، جو میں ہوں  
وہ بنانے کے لیے  
آپ کا شکریہ۔

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the most merciful.*

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## Abstract

Title of Dissertation: **Exploratory Study on Human Factors affecting Safety in the Shipyard of Pakistan**

Degree: **Master of Science**

The study of human factors has emerged as a critical element in understanding and improving the safety requirements of Pakistan's shipyard. The dissertation attempts to study human factors in the risk-based environment and challenging duties of the employees associated with shipyard resulting in accidents and injuries.

While technology and equipment contribute to safety, human actions, decisions, and behaviours often play a critical role in causing accidents. As the number of accidents was increasing in the shipyard, the researcher realised the need to explore contributing factors. A quantitative survey approach was adopted to collect information. The results were compared among employees of various job designations, including officers, supervisors, technical assistants, workers, and sub-contractor workers, to determine which category was primarily affected.

Most accidents are caused by human errors; therefore, the human element plays a crucial role in the maritime industry. This research examined the accident investigation reports of Shipyard of Pakistan in order to understand the causes of human error in complex systems to prevent future accidents. The Research utilised the HFACS method to achieve a thorough understanding of the accident's causes and analyse all contributing factors, related to human performance and behaviour.

In order to understand and improve the complex interactions between human and organization, a multidisciplinary approach is acquired. At the end, the results were organised and assessed, which may help shipyard to identify the potential hazards, improve workplace design, enhance training programs, and optimize overall system performance.

**KEYWORDS:** Human Factors, accident, investigation reports, HFACS, Shipyard, Safety, quantitative survey.

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## List of Abbreviations

ACSNI	Advisory Committee for the Safety of Nuclear Installations
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
BLS	Bureau of Labor Statistics
Fig	Figure
HAT	Harbour Acceptance Trial
HFACS	Human Factors Analysis and Classification System
HOF	Human and Organisational Factors
HSE	Health Safety and Executive
ILO	International Labour Organization
NTSB	National Transportation Safety Board
OHS	Occupational Health and Safety
PPE	Personal Protective Equipment
QC	Quality Control
REC	Research Ethics Committee
SAT	Sea Acceptance Trial
UK	United Kingdom
WMFs	Work Motivational Factors
WMU	World Maritime University
WS	Workplace stress

## Chapter 1: Introduction

### 1.1 Background

It is a universal truth that any culture, whether it is social ethics, values, norms, or safety culture, purely depends upon the human factors that are observed or exercised or maintained by a particular society. Maritime industrial set up where ships are being constructed or repaired, comprising of numerous hazardous industrial activities where a lot of risk to humans' life and health are involved. In such scenarios, human factors play a very essential role to form a robust safety culture within organizations. In fact, the success or failure of an organization depends on its safety culture.

According to a report by the ILO, it is estimated that a worker loses their life approximately every 15 seconds due to a disease or accident related to their work (Darabont et al., 2017). Furthermore, according to Gasiorowski-Denis (2018), it is worth noting that an estimated 374 million work-related injuries and illnesses occur annually, with a significant number of these cases leading to prolonged periods of absence from the workplace. This illustrates the state of the workplace that employees may face significant repercussions solely for the act of fulfilling their job responsibilities. Despite the existence of safety regulations, guidelines, and best practices, accidents and safety incidents continue to occur. One of the central elements contributing to these incidents is the influence of human factors.

Human factors encompass a range of elements, including environmental, organizational, and job-related aspects, as well as individual qualities, that influence workplace behaviour and impact well-being and safety. The term encompasses three interconnected facets that necessitate examination, namely, the individual, the job and

the organization (HSE, 2005). Hence, while analysing the safety of an organization, these factors must be considered

As a matter of fact, safety cannot be fully and effectively achieved unless human factors are considered during implementation. The discipline of human factors encompasses four primary objectives: the augmentation of safety, the mitigation and control of mistakes, the enhancement of comfort, and the promotion of productivity.

As said by author Kahn (1962), it is imperative to always take into account human and moral factors. The inclusion of these elements in policies and public conversations is vital and should never be overlooked.

#### 1.1.1 Achievement of Safety via Human Factors:

The significance of human factors lies in its ability to enhance the efficiency, effectiveness, and safety of work processes. Organizations that prioritize the consideration of human factors will strive to ensure that machinery and equipment utilized by their workforce are designed to be user-friendly and promote safety. The use of human factors entails the design of equipment, and procedures with a focus on the end-user, taking into consideration the capabilities and limits of human beings. This approach ensures that individuals can interact effectively with technology, fostering a positive working environment (Australian Radiation Protection and Nuclear Safety Agency, 2015).

Safety, both in general and specifically within the maritime sector, revolves around the examination of human factors and their potential impact on accident rates that may result in decrease or increase in number of accidents. This dissertation covers the evaluation of accident investigation reports and explores human factors in a maritime industry of Pakistan i.e., Shipyard of Pakistan where specific factors affect safety, resulting in increased accidents.

## 1.2 Problem Statement

Shipbuilding is a very intricate industry that necessitates simultaneous execution of various operations. The process commences with the creation of a jig fabrication that aligns with the block's design. Subsequently, the steel is handled and processed, involving activities such as marking, cutting, and bending of steel plates. These plates are cut into certain shapes to form desired design and then welded together to form blocks. Once the desired shape has been achieved through welding or fabrication, the next step involves surface preparation of the block. This entails subjecting the block to grit or shot blasting, followed by the application of various coatings of paint for the purpose of preservation. Various layers of paint are applied to the block and then the block is transported for block setting, alignment, and levelling at the berth. In a similar manner, many blocks are prepared and assembled at berth. The process further proceeds with outfitting, installation of air conditioning, pipe routing, electrical cable routing and fitting, onboard installation of mechanical and electrical equipment, and foundation's construction. Every step of shipbuilding requires Quality Control inspections and installation checks, including HATs and SATs before the commissioning of ship. Although, this production process requires highly skilled and experienced personnel as well as it requires a significant allocation of organizational resources, infrastructure and facilities. Additionally, the production process adheres to rigorous schedule constraints, thereby occasionally augmenting the workload of employees and necessitating the involvement of subcontracted workers to fulfil project requirements. Therefore, the engagement of subcontractor workers from many organizations introduces additional complexities to the organization as these may lack adequate training in their respective roles.

Although, in numerous shipyards, the implementation of OHS Management System is prevalent. However, there is a recurring occurrence of challenges pertaining to human safety. In specific, shipyard issues commonly involve significant consequences, including but not limited to fire incidents, human injuries, and even fatalities (Barlas & Izci, 2018). When examining the range of multiple intricate tasks, it is evident by

statistics that shipbuilders exhibit a higher degree of vulnerability to injuries in comparison to workers in other industries (BLS, 2020). Furthermore, in accordance with the guidelines set forth by HSE, UK, a significant proportion of annual accidents are attributed to activities in shipyards involving the slips, trips, and falls. Additionally, approximately 10-15% of these incidents can be attributed to machinery-related factors (HSE, 2022).

The construction of ships primarily take place in the open area at a considerable height. The timely completion of major projects typically relies on the labour-intensive efforts of the workforce. Shipyard personnel are frequently exposed to a diverse range of risks, in which building activities take precedence over safety protocols due to fast-paced work conditions.

Shipbuilding Industry is an important part of Maritime Sector where different types and sizes of ships are being built or repaired all over the world. All the construction/manufacturing works of ships requires a huge work force. Under the scenario of Pakistan as a developing country, generally the risk perception among people is quite low in society means people are less conscious about the safety and it can be envisaged that there is a low safety culture that persist generally all over the country. Hence, shipbuilding as a highly labour-intensive industry, the risks of safety violations are always at rise. Further, apart from Yard's owned trained work force, workers of sub contracted jobs are also carrying out work in the Yard. This hired work force is comparatively less safety conscious than the Yard's own work force. Due to some peculiar human factors associated with different types of work force the situation gets complex and level of risk of accident increases further more. That is why, there is need to understand a series of human factors that affect safety.

While the negative effects of human factors on safety have been studied extensively in various industries, including aviation, healthcare, and manufacturing, there exists a research gap concerning their impact specifically in shipyards. Shipyard operations are

unique in their challenges and complexities, which can result in human factors manifesting differently compared to other industries. Therefore, this dissertation seeks to address this research gap by examining accident investigation reports of Shipyard of Pakistan and identifying the existence of human factor in the shipbuilding yard to understand their underlying causes and consequences, and propose evidence-based recommendations for enhancing safety practices in shipyard.

### 1.3 Aims and Objectives

The aim and objective of this study is to ascertain the human elements that exert a detrimental influence on the safety culture of the Yard. The objective of the research to identify existing human factors and their effects in the Shipyard of Pakistan resulting in increasing number of accidents; and to analyse human factors involved in previous accident investigation reports that caused the accident, to help to avoid the occurrence of similar accidents in the future.

### 1.4 Research Questions

- What are the existing human factors in shipyard that are affecting safety?
- Which human factors were involved in accidents in shipyard?

### 1.5 Significance of the study

The dissertation's significance rests in its ability to contribute to the improvement of safety in shipyards, which is a crucial topic within the maritime industry. By shedding light on the negative effects of human factors and propose strategies, this research seeks to:

- improve worker safety and well-being
- reduce the occurrence of accidents, injuries, and fatalities
- promoting a safer and more humane work environment



- ensure development with safety system with the consideration of human factors
- establish and maintain best practices in shipyard safety, benefiting the industry as a whole

## 1.6 Overview of the research

This dissertation is organized into 6 chapters, each serving a specific purpose in addressing the research objectives and problem statement. The following chapters provide an outline of the study's structure:

Chapter 1 (Introduction): This chapter describes the background on occurrence of accidents in industries due to human factors. It provides the major causes of accidents and provides the impact of human-related factors on the effectiveness of occupational safety measures in industries. It further recognizes the multifaceted nature of shipyard operations, where complex tasks, diverse workforces, and various safety challenges converge. The subsequent chapter introduces the research questions that address aims, objectives, and effect of implication the study. It concludes by providing an overview of the research.

Chapter 2 (Literature Review): This chapter reviews understanding of human factors in shipyard safety, exploring various types of human factors and their effects. It further reviewed existing literature on HFACS, its framework, categories, and how it classifies human factors contributing to accidents.

Chapter 3 (Research Methodology): This chapter presents a comprehensive overview of the research methodologies and approaches employed in the study. It encompasses several aspects such as research design, data collection procedures, participant selection, survey questionnaire development, data analysis techniques, ethical considerations, and limitations of the study.

Chapter 4 (Data Presentation): It identifies the existing human factors in the shipbuilding yard of Pakistan by doing survey of the employees, synthesizes the research findings, discusses their implications.

Chapter 5 (Analysing Human Factors using HFACS): The chapter studied cases of accidents investigation reports and analyses factors that affect shipyard safety using HFACS.

Chapter 6 (Recommendations and Conclusion): In this final chapter, the dissertation concludes with a conclusion, recommendations, limitations of the study and avenues for future research.

## Chapter 2 Literature Review

### 2.1 Human Factors

The present chapter aims to provide an introductory overview of the field of human factors. The main document for comprehending HSE's approach to human factors "Reducing error and influencing behaviour" provides a concise overview of general industry recommendations pertaining to human factors as, "Environmental, organizational, and occupational elements, as well as individual abilities. These factors collectively influence work-related behaviour, potentially impacting the well-being and safety of individuals" (HSE, 2019).

### 2.2 Human Factors and Occupational Safety

Human factors encompass various psychological, physiological, and organizational elements that can influence safety in the workplace. Understanding these factors is crucial for developing effective safety measures. This literature review explores the various types of human factors that impact safety.

### 2.3 Human Factors affecting Safety

#### 2.3.1 Fatigue:

Fatigue is a condition characterized by a state of exhaustion resulting from extended work hours or lengthy periods of sleep deprivation. Individuals experiencing fatigue exhibit a heightened susceptibility to damages in cognitive working, diminished ability to sustain focus, and delayed response times, so substantially augmenting the likelihood of accidents and mistakes. Human error has emerged as the predominant

factor contributing to accidents, as evidenced by scholarly research indicating that fatigue is the primary source of such errors (Koonce, 2002; Caldwell, 2005).

The presence of fatigue can provide repercussions for both the safety and productivity of individuals in the workforce. Numerous instances of industrial accidents have been associated with workers who experience fatigue. To ascertain the occurrence of fatigue as a cause in accidents, NTSB conducted extensive research encompassing a thorough examination of all significant accident investigations conducted from 2001 to 2012 (Marcus & Rosekind, 2016).

According to Hardaway & Gregory (2005), organizations as well as employees frequently underestimate the degree of fatigue and its effects on associated performance. Fatigue can have detrimental effects that include a decline in decision-making abilities, cognitive abilities, attention span, reaction time, learning capabilities and memory function. Additionally, it can impair performance accuracy, response time, communication skills, mood, situational awareness, and attentiveness.

Salas and Maurino (2010) explains that fatigue not only arises from sleep deprivation and disruptions in circadian rhythms, but also from an excessive physical and mental workload. The likelihood of accidents and injuries escalates with an increased workload, particularly when exceeding 12 hours of work per day or 70 hours of work per week. The issue is lack of employee awareness.

### 2.3.2 Safety Culture:

Organization's safety culture is shaped by the collective values, perceptions, attitudes, skills, and behavioural patterns of individuals and groups. These factors influence the level of dedication, approach, and effectiveness with which the organization manages health and safety. (ACSNI, 1993)

Safety culture encompasses the attitudes and values of both managers and workers in relation to the effective management of safety and risk. Researchers are significantly emphasizing on doing extensive study pertaining to the safety culture prevalent in industries that are considered high-risk due to frequent accident occurrence. (Martyka & Lebecki, 2014).

According to Cox and Flin (1998), there exists a correlation between an organization's safety culture and its accident occurrence. Numerous scholarly investigations have delineated the safety culture as a subordinate aspect of the organizational culture, a concept widely recognized as crucial for an organization's capacity to effectively handle the safety-related elements. Milczarek and Najmiec (2004) provided a justification for the correlation between an individual's safety culture and their safety behaviour. In the course of a questionnaire-based investigation, researchers discovered a correlation between workers who had previously had accidents have comparatively lower level of safety culture, in contrast to their counterparts who had not encountered any accidents.

The culture of the organization serves as the primary foundation for the development of a safety culture, which in turn has a direct impact on safety-related behaviours. Studies have indicated that the safety culture plays a central role in both the causation of accidents and the prevention of errors, especially in shipbuilding industries which are characterized by high risk. Safety culture has a far more important role in the realm of safety management within shipbuilding industries.

### 2.3.3 Motivation:

Employees possess several characteristics that serve as motivation for them to perform at their optimal level. These components are sometimes referred to as work motivational factors (WMFs). The comprehension and arrangement of the work environment are crucial undertakings for organizations, as they serve to promote

productive behaviours among human resources while discouraging unproductive ones (House & Wigdor, 1967). Every business is influenced by four factors that play a crucial role in determining the levels of motivation among its workers, regardless of whether the impact is positive or bad:

- Job satisfaction that refers to the individual level of contentment that employees experience in relation to their work, and has been found to have an impact on their performance (Thompson and Phua, 2012).
- Job security when employees experience a lack of job security, their ability to perform at their optimal level is compromised. Multiple researches have demonstrated that job insecurity has adverse consequences for long-term organizational outcomes, including work performance, as well as short-term outcomes such as job satisfaction and organizational commitment (Loi et al., 2011).
- Work stress which manifests in various forms and exerts diverse effects on both individual's mental and physical well-being. Workplace stress (WS) is a significant employment issue that has a detrimental impact on both organizational profitability and employee productivity. According to Matteson and Ivancevich (1987), effective job stress management has the potential to enhance productivity, motivation, and decision-making abilities.
- Workload that quantifies the volume of tasks and responsibilities assigned to an employee. Issues such as excessive workload can be identified by conducting an evaluation of employee workload during the development of a new system or the revision of an existing system. (Jung and Jung, 2001).

Research has demonstrated that these factors exert substantial influence on productivity and have the potential to enhance performance. Although, Numerous empirical investigations have demonstrated that motivation exerts a favourable and substantial impact on the performance of employees.

#### 2.3.4 Situational Awareness:

The concept of situation awareness is the ongoing process of monitoring the task environment to gain comprehension of current events and anticipate future occurrences within a time frame of minutes or hours (Endsley & Garland, 2000). Flin et al. (2017) discussed that the occurrence of industrial accidents in various industries has been linked to deficiencies in situation awareness.

According to Stranks (2007), a renowned scholar in the field, individuals exhibit varying perceptions of risk, and it is not uncommon for two individuals to possess distinct perspectives on a given risk. The perception of risk in individuals can be influenced by various factors, including the individual's skills, motivational factors, past experiences, the individual's level of encouragement, and their competence in a specific task.

#### 2.3.5 Decision making and teamwork:

The process of decision-making can be adversely affected by several conditions, such as stress or time constraints, resulting in accidents. According to Ebermann and Scheiderer (2013), a significant proportion of accidents, has attributed to erroneous decision-making or a lack thereof.

In their study, Gautam and Mathur (2018) propose a classification framework consisting of four distinct decision-making styles. One key feature is vigilance, when the decision-maker engages in a thorough examination of many choices and assesses their respective merits and drawbacks before taking any action. The second approach can be classified as buck passing, in this scenario, the individual refrains from making a decision, thereby exhibiting a tendency to shift responsibility to others. The third phenomenon is commonly referred to as procrastination, which pertains to the persistent postponement of decision-making by individuals who occupy themselves with various activities. The final style under consideration is hyper-vigilance. This

pertains to the prompt decision-making process undertaken by individuals in order to mitigate stress and conflict when faced with time constraints.

According to Gautam and Mathur (2018), individuals who possess a mindful approach to decision-making exhibit a greater propensity for improving their decision-making abilities. This is attributed to their heightened receptiveness to feedback and reduced tendency to misinterpret the circumstances. This process of making decisions can be influenced by factors such as fatigue and stress, particularly in relation to decision-making strategies that involve higher levels of cognitive engagement.

#### 2.3.6 Stress:

The experience of stress varies among individuals on an individual basis. As a result of stress and its associated ramifications, a substantial financial burden is borne by organizations and societies globally. This has gathered sustained attention over the course of several decades, prompting analysis and evaluation from scholars, journalists, policymakers, and professionals across various disciplines (Tourigny et al., 2010). The correlation between stress and performance has been the subject of extensive research in recent decades. Stress can potentially result in, heightened fatigue, susceptibility to sickness, or diminished self-esteem.

#### 2.3.7 Complacency:

One other significant human aspect is complacency, which arises when workers have an excessive level of familiarity with their tasks that may lead to a lack of vigilance due to an unwarranted assumption of a satisfactory system state. According to Turan et al., (2016) complacency increase the likelihood of process accidents and/or pose a heightened risk of injury to frontline workers. Complacency is acknowledged as a contributing factor to accidents within the maritime industry. Based on a study published in 2018, it was found that complacency played a role in 11% of accidents attributed to technological issues (Bielić et al., 2017).



Scholarly investigations and evaluations of incidents or instances of near misses demonstrate that various factors such as declining training, maintenance, procedural compliance, and supervision can impact all safety regulations and operational protocols, extending beyond the realm of human-technology interaction are also forms of complacency (Bielić et al., 2017).

#### 2.3.8 Training:

Training is an essential component of the Quality System process. Its purpose is to produce skilled employees, who are capable of fulfilling the requirements of their respective crucial roles. According to Martinussen and Hunter (2017), the presence of highly proficient individuals is crucial for the efficient, secure, and satisfactory functioning of any organization.

Achieving optimal levels of performance and ensuring utmost safety in hazardous work environment (such as the fields of shipbuilding) holds significant significance. Therefore, the matter of ensuring optimal performance in the face of unusual circumstances is presently receiving significant attention in the organizations. As said by Vidulich et al. (2014), to effectively managing anticipated circumstances, operators must possess the capability to effectively handle unanticipated scenarios. Organizations and individuals responsible for educating operators involved in high-risk activities are confronted with a confusing state. However, Charness & Tuffiash (2008) pointed out that modern researchers begin their studies by constructing representative tasks on which superior performance can be directly observed. It is imperative for individuals to promote flexibility, which entails the capacity to recognize and discern unforeseen scenarios, and afterwards analyse these situations by creating novel solutions while maintaining safety (Vidulich et al., 2014).

## 2.4 The management of Human Failures: Common challenges

Wilkins Safety Group (2015) described management of human failure in complex systems encompasses factors beyond the analysis of individual operator actions. Nevertheless, it is crucial to acknowledge the value of effectively overseeing the work of individuals who hold significant responsibilities in the prevention and control of big incidents, while also taking into account the specific circumstances in which their actions take place. Organizations often commit various errors when evaluating human performance. These encompass a variety of elements:

- Treating operators with an elevated status, attributing them with exceptional capabilities to intervene in critical situations.
- Denoting minimal likelihood of failure, lacking recording assumptions or data sources. They need to provide accurate probabilities of human failure.
- Giving assumptions that an operator would invariably be present, identify any potential issue and promptly initiate the necessary course of action.
- Giving assumptions that individuals will consistently adhere to established protocols.
- Declaring operators' as well-trained which lacks clarity regarding its direct correlation to the prevention or control of key accident hazards. Furthermore, organizations fail to acknowledge that training alone does not address the prevention of slips, lapses, or violations, but rather simply addresses mistakes.
- Asserting operators' high level of motivation and therefore less likely to experience unintended failures or engage in deliberate breaches.
- Omitting the human component in risk assessments, along with the absence of any discussion on human performance.
- Utilizing improper methods, such as excessively documenting every task conducted on the site, resulting in a loss of focus on allocating resources in the most efficient manner.
- Generating overarching assertions that human error is effectively mitigated (without explicitly delineating the specific methods).

## 2.5 Identification of factors causing accidents in the context of Shipyard

Barlas (2012a) carried out analysis of fatalities occurred in Turkish shipbuilding sector between the year 2000 and 2010 which were intolerably high. After a thorough analysis researcher found major fatality reasons as fall from height, electrical shock, explosion or fire, hit by objects, and struck between objects. He determined, worker's negligence, lack of education and training, lack of safety awareness, mistakes in operations, insufficient use of PPE, etc. are the key factors of fatalities in Turkish Shipyards. The fatalities categorized by the researcher as instances of human errors. These errors encompass several types, including faults due to memory and forgetting things, learning-gap, carelessness, judgment error, inconsistency, inaccuracy and action errors. Correspondingly, Barlas further determined precautions of these failures through a survey questionnaire using AHP technique (an effective method for separating out competing solutions while taking a variety of objectives into account) as wear and verify safety gear, building handrail when doing work at height, inspect slippery floors and fix net where required, conduct educational sessions regarding workplace safety, install sign boards, regular usage of PPE accordingly for each task, inspect electrical cables, installation of audio warning system, proper check of ventilation when working in confined spaces, follow crane's operating instructions properly, etc to keep the employees safe from these fatalities.

The findings of this analysis indicate Barlas (2012a) determined human error as the grounds of accidents. He clearly described the preliminary causes of accidents whereas the root causes or hidden causes were yet to be identified. Later, Barlas (2012b) investigated the root causes of the fatalities between 2000 and 2010, not as human error types but as human factors in Turkish shipyards, and found human factors were involve in these accidents i.e., less experience, inadequate training, Age less than 35 years, no job satisfaction, poor housekeeping, work in high temperature, non-compliance of Safety Management System, fatigue, inactivity after leisure weekend, inadequate supervision resulting in workload, ignorance of management as the key factors.

## 2.6 Classification of HFACS model and its practical implementation

### 2.6.1 Swiss cheese model:

The "Swiss cheese model", a widely recognized conceptual model of the accident process, was devised by Professor James Reason in 1990 (see fig-1). According to Wiegmann & Shappell (2003), Reason stated that accidents arise during the production process due to faulty interactions between system elements.

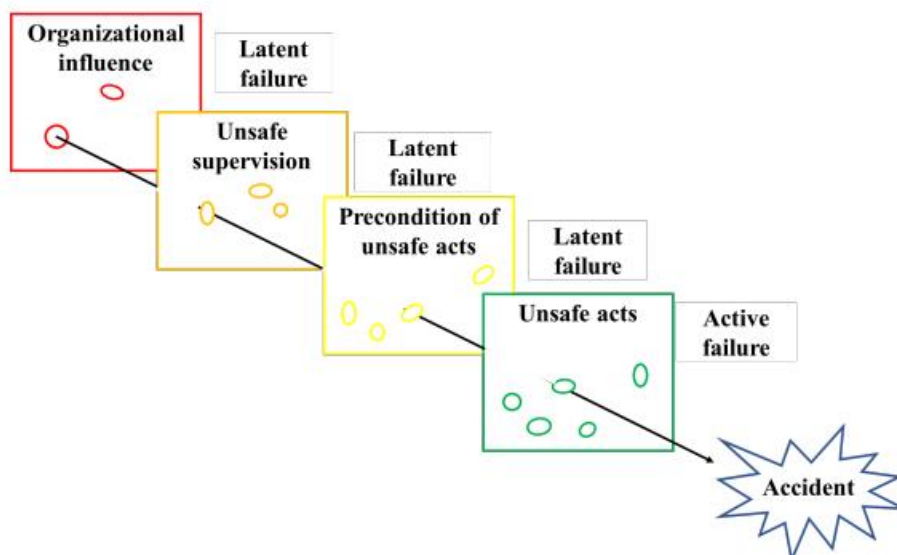


Figure 1: Swiss Cheese Model. Source: Wiegmann and Shappell (2003).

Each slice of cheese in the Swiss cheese paradigm represents a certain level. These levels were classified into two categories:

1. Active failures, also known as Unsafe acts, are instantaneous system-affecting behaviours that are present in front-line workforces.
2. Latent failures, which manifest in long-term systems, become apparent only when they interact with other elements. These failures primarily occur at a higher level, including designers and decision-makers inside the systems. It encompasses three distinct layers:
  - Precondition of unsafe act

- Unsafe supervision
- Organizational influence

Every hole within the cheese model signifies as point error. If all the holes are aligned in a linear configuration allowing a passage for light, the occurrence of the accident will be instantaneous. By ensuring that at least one slice is repositioned in a manner that does not allow passage for light, the occurrence of the accident can be prevented. It highlights the organization's capacity for error prevention.

According to the model, in order to attain a full comprehension of accident, it is important to thoroughly investigate all levels. It was advantageous for accident investigations since it compels investigators to acknowledge and examine latent faults within the process of accident causation (Wiegmann & Shappell, 2017). While the model has been widely used as a conceptual framework for understanding the occurrence of accidents and has been useful in facilitating data gathering (Kaptan et al., 2021), It is crucial to acknowledge that the model does not provide a clear description and identification of the specific error points within each layer of the model which hindered the ability to proactively identify and address these error points prior to accidents. Therefore, the implementation of this model in practical situations becomes challenging (Shappell & Wiegmann, 2000).

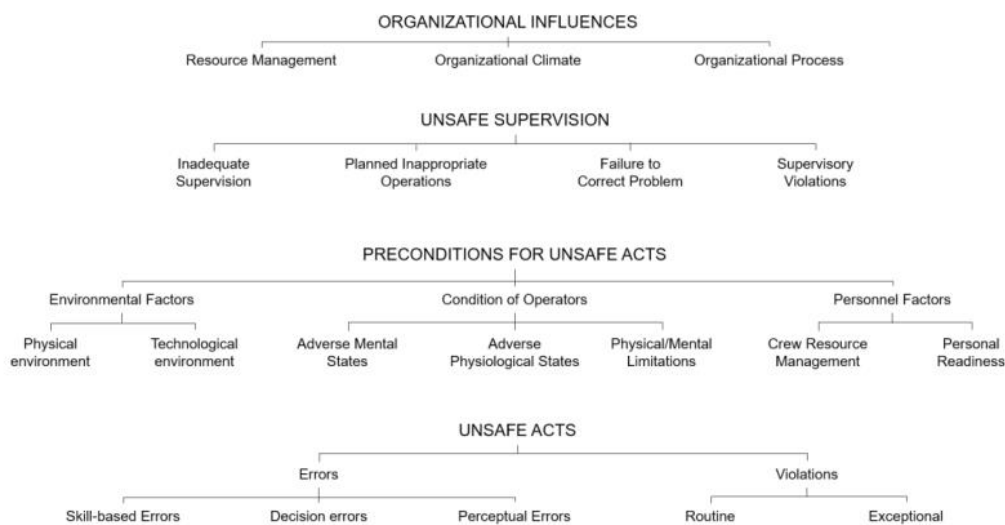
#### 2.6.2 HFACS:

To enhance the utilization of the “Swiss Cheese Model” and identify the factors that impact the occurrence of accidents, Shappell and Wiegmann (2003) devised HFACS. HFACS was developed with the primary aim of systematically analysing human factors and improving accident investigation in the field of aviation. (Shappell & Wiegmann, 2000).

Wiegmann and Shappell identified six underlying distinct viewpoints on human errors, which were developed by considering nature and causes of human errors.

1. Cognitive view
2. Ergonomic view
3. Behavioural view
4. Aviation medical view
5. Social psychology view
6. Organizational view

HFACS provided a comprehensive analysis of the accident's causes, utilizing the four levels outlined in the Swiss Cheese Model. Each level was further specified and detailed to enhance understanding and clarity. Fig-2 presents an overview of the HFACS:



*Figure 2: HFACS. Source: Wiegmann and Shappell (2003).*

The utilization of the HFACS served as a core theoretical framework for the examination and evaluation of the underlying elements that contribute to an accident.

It detailed holes in “Swiss Cheese Model”, wherein human error is examined across four distinct levels.

1. The initial level, which involved the operator’s risky actions resulting in active failures, was the primary focus of accident investigators.
2. 2nd level pertains to the preconditions necessary for unsafe activities, with an emphasis on the potential for failure and the easy identification of active failures within the accident causation chain. Additionally, it also sheds light on the inadequate conditions and behaviours of the operator in practice.
3. The 3rd level focuses on the role of the immediate supervisor in the unsafe events, specifically examining the causes of risky behaviour that led to failure.
4. The 4th level pertains to the possible failure resulting from organizational factors, namely the influence of decision-making errors of top management on the conduct of supervisors and underlying behavioural assumptions guiding the operator's actions.

Originally, HFACS was developed for implementation within the realm of military aviation. However, further investigations have demonstrated its efficacy in the domain of civil aviation as well. Afterwards, it was deployed in other domains such as chemical industry, construction industry, railway, coal mining, medical sector, and others, for the purpose of conducting accident analysis and inquiry. Numerous studies have been conducted by researchers in the field of human factors, utilizing HFACS focusing on identifying the root causes of accidents and developing proactive measures in these domains. The outcomes of these studies have substantial importance in the determination of accident causation and the establishment of preventative strategies.

### 2.6.3 HFACS framework in the construction industry:

A study conducted by Ye et al. (2018) found that the HFACS framework did not effectively capture the interrelationships between various factors across multiple levels. When applying HFACS to analyse accident reports of construction industry,

there are cases where the factors identified in HFACS do not align with the causes described in the accident reports, or there's uncertainty in their relationship. Therefore, an improved version of HFACS was developed specifically tailored for implementation within the construction sector. The critical paths were identified and emphasized.

In a similar vein, several crucial human elements were discovered, as shown in fig-3. The results reported in this study provide useful insights for the construction industry in terms of improving safety performance.

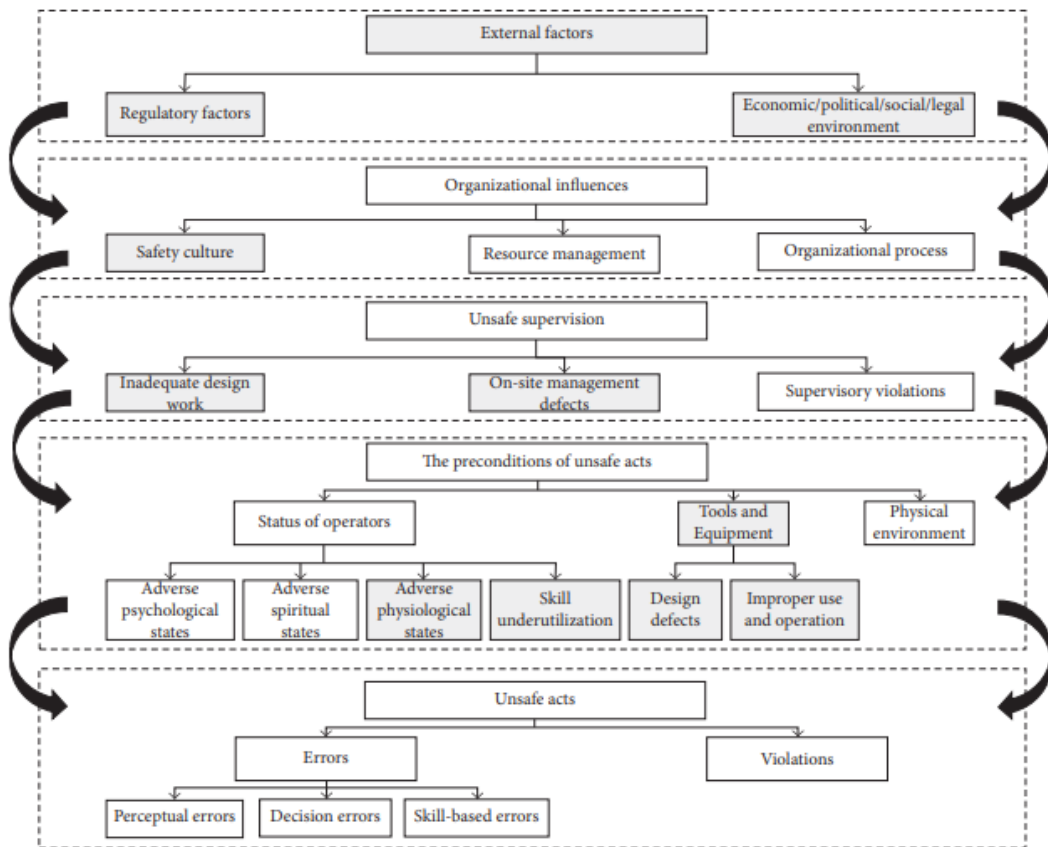


Figure 3: HFACS framework in the construction industry. Source: Ye. et. al (2018)

This HFACS framework has been widely utilized in the construction industry. Within this theoretical framework, an additional level has been incorporated and certain



subcategories have been modified. The modifications made were based on the distinct characteristics of the construction industries. These changes are visually represented in grey boxes in fig-3.

**External Factors:** It was added to encompass the influence of safety flaws that extend beyond the boundaries of organizations. External variables encompass a range of elements, such as regulatory factors and the economic, political, social, and legal environmental factors. According to Reinach and Viale (2006), it was seen that the occurrence of an accident was influenced by the regulatory environment, although in an indirect manner. The regulatory environment's insufficiency may create a conducive climate for complacency and unpredictable decision-making among key stakeholders in the building industry (Chen et al., 2013). Furthermore, Khosravi et al. (2013) have elucidated the significance of the economic, political, social, and legal environment in relation to risky activities.

**Organizational influences:** It includes negative scenarios that encompasses various factors, such as a deficient and flawed organizational framework, as well as a lack of safety culture and inadequate resource management. These circumstances may not solely serve as a causal element for accidents, but they provide a conducive environment for accidents to transpire. The concept of safety culture pertains to the overall environment and working conditions in the industry. It is the result of collective and individual attitudes and behaviours. Resource management encompasses various procedures associated with the administration, distribution, and upkeep of resources within an organization. This category encompasses various factors, including but not limited to, inadequate people training, insufficient equipment, etc. Organizational process encompasses formal procedures, methodologies, and matters of supervision inside the company. The various deficiencies in top-level management and decision-making processes that have an indirect adverse impact on the performance of team members and the overall safety of the organization. The aforementioned components encompass several aspects of the process, including but not limited to the commitment

of individuals involved, time constraints, systems designed to motivate and reward employees, the development of safety programs, establishment of performance benchmarks, and the formulation of company-specific procedures and instructions.

**Unsafe supervision:** It pertains to the identification of nonconformities through to audits that are deemed inadequate or unsuitable. The examination of unsafe supervision encompasses three sub-categories, namely on-site management defects, inadequate design work and supervisory violations. The authors identified site supervision, plan management, and rectifying recognized issues as three significant responsibilities of on-site management. Factors contributing to this category included failure of control chain of command, inadequate performance monitoring, a lack of training provision and failure to effectively manage emergency operations. This also refers to the circumstance where a manager is aware of existing shortcomings or unsuitable conditions pertaining to persons, equipment, training, and so forth, yet fails to implement corrective or preventive measures. In design work, the primary responsibility of project managers was to offer advice to construction employees through the creation of diverse requirements, methods, schemes, and plans. The ineffectiveness of these were one of the contributory factors to increase the frequency of accidents. Therefore, a category of insufficient design work was introduced. According to Shohe and Laufer (1991), supervisors play a crucial role in the facilitation of an organization and promotion of everyday construction management. Supervisory violations refer to instances where the supervisor mechanism is found to be in violation or disregarding the regulations set forth by administration. Examples of non-compliance include the act of permitting unauthorized individuals to engage in work operations, as well as the acceptance of avoidable risks.

**Pre-conditions for unsafe acts:** This level pertains to the formation of risky behaviours can be attributed to the mental-physical circumstances and unsuitable habits of operators. It comprised of three categories status of operators, tools and equipment and physical environment. The status of operators refers to mental states

that have a detrimental impact on an individual's performance. Several factors can contribute to various outcomes, including lack of situational awareness, lack of motivation, stress and fatigue, extreme self-confidence etc. The examination of status of operators is conducted through the analysis of four sub-categories. Adverse psychological states which refer to medical or negative mental conditions that hold comparable significance to bad mental states and have a detrimental impact on performance. Adverse physiological states pertain to the circumstance wherein individuals lack the requisite ability, expertise, and time to effectively manage the present predicament. The research focuses that the concept of "status of operators" should encompass both on adverse psychological states as an inner mental realm and adverse spiritual states as an external realm. In the realm of the construction industries, it has been observed that accidents can arise not only from psychological and physiological conditions, but also from the underutilization of skills. It pertains to situations in which individuals possess skills that exceed the level necessary to fulfil the requirements of their respective job.

In accordance with the features of the construction sector, it was widely accepted that operator's risky activities must be investigated from the perspective of the "man-machine environment" (Xiaoyan & Zhongpeng, 2014). Several studies have indicated that the consideration of man-machine ergonomics was neglected during the design process of mechanical equipment and safety warning signs. Furthermore, employees may deviate from prescribed operating procedures to save time and wages, therefore, these studies resulted in adding the concept of "tools and equipment" which further encompassed both "design defects" and "improper use and operation". The traditional HFACS considered "environmental factors" to comprise the technological and physical surroundings. Though, within the construction industry, this term pertains primarily to the physical characteristics of the construction site. It applied to the external environment and circumstances present within the working environment that have negatively impacted the operational capabilities of individuals. Examples of such factors that can be considered are temperature levels, noise levels etc.

**Unsafe acts:** This level includes activities performed by individuals or operators which directly contribute to the occurrence of an accident. It further classified into 2 categories: errors and violations. Errors refer to inadvertent activities that have the potential to result in an accident. Errors are classified into three sub-categories for analysis i.e., decision errors, skill-based errors and perceptual errors. Decision errors encompass the improper and insufficient decisions made by operators, as well as the faults they commit during the decision-making process. Operators may make inadequate or improper selections during their planning activities. This category, encompasses instances where methods and procedures are inadequately implemented, operators make incorrect choices, improper decisions are made, and information is misinterpreted or misused. Skill-based errors, also known as errors of routine, refer to mistakes committed in settings that do not necessitate conscious cognition, but rather occur as a result of repetitive practice. These faults primarily manifest in practical or routine applications pertaining to procedural execution, training, or qualification. Skill-based errors related with professional expertise and tendency. These errors refer to mistakes or failures that occur due to a lack of proficiency or competence in doing a particular task or activity. Perceptual errors refer to the cognitive biases and inaccuracies that can occur during the process of perception. Its phenomenon encompasses cases where inaccurate feedback is provided. Violations refer to deliberate actions that contravene established rules and regulations. This category encompasses factors when individuals consistently neglect and fail to adhere to established norms and procedures that have become ingrained habits over time or occurrence of violations beyond the limits of established rules and laws. These circumstances managers do not tolerate and are prohibited by law.

## Chapter 3 Research Methodology

### 3.1 Introduction

This chapter opens with a discussion on the research approach. Further, it determines the appropriate research methodology for this study, explains data collection method and details about the number of participants. The chapter then explains the data analysis followed by the ethical consideration and limitation to this study. The purpose of this chapter is to describe the methodology used to explore human factors, from the point of selection to statistical analysis.

### 3.2 Quantitative approach and its appropriateness

The primary research approach employed in this study was mainly quantitative. The chosen research strategy was the utilization of a survey questionnaire administered to collect data followed by close-ended and open-ended questions. According to Ikart (2019), the utilization of appropriate questioning techniques in a questionnaire survey has the potential to produce high-quality responses. Survey was utilized to gain a preliminary understanding of the human factors present in shipyard in Pakistan. They offer an opportunity to identify a broad range of difficulties that affect personnel at various levels, including officers, supervisors, technical assistants, workers, and subcontractor workers. Roopa and Rani (2012) assert that a questionnaire serves as a means for a respondent to express their perspectives or opinions. Further, the questionnaire serves the purpose of generating numerical data subjected to statistical analysis. The inclusion of these numerical values will contribute quantitative aspects to the research. It was easy to make comparisons by asking the same question to

multiple persons of different types of occupations. Because of all these factors, survey was appropriate for this study.

### 3.3 Establishment of Survey Questionnaire

A critical step in the design process was to do a literature review to investigate the context of the research field prior to developing the questionnaire (Perrone, 2020). Research questionnaire was prepared to achieve the research aim, in which researcher tried to understand which human factors are involve in the SOP causing accidents and affecting the employee's wellbeing. Survey questionnaire was divided into 4 levels (Refer Appendix 1). In the first level, researcher asked the respondent to describe their self and included questions i.e., age, educational qualifications, designation, work experiences and language preferences to understand respondent's characteristics. In the second level, researcher asked questions about work-related characteristics, third level was about well-being of employees, and in the last part researcher asked the respondent to provide any suggestion.

The questionnaire intended for all categories of job levels, that is, officers, supervisors, technical assistants, workers and sub-contractors' workers. The questionnaire comprised of contingency questions (Likert format was used for measurement of different factors which was divided into a 5-point scale), close-ended questions, open-ended questions to promote participants' free and open responses, and matrix questions. The particular question types were contingent upon the survey objectives and the responses. Furthermore, the inclusion of Urdu translation in all the questions was done as it is Pakistan's national language and to facilitate respondents who might face difficulties in providing answers in English, allowing them to comprehend the questions more simply.

### 3.4 Data collection and selection of participants

The researcher acquired primary data through the utilization of questionnaires, which proved to be a successful and cost-efficient method for data collection. The utilization of questionnaire surveys in scientific research offers additional value to the specific study (Dharmasiri, 2021; Young et al., 2018).

After the approval of Survey questionnaire by the WMU Research Ethics Committee (Refer Appendix 2), questionnaire was forwarded via PDF format in a hard copy and distributed among employees of the Shipyard of Pakistan with the help of researcher's contacts. This method was employed due to limited internet accessible within the yard, mostly for security reasons.

Employees with different designations, ages, experience were contacted to participate in the survey so that all types be covered and true picture depicts. Responding to the survey was completely optional and depended on the willingness of respondent according to their convenience. Participants were reminded about the research purpose, expected benefits, their right to discontinue participation at any time, and the protection of their personal information. In order to establish rapport with the participants and gain their trust, information about the researcher and the WMU master's program was presented.

Survey questionnaire was received via scan files. A wide range of views were received from the participants who were willing to participate in the research. Furthermore, response of 44 participants were received.

### 3.5 Data Analysis

As recommended by Cohen et al. (2018) analysis to be as clear as possible to show draw conclusions from participants' subjective experiences. After the researcher collected the answers from the respondents, the data was categorized according to the

job position of respondents to get clear idea that which position require more attention. These positions are divided into 5 parts (officers, supervisors, technical assistants, workers and sub-contractor workers). The views of the respondents on that study were collected. Relevant data was drawn, presence of statistical significance was measured, tables and figures were created highlighting finding from each research question and the analysis results of both closed-ended and opened-ended questions were presented in next chapter to get firm conclusions.

### 3.6 Ethical consideration

Ethical consideration was observed and practiced throughout the research. The survey questionnaire was originated only after receiving clearance from the WMU Research Ethics Committee (REC). The identity of the participants was kept confidential. The surveys did not have any connection or association with the identity of the participants. It was ensured that the data collected through the survey is only accessed by the researcher and is protected from unauthorized use without participant's permission and it will be deleted and destroyed from everywhere after the completion of this dissertation. Participants were informed that research is done for academic purposes and also about their right to pull out at any time of the research. As an ethical consideration, this has been communicated to the participant before starting survey questionnaire form.



## Chapter 4 Data Presentation

### 4.1 Introduction

This chapter presented the response of participants, who filled survey questionnaire of total 30 questions to achieve research aim. Survey questionnaire included 25 closed-ended and 5 open-ended questions. Closed-ended research questions numbers were Q# 1-11, 13-15, 17-24 and 26-28, with some having sub-parts and open-ended research questions were Q# 12, 16, 25, 29 and 30 (Refer Appendix 1). 44 complete and valid response received for this study with background of different job roles.

Views of respondents from different job categories (officers, supervisors, technical assistants, workers and sub-contractor workers) from Shipyard of Pakistan were taken and compared as they have different perspectives based on their positions and responsibilities:

- Officers: Officers are senior amongst all and have a deep understanding of the company's policies and procedures.
- Supervisors: Supervisors are typically responsible for overseeing workers and ensuring safety protocols are followed.
- Technical Assistants: Technical assistants often possess technical expertise related to the industry's operations.
- Workers: Workers are directly involved in carrying out. Their responses highlighted practical challenges and concerns that may not be apparent to those in more supervisory or administrative roles.

- **Sub-contractor Workers:** Sub-contractor workers are not directly employed by the shipyard provided an outsider's perspective.

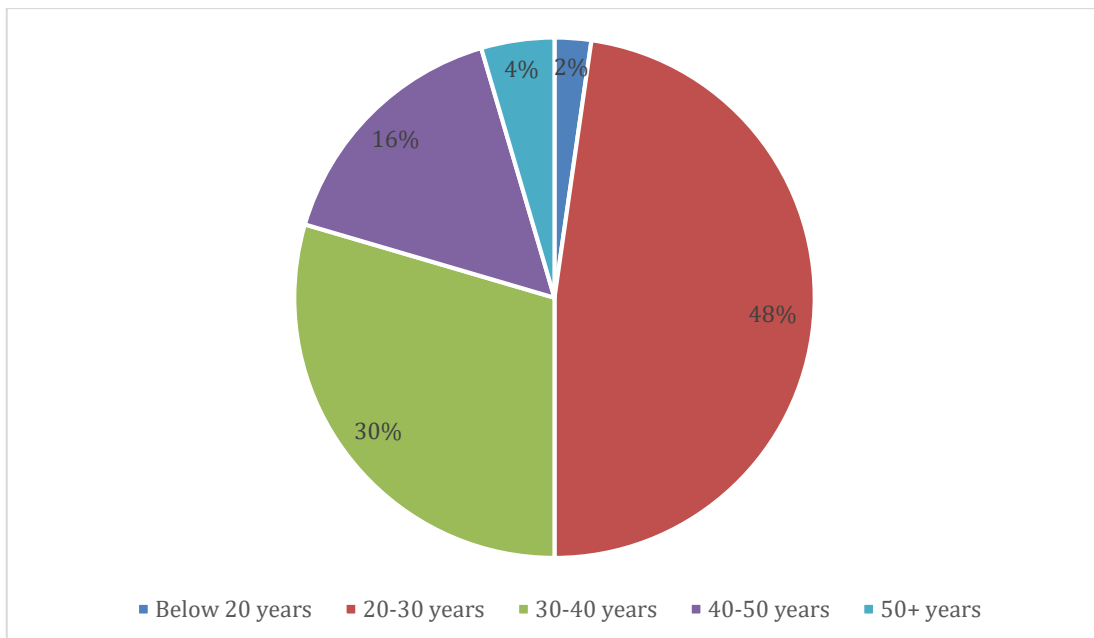
Overall, having a diverse set of respondents from various job roles is beneficial because it allowed for a comprehensive evaluation of human factors within shipyard. By considering the perspectives of officers, supervisors, technical assistants, workers, and sub-contractor workers, researchers gained a holistic understanding of the human factors.

## 4.2 Questionnaire Results

### 4.2.1 Section A:

This section contained 5 questions to defines respondent's characteristics, i.e., age, educational level, designation, years of experience and language preferences.

#### Question 1: What is your age?



*Figure 4: Age of respondents. Source: The researcher.*

*Table 1: Age of respondents of each job category. (Source: The researcher)*

	Below 20	20-30	30-40	40-50	50+
<b>Officers</b>	-	4	1	3	1
<b>Supervisors</b>	-	4	3	3	1
<b>Technical Assistants</b>	-	4	3	-	-
<b>Workers</b>	1	7	4	1	-
<b>Sub-contractor workers</b>	-	2	2	-	-
<b>Total</b>	1	21	13	7	2

As fig-4 showed, the majority of respondents (48%) fall within the age range of 20-30 years, represented a significant portion of the sample, the second-largest age group (30%) was between 30-40 years, 16% respondents were between 40-50 years old, while only 4% respondents were above 50 years old and 2% respondent was below 20 years old. The age distribution of respondents has implications for human factors in shipyard as different age groups have varying levels of experience, training, and familiarity with technology and safety practices. The data represented that younger individual were higher compared to older age groups, and this demographic diversity.

**Question 2: What is your education level?**

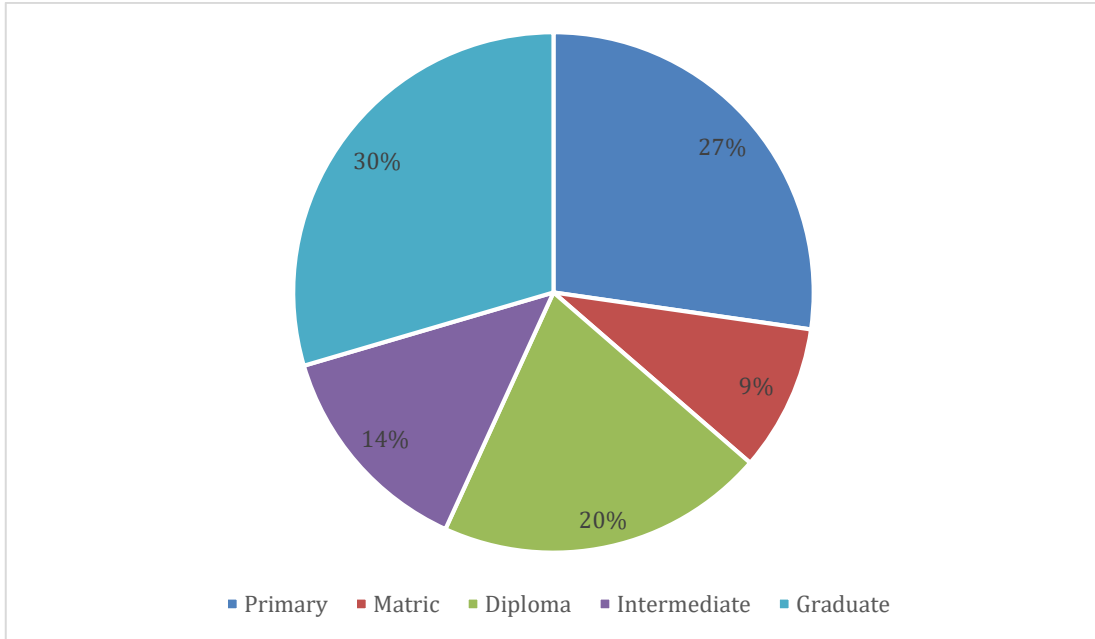


Figure 5: Education of respondents. Source: The researcher.

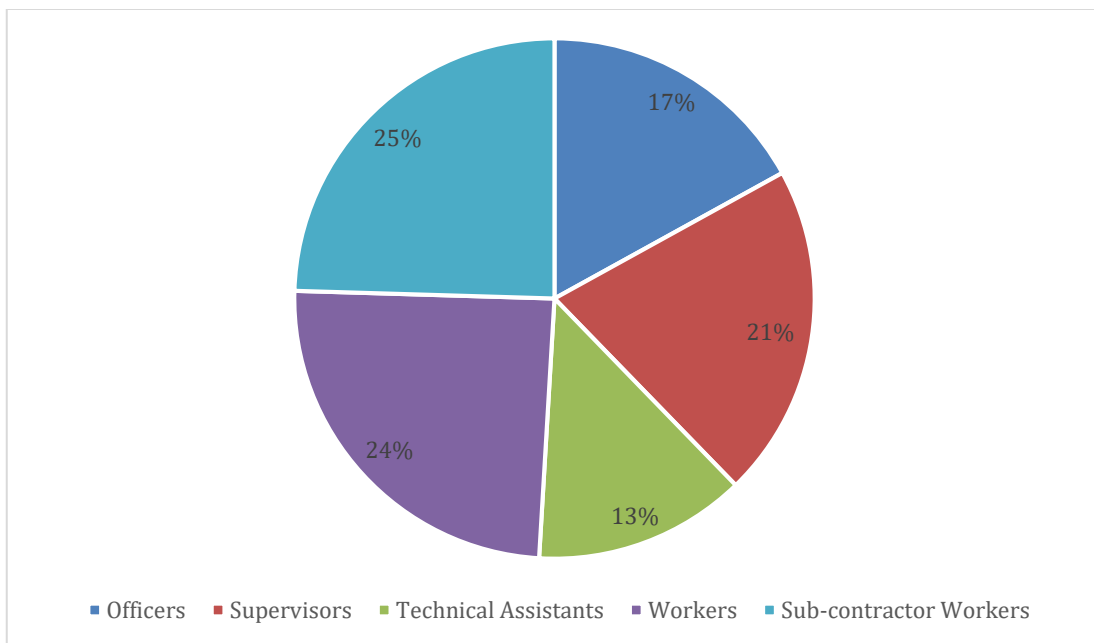
Table 2: Education of respondents of each job category. (Source: The researcher)

	Primary	Matric	Diploma	Intermediate	Graduate
Officers	-	-	-	-	9
Supervisors	-	-	3	5	3
Technical Assistants	-	-	6	1	-
Workers	10	3	-	-	-
Sub-contractor workers	2	1	-	-	1
<b>Total</b>	<b>12</b>	<b>4</b>	<b>9</b>	<b>6</b>	<b>13</b>

The educational levels reflect the skill and competency levels of the respondents. The result in fig-5 shows, the most common educational level among workers and sub-

contractors' workers was "primary and matric" with 36% respondents falling into this category. Table-2 indicates, supervisors and technical assistants, who often have more technical and supervisory roles, tend to have higher educational levels with 6 technical assistants and 3 supervisors hold diplomas while 1 technical assistant and 5 supervisors hold intermediate education certificate. 13 respondents reported having graduation degree, primarily consisting of all officers, 3 supervisors and 1 sub-contractor worker. The educational distribution indicated a hierarchy, with officers and supervisors having the highest educational qualifications, followed by technical assistants, and then workers and sub-contractor workers.

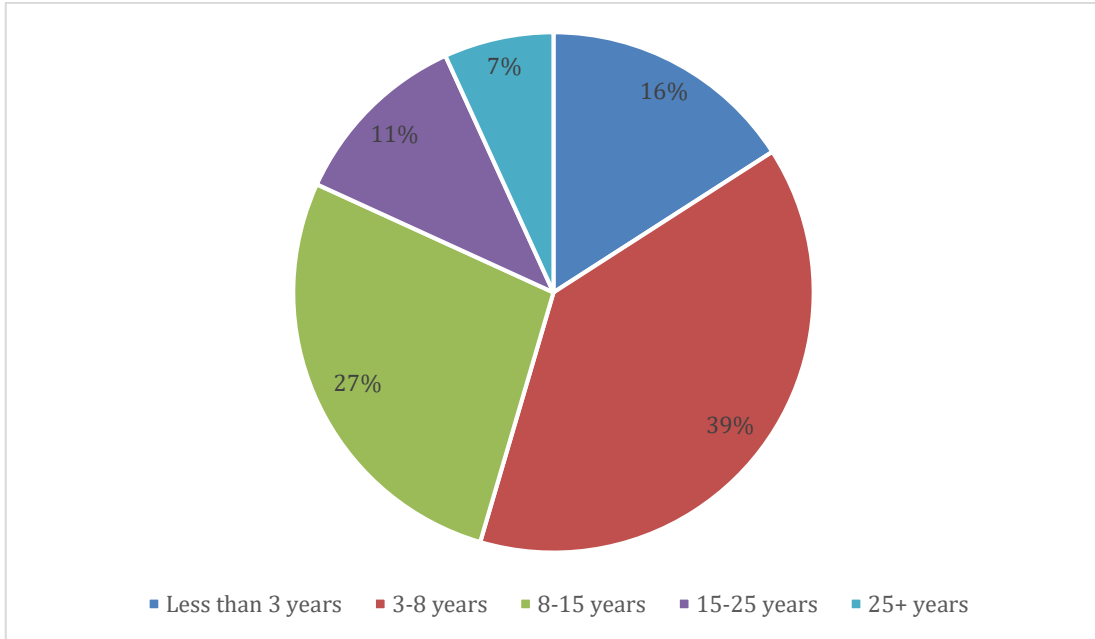
**Question 3: What is your designation?**



*Figure 6: Designation of respondents. Source: The researcher.*

As fig-6 shows designations of respondents included, 9 officers, 11 supervisors, 7 technical assistants, 13 workers, and 4 sub-contractors.

**Question 4: How many years of experience do you have?**



*Figure 7: Experience of respondents. Source: The researcher.*

*Table 3: Experience of respondents of each job category. (Source: The researcher)*

	Less than 3	3-8	8-15	15-25	25+
<b>Officers</b>	3	1	2	2	1
<b>Supervisors</b>	2	3	4	1	1
<b>Technical Assistants</b>	2	5	-	-	-
<b>Workers</b>	-	6	4	2	1
<b>Sub-contractor workers</b>	-	2	2	-	-
<b>Total</b>	7	17	12	5	3

The range of experience levels indicates expertise, decision-making, and risk assessment capabilities of individuals. As per fig-7, 16% respondents have less than 3 years of experience, with representation from officers, supervisors, and technical

assistants. These individuals are relatively early in their careers. The largest group of respondents 39% falls within the 3-8 years of experience bracket. This group includes individuals from approximately all job roles. They can be considered mid-career professionals. Respondents with 8-15 years of experience represent a substantial portion of 27%, suggesting a mix of roles and experience levels. A smaller group of respondents (5) has 15-25 years of experience, and an even smaller group (3) has over 25 years of experience. These individuals could be considered as veterans in shipyard.

**Question 5: Which language you are most comfortable with, in speaking, listening, writing and reading?**



Figure 8: Language of respondents. Source: The researcher.

The key findings dominance among respondents preferring Urdu language. The majority of workers and sub-contractor workers reported that they were most comfortable with the Urdu language. This indicated that Urdu is the preferred language of communication for a significant portion of the workforce. Though, a small number of respondents mentioned that they were prefer English language for communication.

These respondents mostly included officers and supervisors. Even minor number of respondents reveal that they were most comfortable with "other" languages. The specific languages were not provided, but this suggests that there were individuals who were more comfortable communicating in languages other than Urdu or English.

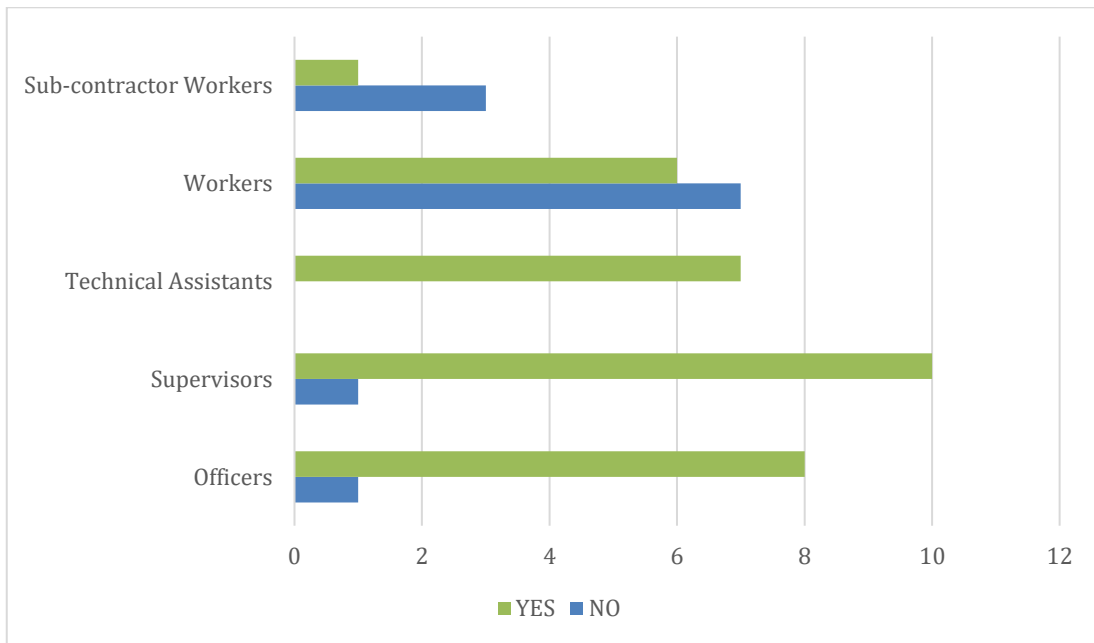
#### 4.2.2 Section B:

##### **Question 6: Which high-risk activities have you done or supervised?**

Respondents mentioned high-risk activities i.e., work at height, work in confined space, welding, Carrying Heavy Weight/Machinery, pipe pressure testing, block fabrication, brazing, crane operation, store management, Hull QC, painting, machinery outfitting, engine work, wiring, electrical work, pipe bending, electrical cable work, rigging, forklift operation, and painting. This demonstrated the wide array of tasks performed within the industry. These activities often require specialized training and proper handling techniques, skill, proper safety equipment, safety procedures and precautions due to the increased risk to prevent accidents and injuries.



**Question 7: Is there a procedure for risk assessment in place before carrying out high-risk activities? If yes, do you feel that the assessment is being done and the procedure are being followed properly?**



*Figure 9: Risk assessment procedure. Source: The researcher.*

Risk assessment helps in the prevention of accidents and incidents. By proactively identifying risks and implementing control measures, organizations can reduce the likelihood of accidents, injuries, and fatalities. Fig-9 indicated that a significant majority of respondents 73% reported that their organizations have a procedure for risk assessment in place before carrying out high-risk activities which indicated a commitment to safety and risk management within these organizations. Mostly, officers, supervisors and technical assistants, reported the presence of risk assessment procedures. While a notable number 27% indicated that their organizations do not have such procedures. Most of them included workers and sub-contractor workers, which is critical as they are directly involved in high-risk activities. This specified a potential gap in safety practices within a portion of the industry.

*Table 4: Rate of respondents of each job category following risk assessment procedure.  
(Source: The researcher)*

	Always	Often	Sometimes	Rarely	Never
<b>Officers</b>	1	4	2	1	-
<b>Supervisors</b>	-	4	5	1	-
<b>Technical Assistants</b>	1	2	3	1	-
<b>Workers</b>	-	2	3	1	-
<b>Sub-contractor workers</b>	-	-	-	1	-
<b>Total</b>	2	12	13	5	-

Among respondents who reported having risk assessment procedures, 44% reported that safety procedures are being followed at least "Often" or "Always" which is a relatively positive perception of safety practices within the industry. While, 56% responses of respondents indicate some level of concern, as they reported "Sometimes" or "Rarely" regarding the proper implementation of safety procedures which specified place for improvement in risk assessment and safety practices especially among workers and sub-contractor workers.

**Question 8: How often do you use work permit before carrying out any high-risk activities?**

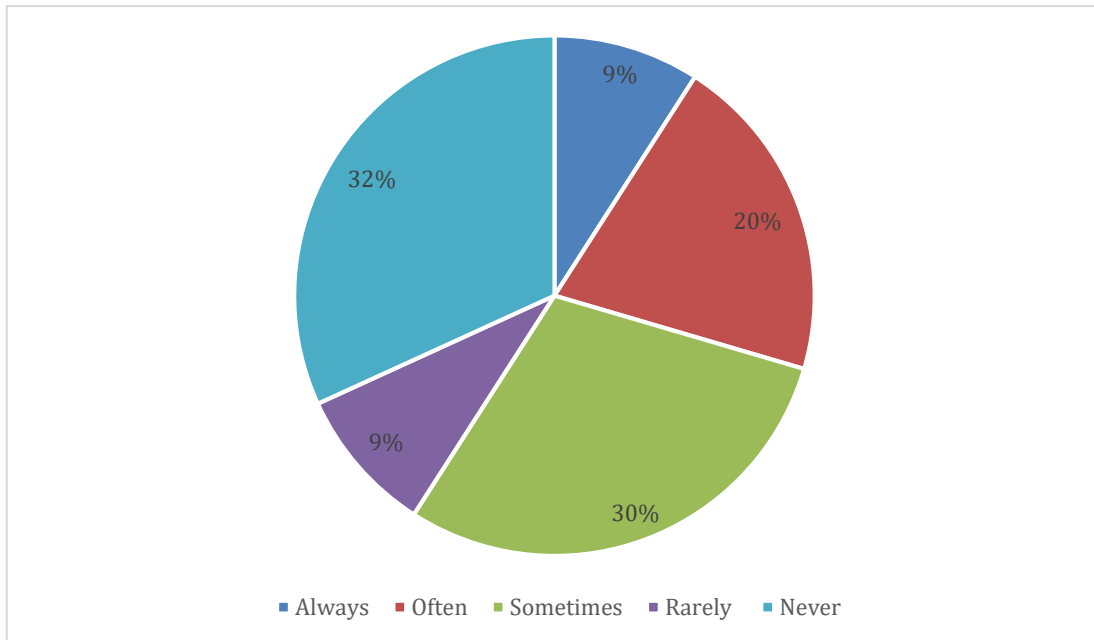


Figure 10: Use of work permit by respondents. Source: The researcher.

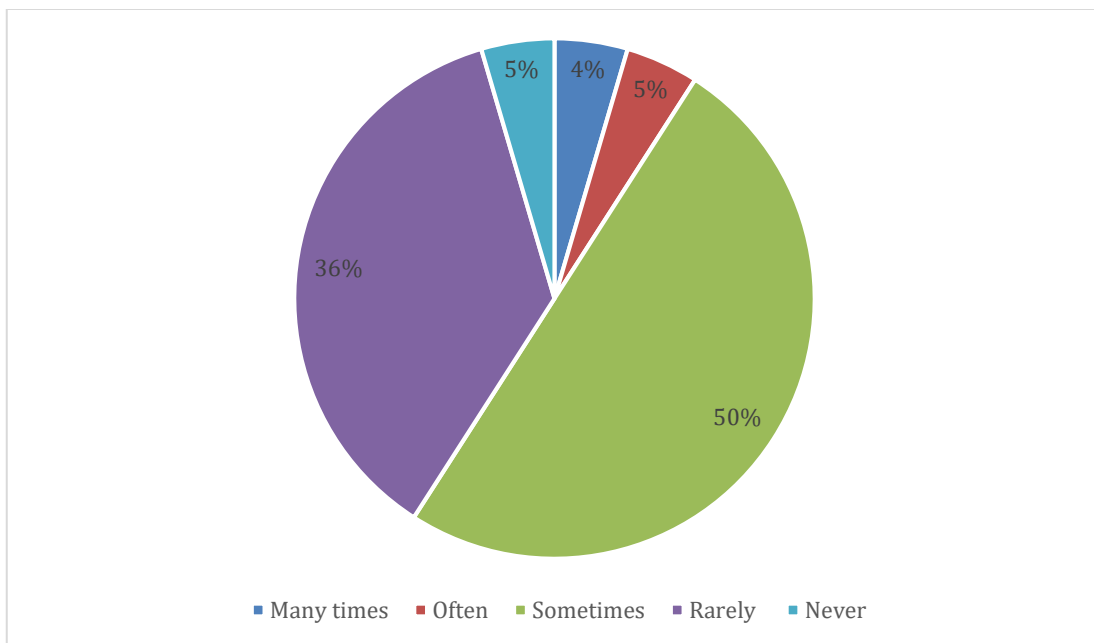
Table 5: Respondents of each job category using work permit. (Source: The researcher)

	Always	Often	Sometimes	Rarely	Never
Officers	2	1	3	2	1
Supervisors	2	4	2	1	2
Technical Assistants	-	4	3	-	-
Workers	-	-	3	1	9
Sub-contractor workers	-	-	2	-	2
<b>Total</b>	<b>4</b>	<b>9</b>	<b>13</b>	<b>4</b>	<b>14</b>

The primary purpose of a work permit is to ensure the safety of workers and the workplace. Work permits require a thorough risk assessment to be conducted before

work starts. Respondents reported varying levels of adherence to using work permits before engaging in high-risk activities. A significant portion of respondents 59% reported using work permits “sometimes, often, or always” before carrying out high-risk activities providing commitment to safety procedures. Most of them are officers, supervisors and technical assistants. However, 41% indicated that they rarely or never use work permits for high-risk activities. It's noteworthy that workers and sub-contractor workers were high in number among these. This raised concerns about the safety culture and practices among this group. Addressing this issue is critical for maintaining a safe work environment and preventing accidents and incidents.

**Question 9: How often have you witnessed any near miss at your workplace?**



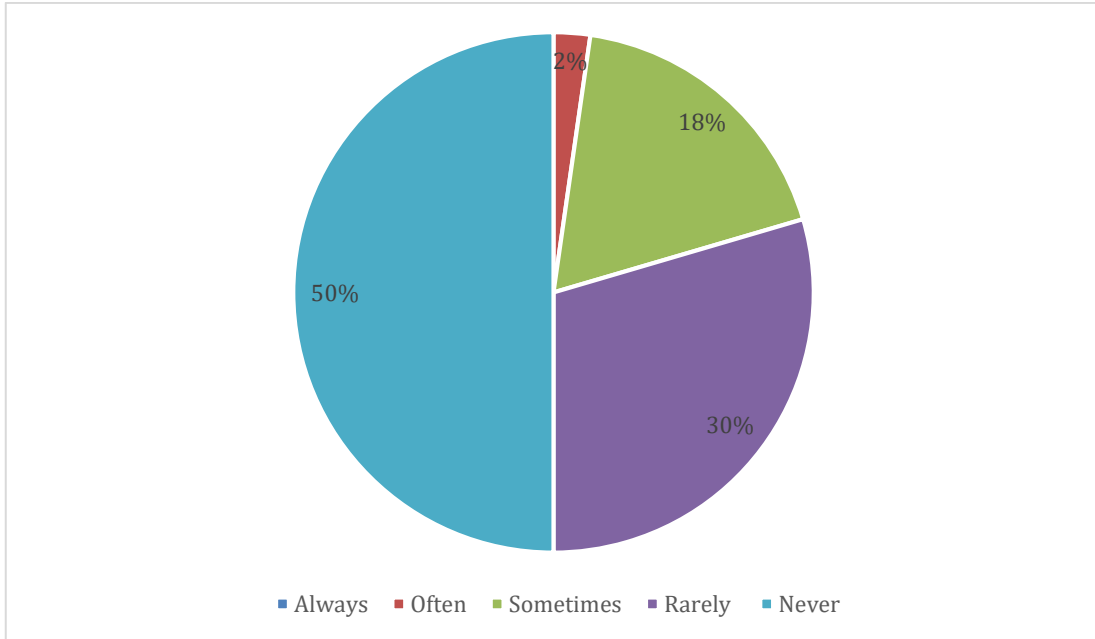
*Figure 11: Respondents witnessing near-miss at workplace. Source: The researcher.*

*Table 6: Respondents of each job category witnessing near-miss at workplace. (Source: The researcher)*

	Many times	Often	Sometimes	Rarely	Never
<b>Officers</b>	1	1	4	2	1
<b>Supervisors</b>	-	-	7	3	1
<b>Technical Assistants</b>	-	-	4	3	-
<b>Workers</b>	-	1	4	8	-
<b>Sub-contractor workers</b>	1	-	3	-	-
<b>Total</b>	2	2	22	16	2

The data in fig-11 reveals 95% respondents amongst various roles reported witnessing near misses in their workplace. The majority of respondents 50% reported that they witness near misses "Sometimes" which reveals that near misses are a relatively common occurrence in shipyard. It was worth noting that despite the relatively high frequency of near misses, only 5% respondents reported never witnessing a near miss. This might indicate underreporting of near misses. The data indicated that the frequency of witnessing near misses across workers and sub-contractor workers was more frequent than others which specified that those directly involved in the operations were more likely to encounter near miss situations. Individuals responsible for overseeing and supporting operations i.e., supervisors and technical assistants, were also not immune to such incidents. The findings also revealed a need for further investigation into the root causes of near misses, especially in roles where they are more common.

**Question 10: How often have you reported these near misses at your workplace?**



*Figure 12: Reporting of near miss at workplace. Source: The researcher.*

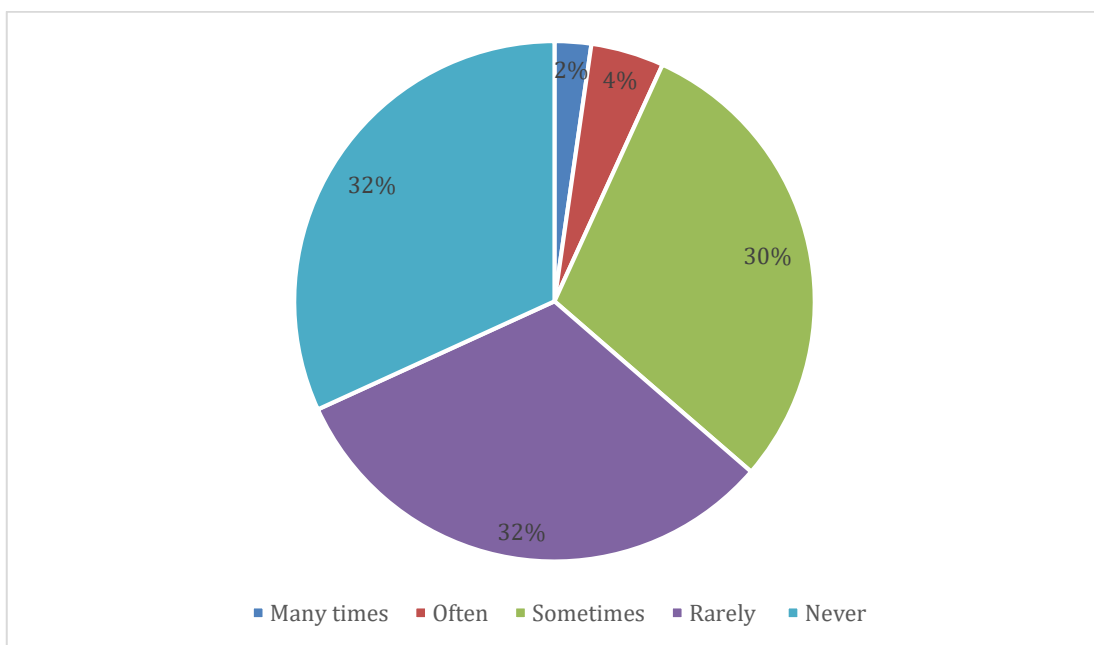
*Table 7: Respondents of each job category reporting near-miss at workplace. (Source: The researcher)*

	Always	Often	Sometimes	Rarely	Never
<b>Officers</b>	-	1	3	3	2
<b>Supervisors</b>	-	-	3	5	3
<b>Technical Assistants</b>	-	-	1	4	2
<b>Workers</b>	-	-	-	1	12
<b>Sub-contractor workers</b>	-	-	1	-	3
<b>Total</b>	-	1	8	13	22

This question is linked to the preceding question. The table-7 showed that a significant portion of the respondents 50% had never reported near misses at their workplace, seem a prevalent issue of underreporting near misses. The data further revealed that

underreporting is not limited to specific job roles. It was noteworthy that even officers, who were typically in positions of authority and responsibility, reported low levels of reporting. While some supervisors also indicated that they rarely or never reported them. The research highlights a potential lack of a reporting culture within the industry. This could be due to various factors, such as fear of consequences, lack of trust in the reporting system, inadequate reporting mechanisms, or perceived lack of responsiveness from management, etc.

**Question 11: How often have you witnessed any workplace accident? How severe were those accidents, with 5 being ‘very critical’ to 1 being ‘low level’?**



*Figure 13: Respondents witnessing workplace accidents. Source: The researcher.*

*Table 8: Respondents of each job category witnessing workplace accidents. (Source: The researcher)*

	Many times	Often	Sometimes	Rarely	Never
<b>Officers</b>	-	1	3	1	4
<b>Supervisors</b>	-	-	4	5	2
<b>Technical Assistants</b>	-	-	2	3	2
<b>Workers</b>	-	1	4	2	6
<b>Sub-contractor workers</b>	1	-	-	3	-
<b>Total</b>	1	2	13	14	14

While 1 respondent reported witnessing workplace accidents "Many times", a substantial portion reported having witnessed accidents "Often" or "Sometimes", revealed that workplace accidents are a relatively common occurrence in shipyard. 5 workers reported witnessing most of the workplace accidents stating often and sometimes, with 1 sub-contractor worker even stating that he had witnessed accidents "Many times". While officers and Supervisors generally reported lower frequencies, 4 officer and 4 supervisors did report witnessing accidents "Often and sometimes", which showed that even those in leadership roles were exposed to such accidents.

It could also be worth noting that a considerable number of respondents (14) reported never witnessed workplace accidents which could indicate underreporting of accidents. Findings also raised questions about investigation culture, which may warrant further examination and improvement.

Those who witnessed workplace accident were asked about severity level of the accident, fig-13 showed that the majority of respondents rated workplace accidents as having moderate to high severity. 70% respondents rated accidents severity level as 3, 4, or 5. Mostly workers and sub-contractor workers showed higher level of severity,

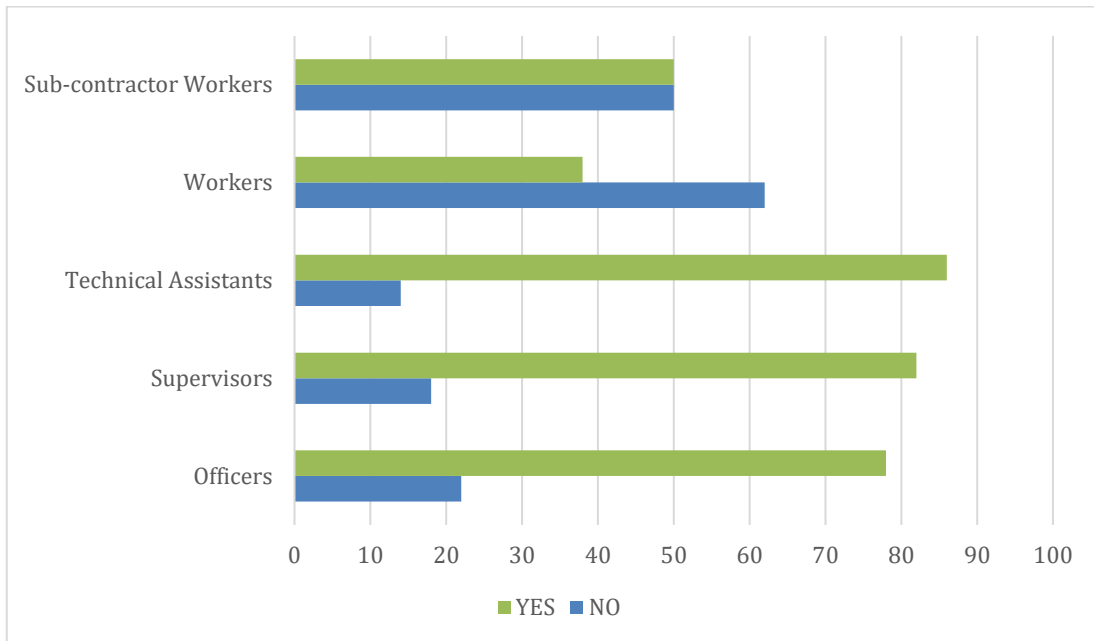


revealed that accidents can have a significant impact on those directly involved in workplace tasks. Further, 30% respondents also reported low severity ratings as “1 or 2”. The data underscores the importance of continuous safety improvement efforts within the industry to mitigate and prevent accidents, particularly those rated with higher severity levels.

**Question 12: Has any work accident that you saw or heard or happened with you that changed your morale?**

Respondents described various incidents where work accidents had a profound impact on their morale and safety awareness. These accidents served as eye-openers, leading to increased caution and awareness. One respondent mentioned an incident “a worker who, upon seeing a safety officer, became frightened and jumped from a fork lifter, resulting in an accident”. This incident highlighted the potential for fear or anxiety to influence worker behaviour and safety outcomes. Another respondent mentioned “I witnessed an incident when a worker working at height without PPE, leading to a fatal fall”. This incident made the respondent realize the critical importance of wearing PPE for safety. One respondent mentioned “he wore gloves because he got electrocuted once”, which served as a personal experience that changed their behaviour. “An accident occurred due to the careless attitude of a forklift operator” was mentioned by another respondent. Another respondent referred “a fire incident caused by the negligence of a worker”. One respondent witnessed “a worker got injured due to unstable scaffolding, resulting in a fracture”. This incident underscored the critical need for stable and secure working platforms in high-risk environments. These incidents likely raised awareness about the significance of attentiveness and responsibility. These emphasize the significance of fostering a strong safety culture within the industry.

**Question 13: Have you received any formal training in occupational safety and hazard identification or work-related injuries and accident prevention? If yes, please rate, how beneficial was the training, with 5 being ‘very much beneficial’ to 1 ‘not beneficial’?**



*Figure 14: Formal training received by respondents. Source: The researcher.*

Safety training and education within the industry is essential to equip employees with the knowledge and skills to identify and prevent hazards and work-related injuries and accidents. As the fig-14 indicates that a majority of respondents 66% have received formal training which demonstrates a positive commitment to providing employees with the necessary knowledge and skills to address safety issues. More or less, respondents from various job roles, have received formal training which indicated that training is not limited to specific positions and is provided across the organization. While the majority received training, there is a group of respondents 34% who reported not having received formal training in these areas. The data also indicates that a substantial number of workers and sub-contractor workers have not received formal training.

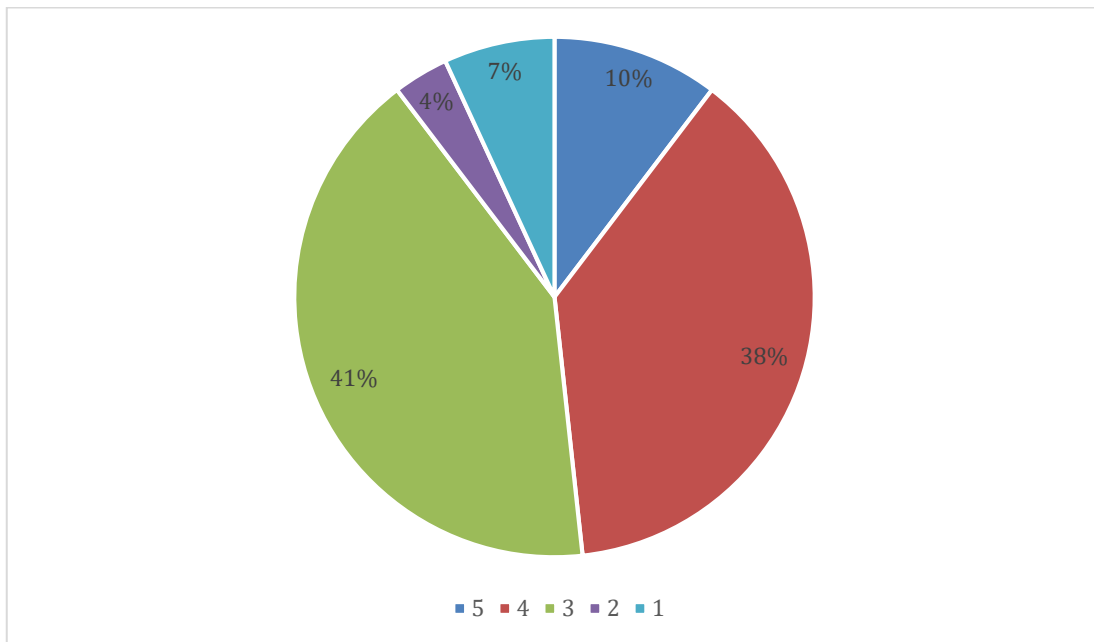


Figure 15: Respondent's rate of Formal training assessment. Source: The researcher.

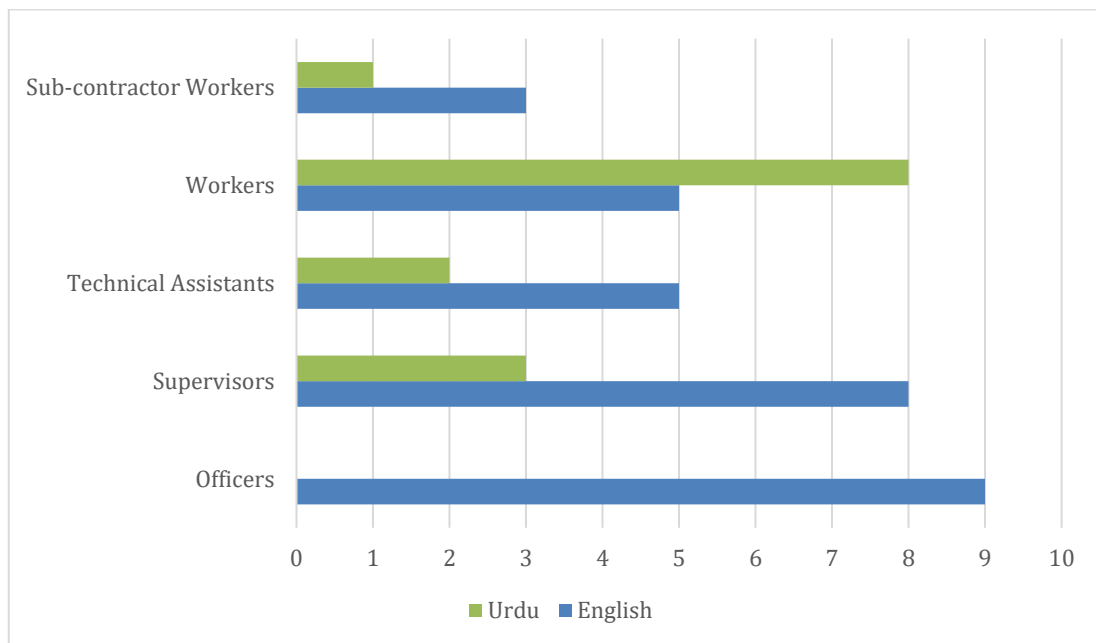
Table 9: Respondents of each job category rate of Formal training assessment. (Source: The researcher)

	5	4	3	2	1
<b>Officers</b>	2	3	2	-	-
<b>Supervisors</b>	-	4	5	-	-
<b>Technical Assistants</b>	1	2	3	-	-
<b>Workers</b>	-	1	2	-	2
<b>Sub-contractor workers</b>	-	1	-	1	-
<b>Total</b>	3	11	12	1	2

Overall, regarding the perceived benefit of training, the majority of respondents rated the training as beneficial, with a total of 48% respondents rating it as either "4" or "5" which indicated that a significant portion of those who received training found it to be valuable. While, there is still a group of respondents 52% who rated it as either "3" or lower which indicated that there may be room for improvement in the content,

delivery, or effectiveness of the training programs. Although 4 workers rated it as "3 and 1" indicating that they did not find the training much beneficial. The result highlighted the significance of tailoring training programs to meet the diverse needs and perspectives of all employees.

**Question 14 and 15: Which language is used in your organization for safety instructions, risk assessment and safety procedure? What is your level of understanding of this language, with 5 being ‘very high’ to 1 being ‘very low’?**



*Figure 16: Language used in organization. Source: The researcher.*

The most common language used for safety instructions, risk assessment, and safety procedures in the organization is English, with 30 respondents indicating its use, revealed that English is the primary language for safety-related communication. However, it is hard for many workers and sub-contractor workers to understand English as all workers and majority of sub-contractor workers preferred Urdu language. Most of these workers and sub-contractor workers responded that they have lower levels of understanding of English with rating their understanding as "2 and 1".

These individuals faced language barriers or challenges in fully comprehending and communicating in their preferred language.

**Question 16: Please specify, what factors according to you are involved in the occurrence of accidents.**

Inadequate oversight can lead to unsafe practices and behaviours going unchecked. Respondents highlighted the improper supervision as a factor in accident occurrence. The attitude and behaviour of workers was cited as contributing factor to accidents. An unsafe attitude, carelessness, or lack of awareness increase the risk of incidents. Some respondents mentioned that the pressure to work quickly due to the demands of the job contribute to accidents. Rushing through tasks lead to lapses in safety procedures. Moreover, workload and time constraints were identified as factors that make it challenging to complete tasks safely and on time. These conditions lead to shortcuts and increase risk. Additionally, the perception that some workers do not prioritize their own safety was mentioned. A respondent mentioned that some workers do not have a strong perception of risks associated with their tasks. The result highlighted absence of a safety culture and lack of safe system of work within the workplace.

4.2.3 Section C:

**Question 17: Please rate, the level of strictness of your management towards employees, with 5 being ‘very strict’ to 1 ‘not strict’?**

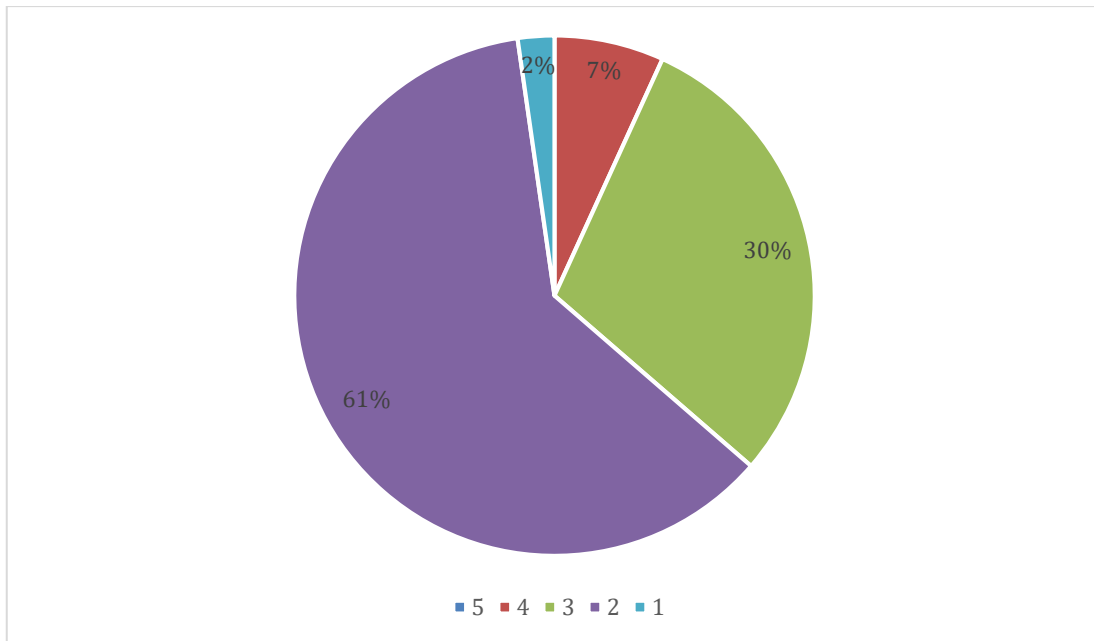


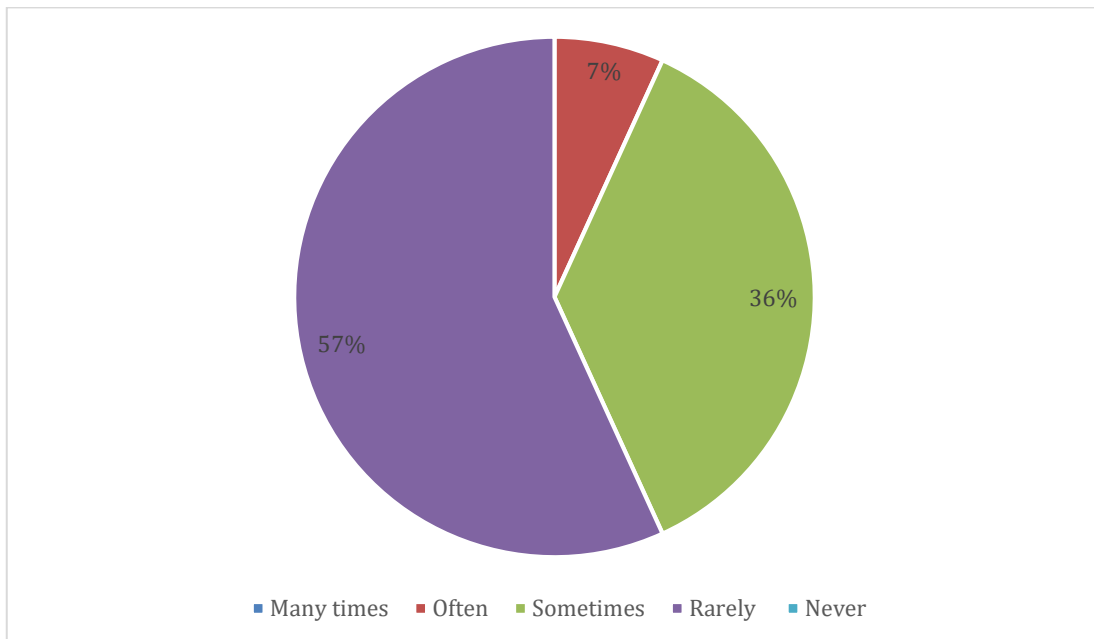
Figure 17: Level of strictness of management. Source: The researcher.

Table 10: Respondents of each category giving rate of level of strictness of management. (Source: The researcher)

	5	4	3	2	1
Officers	-	-	5	4	-
Supervisors	-	-	1	10	-
Technical Assistants	-	1	1	4	1
Workers	-	-	4	9	-
Sub-contractor workers	-	2	2	-	-
<b>Total</b>	-	3	13	27	1

The level of strictness in management can have a significant impact on workplace culture, and employee morale. Majority of the respondents 64% rated the level of strictness of their management as "2 and 1" indicating a moderate level of strictness. Variation in the perception of management strictness among different job roles was found. Officers, supervisors, technical assistants, workers and sub-contractor workers all provided different ratings, indicated that management approaches may vary across departments or positions. Officers and supervisors generally rated management as less strict, with a majority giving a rating of "2". While 36% perceived management as moderately strict, who rated it as "3" or higher. The research highlighted the balanced approach of management's authority.

**Question 18: How often have you been scolded by your senior when you are not at fault?**



*Figure 18: Respondents scolded by senior. Source: The researcher.*

Table 11: Respondents of each category got scolded by senior. (Source: The researcher)

	Many times	Often	Sometimes	Rarely	Never
<b>Officers</b>	-	-	4	5	-
<b>Supervisors</b>	-	-	2	9	-
<b>Technical Assistants</b>	-	2	1	4	-
<b>Workers</b>	-	1	5	7	-
<b>Sub-contractor workers</b>	-	-	4	-	-
<b>Total</b>	-	3	16	25	-

Creating a respectful and supportive workplace culture is essential for employee engagement and retention. The majority of respondents 57% reported being scolded "Rarely", revealed that for most employees, this was not a frequent occurrence. However, the presence of 43% respondents who reported being scolded either "Often or Sometimes" is noteworthy. This was mostly reported by workers and sub-contractor. Frequent scolding when not at fault have negative effects on employee morale, job satisfaction, and well-being. It may lead to stress and reduced job motivation. Addressing this issue is required to improve communication and conflict resolution within the workplace to create a more respectful and supportive environment for all employees.



**Question 19: How often do you think, the behaviour of management/ senior affects the work?**

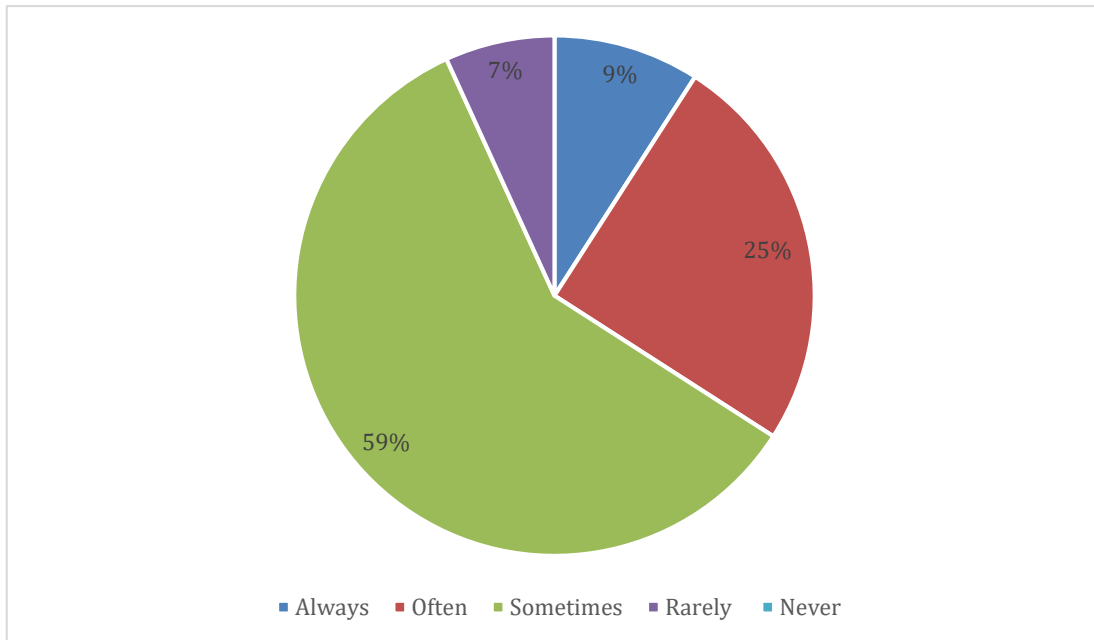


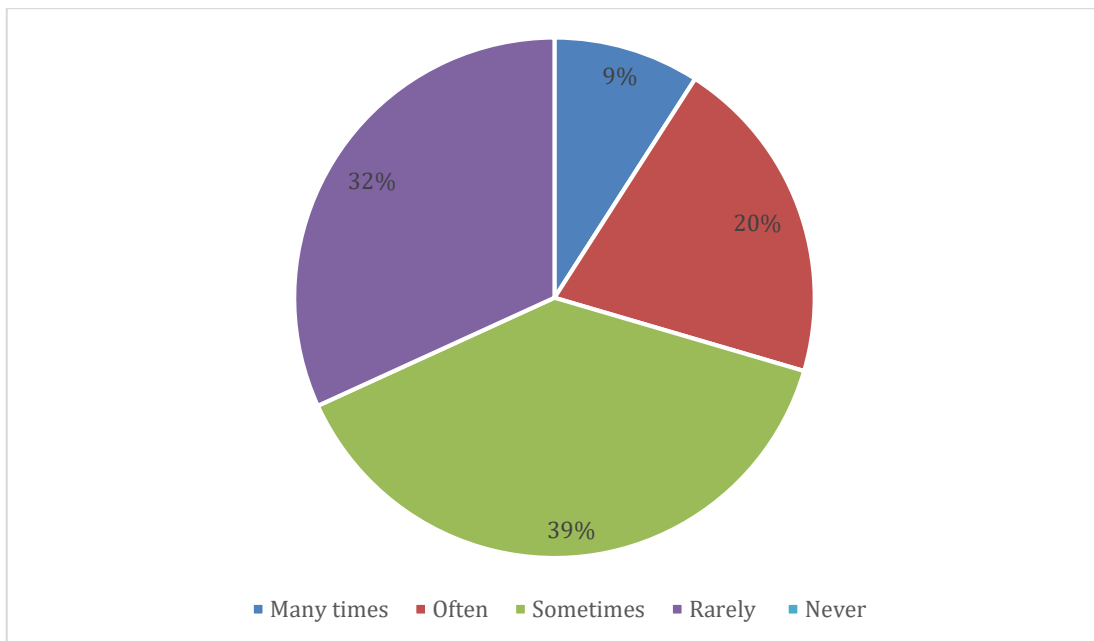
Figure 19: Work affected due to behaviour of management. Source: The researcher.

Table 12: Work affected due to behaviour of management a/c to respondents of each job category. (Source: The researcher)

	Always	Often	Sometimes	Rarely	Never
<b>Officers</b>	1	3	5	-	-
<b>Supervisors</b>	-	1	9	1	-
<b>Technical Assistants</b>	2	-	4	1	-
<b>Workers</b>	-	4	8	1	-
<b>Sub-contractor workers</b>	1	3	-	-	-
<b>Total</b>	4	11	26	3	-

A significant number of respondents (34%) believed that the behaviour of management or senior employees has an impact on their work which indicated that management behaviour was perceived as influential in the workplace. They see management as consistently playing a role in their job performance. While the majority of respondents (59%) believed that management behaviour sometimes affects their work. Further, there was a smaller number of respondents (7%) who believe that management behaviour rarely affects their work, there may be opportunities for management to better engage with employees and create a more supportive and collaborative workplace culture.

**Question 20: Does constantly growing work pressure at your work place affect your health?**



*Figure 20: Health affected due to work pressure. Source: The researcher.*

*Table 13: Health affected due to work pressure a/c to respondents of each job category.  
(Source: The researcher)*

	Many times	Often	Sometimes	Rarely	Never
<b>Officers</b>	-	2	5	2	-
<b>Supervisors</b>	-	2	4	5	-
<b>Technical Assistants</b>	2	-	2	3	-
<b>Workers</b>	-	3	6	4	-
<b>Sub-contractor workers</b>	2	2	-	-	-
<b>Total</b>	4	9	17	14	-

The result indicated that work pressure is a significant concern within the industry. A substantial portion of respondents (68%) perceived that constantly growing work pressure at their workplace affects their health, indicated “Many times or Often”. Approximately all categories of jobs reported work pressure affecting their health, with majority indicating "Sometimes". Consistently experiencing work pressure that affects health have various health implications, including increased stress, anxiety, and potential long-term health issues if not addressed.

**Question 21: How many times do you work for late hours?**

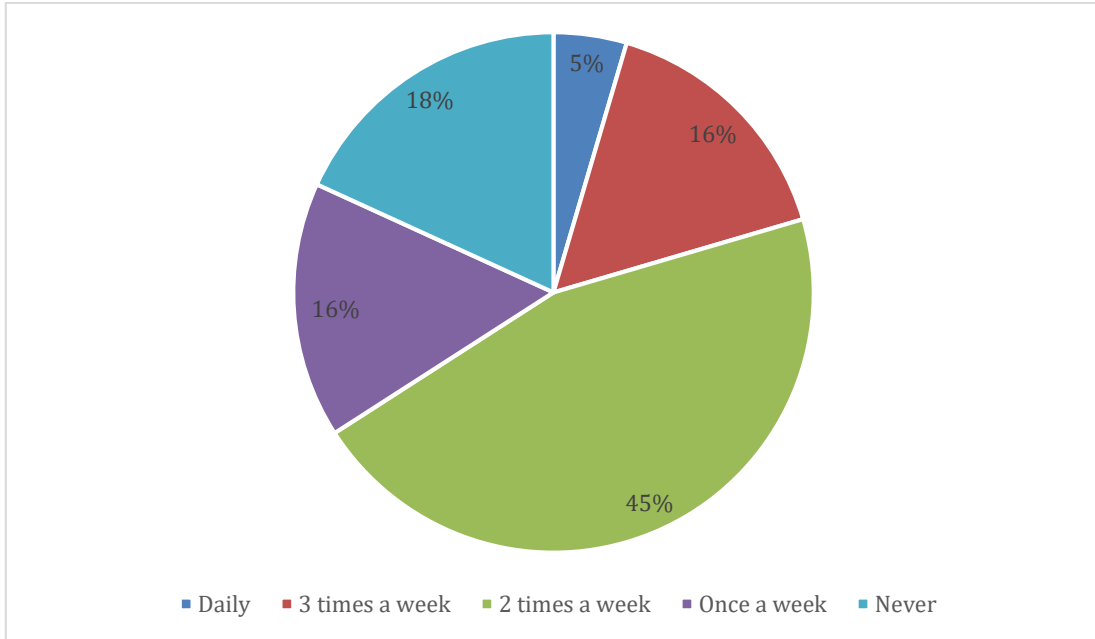


Figure 21: Working late hours. Source: The researcher.

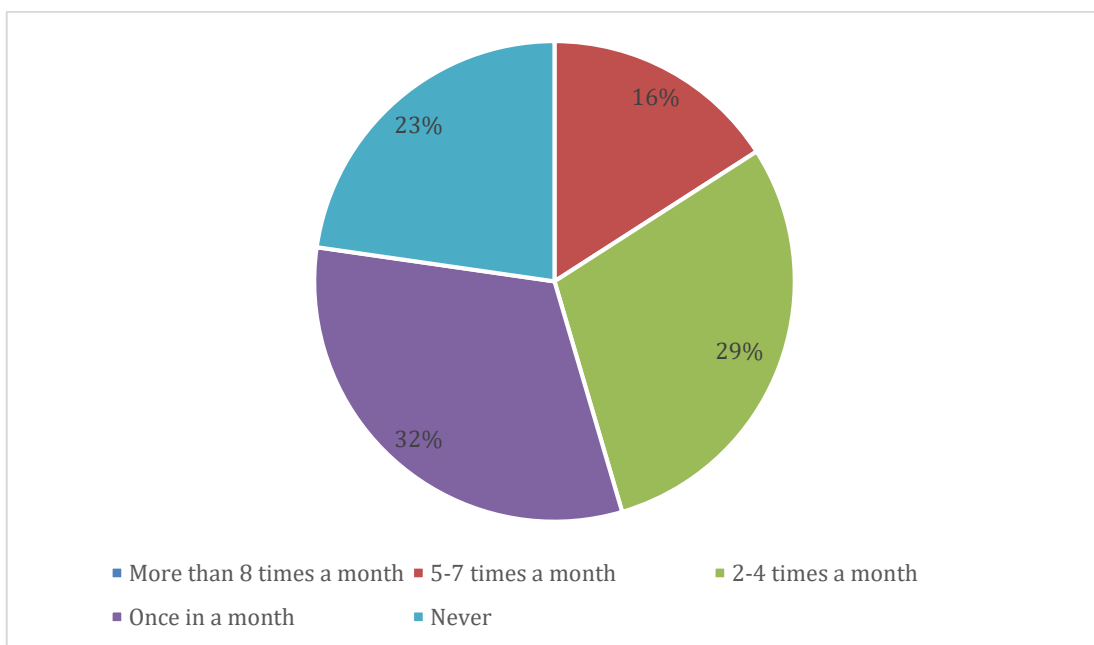
Table 14: Respondents of each job category working late hours. (Source: The researcher)

	Daily	3 times a week	2 times a week	Once in a week	Never
Officers	-	-	1	3	5
Supervisors	-	1	6	3	1
Technical Assistants	-	1	4	1	1
Workers	-	3	9	-	1
Sub-contractor workers	2	2	-	-	-
<b>Total</b>	2	7	20	7	8

A noteworthy finding is that a significant portion of respondents (20%) reported working late hours at least “three times a week or daily”. All Sub-contractor workers

were more likely to report working late hours, indicated the potential for challenging work conditions within this category of employees. Workers also reported working late hours more frequently. Frequent late hours impact employees' work-life balance, potentially led to increased stress and reduced personal time. Officers were less likely to work late hours, with the majority reporting working late either once a week or never. Addressing the factors contributing to this and finding ways to improve work-life balance is important for employee well-being and job satisfaction within the industry.

**Question 22: How often do you work on weekend / holiday?**



*Figure 22: Working on weekend/ holiday. Source: The researcher.*

*Table 15: Respondents of each job category working on weekend/ holiday. (Source: The researcher)*

	More than 8 times a month	5-7 times a month	2-4 times a month	Once in a month	Never
<b>Officers</b>	-	-	1	1	7
<b>Supervisors</b>	-	1	4	5	1
<b>Technical Assistants</b>	-	1	2	3	1
<b>Workers</b>	-	3	5	4	1
<b>Sub-contractor workers</b>	-	2	1	1	-
<b>Total</b>	-	7	13	14	10

The data shown in table-15 revealed that weekend and holiday work is relatively common within the industry. Apart, officers were less likely to report working on weekends or holidays, with a majority indicating that they never have to work during these times. While, Workers and sub-contractor workers exhibited a higher propensity to report engaging in regular work on weekends and holidays, with a significant number suggesting a frequency of 5-7 times per month. The results indicated the necessity of implementing efficient shift management strategies and task allocation in order to reduce the occurrence of weekend and holiday work, while still providing employees with sufficient opportunities for rest and personal time.

**Question 23: How often do you feel tired and sleepy during work?**

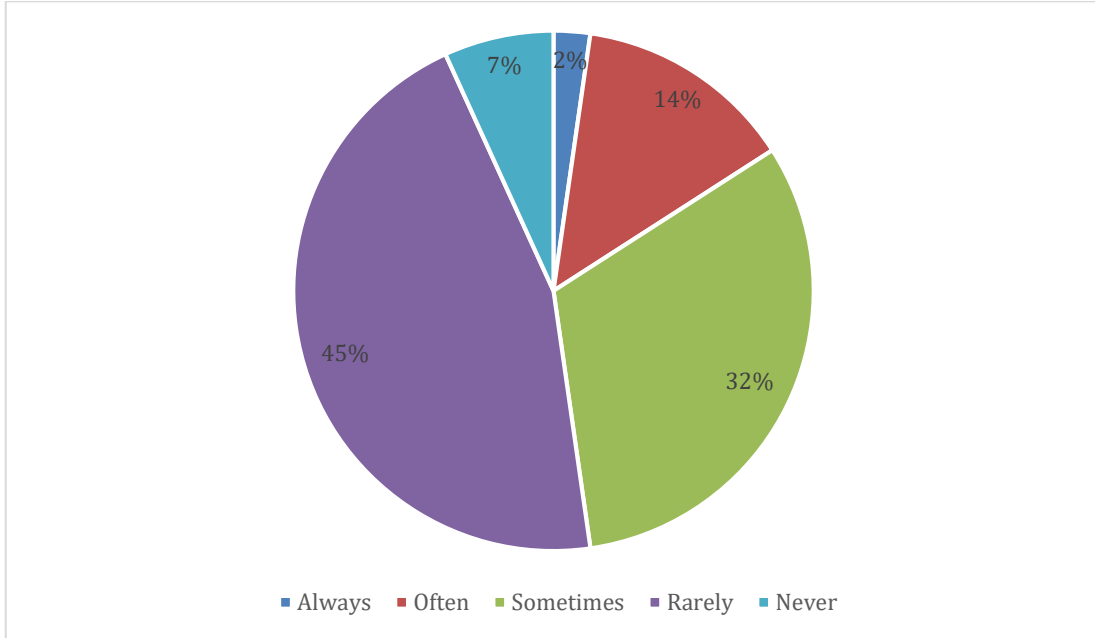


Figure 23: Respondents feeling sleepy during work. Source: The researcher.

Table 16: Respondents of each job category feeling sleepy during work. (Source: The researcher)

	Always	Often	Sometimes	Rarely	Never
<b>Officers</b>	-	1	1	6	1
<b>Supervisors</b>	1	-	3	5	2
<b>Technical Assistants</b>	-	2	2	3	-
<b>Workers</b>	-	2	5	6	-
<b>Sub-contractor workers</b>	-	1	3	-	-
<b>Total</b>	1	6	14	20	3

The prevalence of fatigue was seen among a substantial proportion of participants, 48% respondents reported diverse degrees of exhaustion and sleepiness during work which is a prevalent concern within the sector. Although some officers and supervisors reported rarely or never feeling tired and sleepy during work. While, fatigue during

work, have a high impact on workers and sub-contractor workers. Fatigue have a significant impact on work performance, leading to reduced productivity, increased errors, and potentially compromising safety in the workplace. Addressing fatigue is crucial for maintaining a safe work environment, as tired and sleepy employees may be at greater risk of accidents and incidents.

**Question 24: Do you feel stressed at home due to your job environment?**

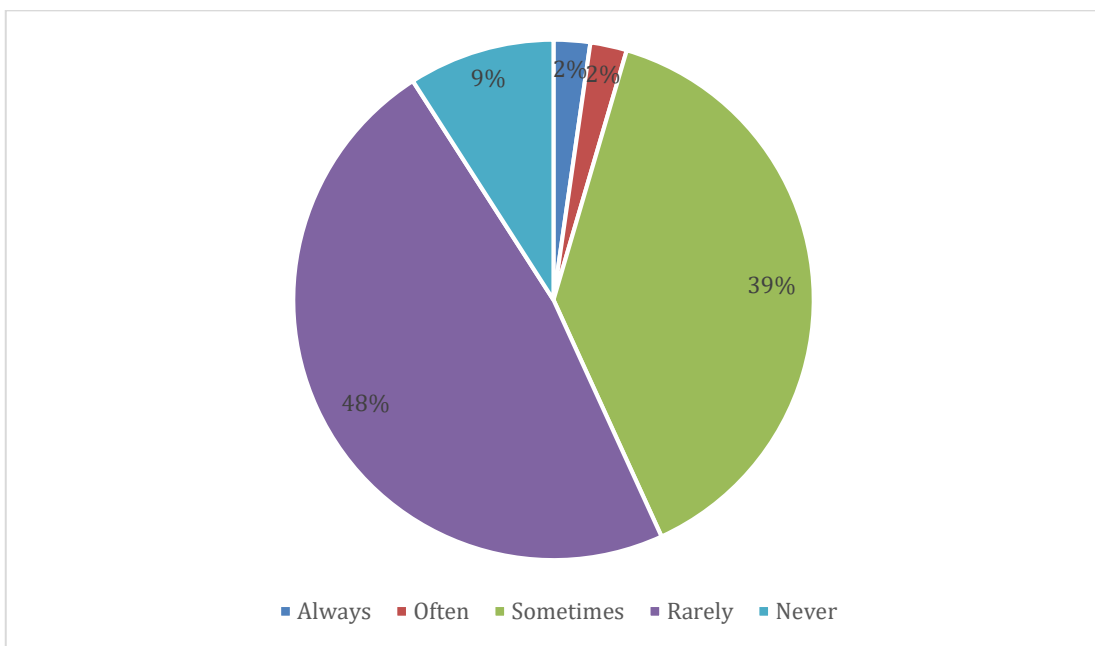


Figure 24: Feeling stressed at home due to work. Source: The researcher.

Table 17: Respondents of each job category feeling stressed at home due to work. (Source: The researcher)

	Always	Often	Sometimes	Rarely	Never
<b>Officers</b>	-	-	2	5	2
<b>Supervisors</b>	-	-	3	6	2
<b>Technical Assistants</b>	1	-	2	4	-
<b>Workers</b>	-	-	7	6	-



<b>Sub-contractor workers</b>	-	1	3	-	-
<b>Total</b>	1	1	17	21	4

Negative work environment can spread fatigue into personal lives. Result in fig-24 revealed that stress at home was a concern for employees across different job roles within the industry. The majority of respondents reported experienced stress at home to some degree. Work-related stress at home can have a significant negative impact on employees' work-life balance, potentially leading to strained personal relationships and reduced well-being. Although, it was worth noting that 57% individuals were better able to maintain a healthy work-life balance reported never feel stressed at home due to their job environment.

**Question 25: Please specify, what do you think about work related stress?**

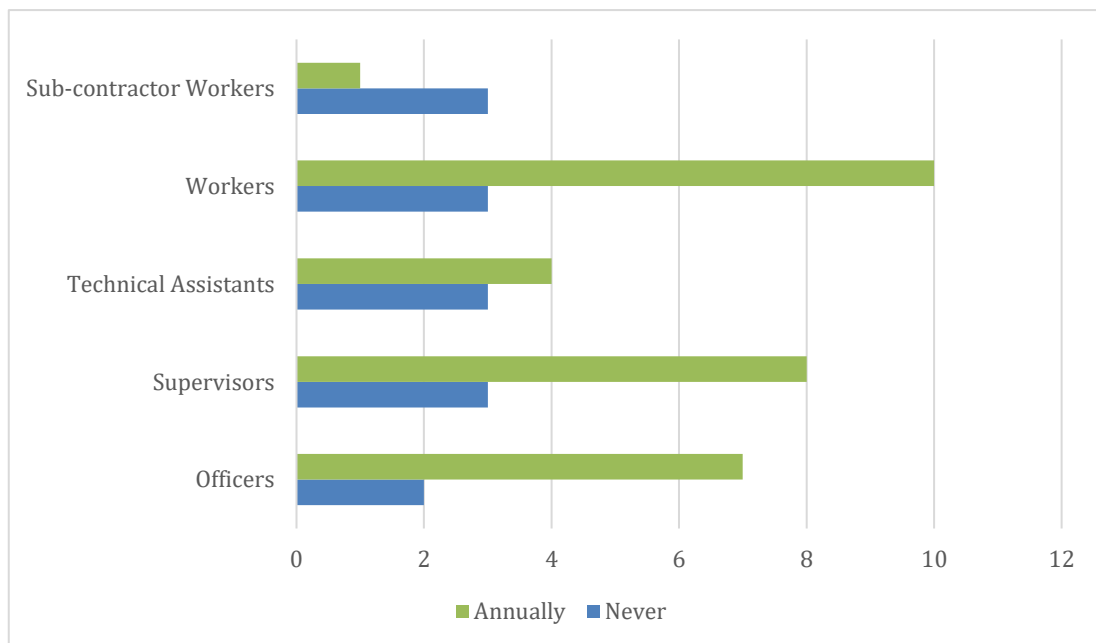
Respondents mentioned that the harsh work environment and physical demands of the job led to stress and fatigue. Some respondents attributed work-related stress to the behaviour of senior employees or supervisors. One respondent mentioned that work pressure is causing sleep disturbance. High levels of work-related stress affect sleep quality and overall well-being. The timing of work and strict adherence to schedules were mentioned as factors that can lead to stress. Rigorous time constraints increase the pressure on workers. Workload was identified as a significant factor contributing to stress. Heavy workloads and tight deadlines create pressure and stress among employees. Some respondents noted that shipyard work is inherently hard, and this is the reason of physical and mental strain. Further, favouritism or unfair treatment shown by senior employees towards certain individuals or groups was identified as a source of stress. This created tension and a sense of unfairness among workers. Moreover, working in extreme environmental conditions, such as high humidity and high temperatures, for long hours was also cited as a source of stress. A respondent mentioned that stress induced when workers perceive that adequate risk controls are

not in place for hazardous tasks. These lack of safety measures can lead to anxiety and stress.

**Question 26: Have your organization provided you with any recreational facilities on your free time, e.g., fun activities, games, sports etc.?**

Leisure activities contribute to stress reduction, relaxation, and overall job satisfaction. The result indicated that the vast majority of respondents (100%) reported that their organizations have not provided them with any recreational facilities for their free time. The absence of recreational facilities was consistent across different job roles within the industry and no respondents in the survey reported having access to such facilities. It can be said that, in general, industry may not prioritize or invest in recreational activities or facilities for employees.

**Question 27: Do your organization conduct motivational sessions?**



*Figure 25: Motivational sessions in organization. Source: The researcher.*

Motivational sessions have a positive impact on employee engagement, job satisfaction, and overall well-being. These sessions are an opportunity for organizations to boost morale and motivation of employees. Fig-25 indicates that 68% respondents reported that their organizations conduct motivational sessions, typically on an annual basis which showed that organization invest in motivating and engaging with considerable portion of employees through such sessions. However, 32% respondents specified that their organizations do not conduct such sessions in which majority are sub-contractor workers. It indicated the room for improvement in organization to introduce or enhance motivational programs.

**Question 28: How much does the organization takes care of your psychological wellbeing?**

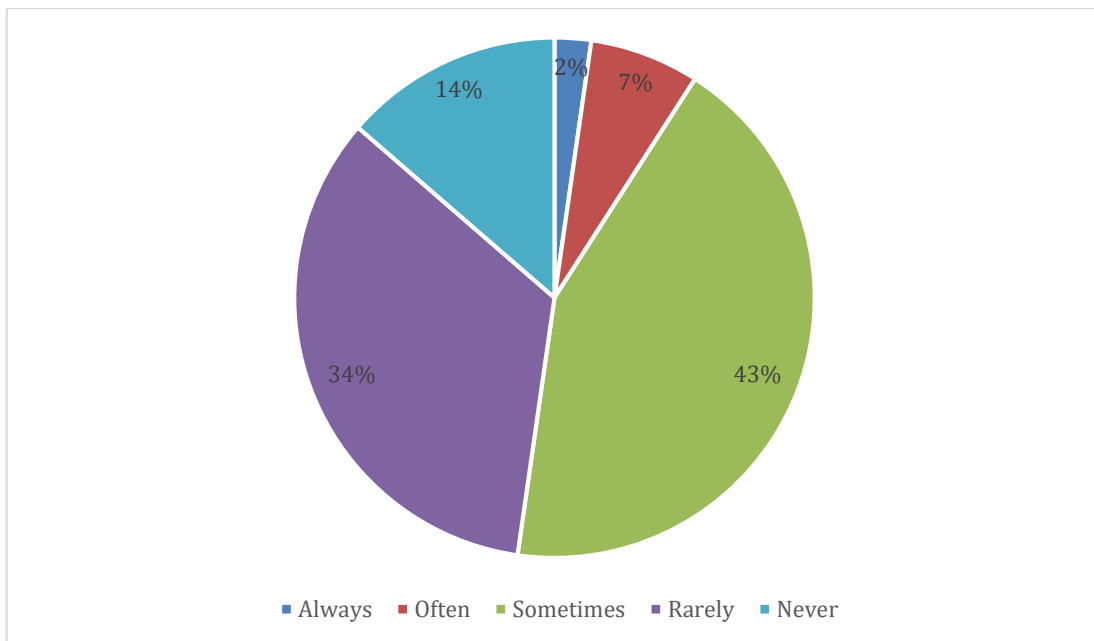


Figure 26: Care of psychological well-being by organization. Source: The researcher.

*Table 18: Respondents of each job category giving rate of care of psychological well-being by organization. (Source: The researcher)*

	Always	Often	Sometimes	Rarely	Never
<b>Officers</b>	1	-	5	1	2
<b>Supervisors</b>	-	2	3	5	1
<b>Technical Assistants</b>	-	-	3	3	1
<b>Workers</b>	-	1	8	3	1
<b>Sub-contractor workers</b>	-	-	-	3	1
<b>Total</b>	1	3	19	15	6

The data revealed mixed perceptions among respondents regarding how well their organizations take care of their psychological well-being. 9% respondents indicated that their organizations always or often take care of their psychological well-being which indicated that certain employees feel well-supported in terms of their mental health. A substantial portion of respondents (43%) reported that their organizations sometimes take care of their psychological well-being which showed while some efforts are made, there is room for improvement in providing consistent support. A total of 50% respondents expressed concerns about the level of care for their psychological well-being reported "Rarely and "Never. This indicated that a notable number of employees feel that their mental health needs were not adequately addressed.

**Question 29: Please add any comment on your psychological wellbeing in your organization.**

Some respondents expressed the perception that shipyard do not adequately address or care about their psychological well-being. This indicated a gap in addressing mental health and well-being within the workplace. Some respondents expressed a desire for

sessions or programs focused on psychological well-being. They see the value in addressing mental health issues and promoting a healthier workplace. A few respondents mentioned that shipyard appreciates psychological well-being during safety reviews. While, some noted that there was no adequate systems or processes in place for addressing psychological issues within their organization. This led to unaddressed concerns and challenges related to mental health.

#### 4.2.4 Section D:

**Question 30: Please provide additional information or suggestion related to your work which you feel is essential for reducing the number of accidents.**

Respondents recommended the implementation of a system of rewards and punishments to promote safe behaviours and discourage unsafe practices. Such systems motivate employees to prioritize safety. Understanding the issues and concerns of workers was highlighted as essential by a respondent. Effective communication between management and workers can lead to better safety outcomes by addressing worker needs and concerns. Further, minimizing work hours or optimizing work schedules to reduce fatigue and stress was suggested. Proper risk assessment was emphasized as a crucial step in accident prevention. Building a strong safety culture that prioritizes safe behaviours and practices at all levels of the workforce within the organization was recommended. Continuous meetings between top management and lower-level employees were suggested to promote understanding and problem-solving. Open communication channels help address safety concerns effectively. Respondents mentioned the importance of working with proper focus and attention to detail. Distractions or lack of focus can contribute to accidents, making concentration a critical factor in safety. A respondent mentioned, seniors and supervisors should not add unnecessary tension to workers and support stress-free work environment that contribute to safer working conditions. Respondents also recommended enhancing and updating training sessions to handle tasks safely and stay

informed about best practices. Adequate supervision was mentioned as crucial for accident prevention.

### 4.3 Summary

This chapter presents the findings from responses through survey questionnaire. The survey aimed to assess employee perceptions, experiences, and concerns related to human factors in shipyard. The results clearly showed the presence of various human factors which increases the risk of accidents in shipyard. This suggested that there is a need for effective and practical measures for reducing impacts of human elements in shipyard. Addressing these human factors through targeted interventions, training, and cultural changes will be instrumental.

## Chapter 5 Analysing Human Factors using HFACS

When authorities conduct an investigation of an accident, they generate a report called the "accident investigation report". The process of investigation is quite complicated in shipbuilding sector of Pakistan. For each accident, a new investigation committee is constituted. This investigation committee compile all available data about an accident and prepare accident investigation report which consist of comprehensive examination of the accident and its investigation, descriptions of those injured or fatally affected, details regarding witnesses, findings of the accident, assessment of damage and loss, and recommendations for improving safety. However, they mostly only focus on the direct causes of accident because they are the most apparent, straightforward and easy to examine while indirect causes, such as employee training, management flaws, etc., are often overlooked because they are more difficult to identify.

The literature indicates that there has been sufficient research conducted on the identification of human factors using HFACS method and numerous research findings have further explained underlying factors, including structural difficulties related to human factors and their impact on risky behaviour. HFACS can be considered a highly effective instrument for investigating the underlying factors of an accident, as it allows for a comprehensive and logical classification of these factors within a well-defined framework. Researcher conducted a study to examine human factors of 20 accident investigation reports of shipbuilding yard of Pakistan using the modified HFACS model. The factors involved in accident were classified and counted (Appendix 3), and the results are shown in Table 19.

Table 19: Exploration of human factors of 20 accidents investigation reports. (Source: The researcher)

External factors	2 (10%)
Regulatory factors	1 (5%)
Economic / Political / Social / Legal / Environmental factors	1 (5%)
Organizational Influences	19 (95%)
Safety Culture	15 (75%)
Resource Management	6 (30%)
Organizational Process	11 (55%)
Unsafe Supervisions	14 (70%)
Inadequate Design Work	6 (30%)
On-site Management Defects	11 (55%)
Supervisory Violations	10 (50%)
Preconditions For Unsafe Acts	16 (80%)
Status of Operators	10 (50%)
Adverse psychological state	8 (40%)
Adverse Spiritual state	0
Adverse physiological state	2 (10%)
Skill underutilization	2 (10%)
Tools and equipment	8 (40%)
Design defects	6 (30%)
Improper use and operation	6 (30%)
Physical environment	2 (10%)
Unsafe Acts	20 (100%)
Errors	19 (95%)
Perceptual Errors	7 (35%)
Decision Errors	11 (55%)
Skill-Based Errors	8 (40%)
Violations	8 (40%)



## 5.1 Analysis

Totally 121 contributing factors are retrieved from 20 reports with the use of the modified HFACS framework as the result is illustrated in Appendix-3. Result shows the involvement of human factors in the significant number of accidents.

Unsafe acts are consistently cited as a primary contributor to every accident report. Unsafe actions are the final line of defence in the HFACS model, and if they are crossed, accidents can no longer be avoided. Unsafe acts encompass both violations and errors. Most accidents occurred due to errors, mainly decision errors (55%), employees of the yard were often too hesitant to take decision or mostly actions that were not appropriate for the situation, resulted in accidents. Perceptual errors (35%) are also identified, which are mainly due to lack of situational awareness, in which employees did not perceive risk, until it is too late to act. Further, 40% reports mentioned skill-based errors, which included, lack of professional experience and tendency to work in risky environment and poor decision-making in applying skills or knowledge.

16 of the 20 accident investigation reports reveals Preconditions for unsafe acts. Accidents that are associated with these conditions involved, degradation of machine defects because of not doing maintenance on time, employees not taking any assistance regarding work and overlooked safety aspects, behavioural issue, operator negligence or carelessness, absence of mind during work, working in noisy environment or outdoor hazardous environment, etc.

At the level of unsafe supervisions in which 70% factors are involved, lack of proper supervision or ineffective management at the worksite, violations of safety protocols by supervisors, supervisor not aware of machinery and ignoring maintenance, supervisors unable to identify and control hazards, inappropriate planning, miscommunication with employees, supervisors not able to identify adequate training

that workers require, improper handling of work, and violations of Safety Management System, were identified as the underlying factors for accidents.

Organizational influences have also very high percentage, mentioned in 19 reports. Lack of safety culture was issue found in almost every report. Employees ignoring personal safety precautions, not clearing area when doing hazardous activity, not utilizing work permits, were the factors found in reports. Further inadequate maintenance associated to resource management was a prevalent issue, insufficient training, workload, absence of safety programs, procedures and instructions and not getting proper information due to error in channel were also found in the reports. Administration should take proactive action against this reckless behaviour of individuals.

Less number of accidents were attributed to external factors which include circumstances beyond the control of the organization or individuals, that is, hot weather and windy environment.

These factors impact and influence individual performance, impact their ability to work safely and can undermine safety efforts. It is a big challenge for the authorities to improve these conditions. In order to lessen the effect of these factors, the management of the shipyard should monitor properly on-field work activities and help employees manage and control errors.

## Chapter 6 Conclusion and Recommendations

### 6.1 Conclusion

Addressing human factors and promoting a supportive work environment that prioritizes employee's well-being is crucial for maintaining a healthy and productive workforce in shipyards.

The researcher utilised quantitative survey approach to address the first part of the research question and meet the research aims, which is to identify the presence of human factors in the Shipyard of Pakistan. The study demonstrates that human factors have a significant impact on the employees, which in turns increases the risk of accidents. Employees in this yard often face hazardous conditions, including handling heavy machinery, working at height, and onsite exposure to harsh weather conditions. The aforesaid issues prevail mostly within shipyard workers and sub-contractor workers, they are highly affected because they are directly involved in the operational tasks. The result reveals that they neither utilize their work permit frequently nor every worker received formal training or those who perceived training are not satisfied with it. The further finding of the research reveals that language is also a barrier for workers, as they cannot understand English; the language in which most procedures and instructions are written. Additionally, workers and sub-contracted workers report incidents of being frequently scolded and engaging them in regular work for late hours, even on weekends and holidays. This could have a negative effect on employee's morale and may lead to stress and reduce job motivation.

Further it is identified, that there is an issue of underreporting of near misses that has been observed across all the different job roles. Moreover, this research finds that work pressure among employees could be a potential cause of stress, anxiety, and long-term health issues. The result also indicates that the occurrence of fatigue can be due to excessive working hours and lack of sleep. Further finding shows that harsh work environment, workload, strict timing, working in high temperatures, unsafe and

careless attitude, lack of risk perception and favouritism or unfair treatment shown by senior employees is a source of stress. The researcher perceives that the absence of leisure activities could be one of the contributing factors that impact employee well-being and job satisfaction. It is also estimated that mental health needs are not adequately addressed and organization does not effectively care about employee's psychological well-being.

According to the literature, the modified HFACS model framework is used for many accident investigations. Though, to address second part of the research question, researcher uses modified-HFACS framework to analyse investigation reports of 20 accidents. The content of each report is statistically examined and the underlying factors of accidents are attained from five different aspects i.e., organizational factors, external factors, unsafe supervision, unsafe acts and the precondition of unsafe acts. Nevertheless, it is important to consider that the prevention of accidents is the prime responsibility of the organization, rather than solely relying on the individual actions of the employees. To put it simply, even if the laws are precisely crafted, their efficacy could be rendered null if the industry fails to comply or least-engaged in the regulatory process. Based on the above findings some recommendations are suggested that could be taken into account in the future policy amendments of the organization.

## 6.2 Recommendations

The principal recommendations for shipyard are:

- Investment should be made in training and enforcement mechanisms, tailoring training programs and feedback mechanism should be enhanced to continuously improve it to meet the diverse needs and perspectives of all employees.
- Proactive reporting system may be established to create awareness programs and to educate the employees on the importance of workplace safety and near-miss reporting.

- The organization may provide multilingual safety materials to mitigate the miscommunication resulting due to language barriers.
- Communication skills and conflict resolution programs may be introduced among the employees and management to create a harmonize and supportive environment within the organization.
- Workload management strategies can be adopted to reduce the workload of the employees by outsourcing labour or creating part-time job opportunities.
- The organization may adopt fatigue management strategies, that involves proper scheduling, breaks, and ensuring that employees get adequate rest time, necessary for the well-being of the employee and to maintain a work-life balance.
- The organizations can adopt HFACS investigation method to identify factors involving in the accidents and investigations should be conducted by competent and well-trained investigators.

### 6.3 Limitations and Future Research

It is important to acknowledge that no study can be considered flawless or encompass all potential aspects. Nonetheless, certainly this research study also has several shortcomings.

It is noteworthy that prior research on human factors in Pakistan was insufficient, without any investigations specifically addressing this topic. Consequently, this study represents the inventive research effort in this particular domain inside Pakistan, commencing from its inception. This work can serve as a reference for future researcher with the aim of offering comprehensive information and analysing the gap.

Furthermore, the process of collecting data through the survey questionnaire was very challenging keeping in view the confidential ethics of shipyard. Physical and geographical distance, limited time and security settings of shipyard have played a

crucial role in the collection of the questionnaires manually that could be filled digitally. This could be considered as a limiting factor when interpreting the findings. Moreover, the increase in number of participants would definitely increase the strength of the paper.

Lastly, the researcher determines the involvement of human factors in the Shipyard of Pakistan but did not compare the results with other shipyards in the world as it is difficult to cover other shipyards within limited time frame. Whereas, the comparison of shipyards for the respective area can help research results in identifying different scenario and solutions.

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## Appendices

### Appendix 1: Survey Questionnaire

**Describe yourself:** اپنی معلومات بیان کریں:

1. What is your age? آپ کی عمر کیا ہے؟  
 Below 20 کم سے کم  20-30  30-40  40-50  50+

2. What is your education level? آپ کی تعلیمی سطح کیا ہے؟  
 Primary بنیادی  Matric میٹرک  Diploma ڈپلوما  Intermediate انٹرمیڈیٹ  
 Graduate گریجویٹ

3. What is your designation? آپ کا عہدہ کیا ہے؟  
 Officer افسر  Supervisor سپروائزر  Technical assistant ٹیکنیکل اسسٹنٹ  
 Worker ورکر  Sub-contractor worker سب کنٹریکٹور ورکر

4. How many years of experience do you have? آپ کے پاس کتنے سالوں کا تجربہ ہے؟  
 less than 3 کم سے کم  3-8  8-15  15-25  25+

5. Which language you are most comfortable with? آپ کو کونسی زبان سب سے زیادہ آسان لگتی ہے؟

Speaking بولنے میں  
 Urdu اردو  English انگریزی  Turkish ترکی  Mother tongue مادری زبان  
 Others, please specify \_\_\_\_\_ کوئی اور، وضاحت کریں

Listening سننے میں  
 Urdu اردو  English انگریزی  Turkish ترکی  Mother tongue مادری زبان  
 Others, please specify \_\_\_\_\_ کوئی اور، وضاحت کریں

Writing لکھنے میں  
 Urdu اردو  English انگریزی  Turkish ترکی  Mother tongue مادری زبان  
 Others, please specify \_\_\_\_\_ کوئی اور، وضاحت کریں

Reading پڑھنے میں  
 Urdu اردو  English انگریزی  Turkish ترکی  Mother tongue مادری زبان  
 Others, please specify \_\_\_\_\_ کوئی اور، وضاحت کریں

**Work-related characteristics: کام سے متعلق خصوصیات**

6. Which of the following high-risk activities have you done or supervised?  
متدرجہ ذیل میں سے آپ نے کون سے کام کیئے ہیں یا انکی نگرانی کی ہے؟  
 Work at height اونچائی پر کام  Confined space محدود جگہ پر کام  Welding ویلڈنگ  
 Carry heavy weight/ machinery بھاری وزن / مشینری اٹھانا  
 Others, please specify \_\_\_\_\_ کوئی اور، وضاحت کریں

7. Is there a procedure for risk assessment in place before carrying out these activities?  
کیا ان سرگرمیوں کو انجام دینے سے پہلے خطرے کی تشخیص کے لئے کوئی طریقہ کار موجود ہے؟  
 Yes ہاں  No نہیں

- 7.1. If yes, do you feel that the assessment is being done and the procedure are being followed properly?  
اگر ہاں، تو کیا آپ کو لگتا ہے کہ خطرے کی تشخیص اور طریقہ کار پر مناسب طریقے سے عمل کیا جا رہا ہے؟
- Always ہمیشہ  Often اکثر  Sometimes کبھی کبھی  Rarely بہت کم  Never کبھی نہیں
8. How often do you use work permit before carrying out any high-risk activities?  
کسی بھی کام کو انجام دینے سے پہلے آپ کتنی بار ورک پرمٹ کا استعمال کرتے ہیں؟
- Always ہمیشہ  Often اکثر  Sometimes کبھی کبھی  Rarely بہت کم  Never کبھی نہیں
9. How often have you witnessed any near miss at your workplace?  
آپ نے کتنی بار اپنے کام کی جگہ پر کسی بھی غلطی کو دیکھا ہے؟
- Many times کئی بار  Often اکثر  Sometimes کبھی کبھی  Rarely بہت کم  Never کبھی نہیں
10. How often have you reported these near misses at your workplace?  
آپ نے اپنے کام کی جگہ پر کتنی بار ان غلطیوں کی اطلاع دی ہے؟
- Always ہمیشہ  Often اکثر  Sometimes کبھی کبھی  Rarely بہت کم  Never کبھی نہیں
11. How often have you witnessed any workplace accident?  
آپ نے کتنی بار کام کی جگہ پر کوئی حادثہ دیکھا ہے؟
- Many times کئی بار  Often اکثر  Sometimes کبھی کبھی  Rarely بہت کم  Never کبھی نہیں
- 11.1. How severe were those accidents, with 5 being 'very critical' to 1 being 'low level'?  
حادثات کتنے سنگین تھے، جس میں 5 'انتہائی نازک' اور 1 'تجلی سطح' تھے؟
- 5  4  3  2  1
12. Has any work accident that you saw or heard or happened with you that changed your morale? Please explain  
کیا کام کی جگہ پر کوئی حادثہ آپ نے دیکھا یا سنا یا آپ کے ساتھ پیش آیا جس نے آپ کے حوصلے کو تبدیل کیا؟ وضاحت کریں۔
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
13. Have you received any formal training in occupational safety and hazard identification or work-related injuries and accident prevention?  
کیا آپ نے پیشہ ورانہ حفاظت اور خطرے کی شناخت یا کام سے متعلق چولوں اور حادثات کی روک تھام میں کوئی رسمی تربیت حاصل کی ہے؟
- Yes ہاں  No نہیں
- 13.1. If yes, please rate, how beneficial was the training, with 5 being 'very much beneficial' to 1 'not beneficial'?  
اگر ہاں، تو بتائیں، تربیت کتنی فائدہ مند تھی، 5 یعنی بہت زیادہ فائدہ مند اور 1 یعنی بالکل فائدہ مند نہیں تھی؟
- 5  4  3  2  1
14. Which language is used in your organization for safety instructions, risk assessment and safety procedure?  
آپ کے ادارہ میں حفاظت کی ہدایات، خطرے کی تشخیص اور حفاظت کے طریقہ کار کے لئے کون سی زبان استعمال کی جاتی ہے؟
- Urdu اردو  English انگریزی  Turkish ترکی  Mother tongue مادری زبان
- Others, please specify \_\_\_\_\_ کوئی اور، وضاحت کریں

15. What is your level of understanding of this language, with 5 being 'very high' to 1 being 'very low'?  
اس زبان کے بارے میں آپ کے سمجھنے کی سطح کیا ہے، جس میں 5 بہت زیادہ اور 1 بہت کم ہیں؟
- 5       4       3       2       1
16. Please specify, what factors according to you are involved in the occurrence of accidents.  
وضاحت کریں کہ آپ کے مطابق حادثات کے وقوع میں کون سے عوامل شامل ہوتے ہیں۔
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

**Well-being of employees: ملازمین کی فلاح و بہبود**

17. Please rate, the level of strictness of your management towards employees, with 5 being 'very strict' to 1 'not strict'?  
ملازمین کے ساتھ آپ کی انتظامیہ کی سختی کی سطح کیا ہے، 5 یعنی بہت سخت اور 1 یعنی بالکل سخت نہیں ہے؟
- 5       4       3       2       1
18. How often have you been scolded by your senior when you are not at fault?  
آپ کو کتنی بار آپ کے سینئر کی طرف سے ڈانٹا گیا ہے جب کہ آپ کی غلطی نہیں ہوتی؟
- Many times کئی بار     Often اکثر     Sometimes کبھی کبھی     Rarely بہت کم     Never کبھی نہیں
19. How often do you think, the behavior of management/ senior affects the work?  
آپ کو کیا لگتا ہے، کیا انتظامیہ / سینئر کا رویہ کام کو متاثر کرتا ہے؟
- Always ہمیشہ     Often اکثر     Sometimes کبھی کبھی     Rarely بہت کم     Never کبھی نہیں
20. Does constantly growing work pressure at your work place affect your health?  
کیا آپ کے کام کی جگہ پر مسلسل بڑھتا ہوا کام کا دباؤ آپ کی صحت کو متاثر کرتا ہے؟
- Many times کئی بار     Often اکثر     Sometimes کبھی کبھی     Rarely بہت کم     Never کبھی نہیں
21. How many times do you work for late hours?  
آپ کتنی بار دیر تک کام کرتے ہیں؟
- Daily ہر دن     Three times a week ہفتے میں تین بار     Two times a week ہفتے میں دو بار     Never کبھی نہیں
22. How often do you work on weekend / holiday?  
آپ اہتمام ہفتہ / چھٹی پر کتنی بار کام کرتے ہیں؟
- More than 8 times a month ایک مہینے میں 8 سے زیادہ بار     5-7 times a month ایک مہینے میں 5-7 بار     2-4 times a month ایک مہینے میں 2-4 بار     Once in a month ایک بار     Never کبھی نہیں
23. How often do you feel tired and sleepy during work?  
کام کے دوران آپ کتنی بار تھکاوٹ اور نیند محسوس کرتے ہیں؟
- Always ہمیشہ     Often اکثر     Sometimes کبھی کبھی     Rarely بہت کم     Never کبھی نہیں

24. Do you feel stressed at home due to your job environment?

کیا آپ اپنے کام کے ماحول کی وجہ سے گھر پر تناؤ محسوس کرتے ہیں؟  
 Always ہمیشہ  Often اکثر  Sometimes کبھی کبھی  Rarely کم بہت  Never کبھی نہیں

25. Please specify, what do you think about work related stress

وضاحت کریں، آپ کام سے متعلق تناؤ کے بارے میں کیا سوچتے ہیں۔

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26. Have your organization provided you with any recreational facilities on your free time, e.g., fun activities, games, sports etc.?

کیا آپ کے ادارہ نے آپ کو اپنے فارغ وقت پر کوئی تفریحی سہولیات فراہم کی ہیں، جیسے تفریحی سرگرمیاں، کھیل، وغیرہ؟  
 Yes ہاں  No نہیں

27. Do your organization conduct motivational sessions?

کیا آپ کا ادارہ آپ کی حوصلہ افزائی کے لئے سیشن منعقد کرتا ہے؟  
 Weekly ہفتہ وار  Monthly ماہانہ  Biannually سال میں دو بار  Annually سالانہ  Never کبھی نہیں

28. How much does the organization takes care of your psychological wellbeing?

آپ کا ادارہ آپ کی نفسیاتی صحت کا کتنا خیال رکھتا ہے؟  
 Always ہمیشہ  Often اکثر  Sometimes کبھی کبھی  Rarely کم بہت  Never کبھی نہیں

29. Please add any comment on your psychological wellbeing in your organization:

اپنے ادارہ میں اپنی نفسیاتی صحت پر کوئی تبصرہ شامل کریں:

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#### Additional information اضافی معلومات

30. Please provide additional information or suggestion related to your work which you feel is essential for reducing the number of accidents.

اپنے کام سے متعلق اضافی معلومات یا تجاویز فراہم کریں جو آپ کے خیال میں حادثات کی تعداد کو کم کرنے کے لئے ضروری ہیں۔

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## Appendix 2: WMU REC Approval

REC DECISION # REC-23-067(M) Inbox x



**Email, PhD** <PhD@wmu.se> (sent by cef@wmu.se)  
to me, Aykut ▾

Tue, Aug 8, 11:10 AM ☆ ↶ ⋮

Dear Bisma Khan,

I am pleased to let you know that the members of the WMU Research Ethics Committee (REC) have now **approved** the (revised) research related documents that you submitted to this office on 2 August 2023 concerning your research study involving human participation.

You are now free to start your data collection work in consultation with your supervisor.

With kind regards,

Carla Fischer  
REC Secretary  
Faculty Support Officer  
Research Projects and Doctoral Programs  
World Maritime University

Malmö, Sweden  
Tel: +46 40 35 63 91  
Fax: +46 40 12 84 42  
E-mail: [phd@wmu.se](mailto:phd@wmu.se)  
E-mail: [phd@wmu.se](mailto:phd@wmu.se)

### Appendix 3: Examination of accidents investigation reports via HFACS

Factors	Accident Reports																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Org influences																				
org resources				1	1		1		1					1						1
org process				1	1		1			1	1		1		1	1	1	1		1
safety culture	1	1				1	1	1	1		1	1	1	1	1		1	1		1
Unsafe supervision																				
inadequate design work				1		1				1			1	1					1	
supervisory violations		1		1	1			1			1	1	1		1		1			1
onsite management defects	1	1		1	1			1	1		1		1	1	1		1			
Pre-conditions of unsafe act																				
status of operators																				
adverse psychological	1						1							1		1		1	1	1
adverse spiritual																				
adverse physiological	1															1				
skill underutilization									1											1
tools and equipment																				
design defects				1	1					1				1	1	1				
improper use and operation				1	1				1						1		1			1
physical environment												1	1							
Unsafe acts																				
errors																				
preceptual errors							1				1				1		1	1	1	1
decision errors	1	1	1	1	1		1	1	1		1		1				1			1
skill based errors		1		1		1	1				1			1	1		1			
violations					1		1				1			1		1	1		1	1
regulatory factors			1																	
Economic/ Social/ Legal/ Political/ Environment													1							