A COMPARATIVE STUDY OF HUMAN FACTORS INFLUENCING HEALTH AND SAFETY IN CONSTRUCTION

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ABSTRACT

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Health and safety (H&S) performance in the construction industry remains a concern globally, given the continuous high rates of accidents across both developed and developing countries. This dissertation investigates the factors influencing H&S performance, with particular emphasis on human factors compared to non-human elements, in a comparative study of the United Kingdom and Saudi Arabia. While many studies have examined health and safety, this research takes a comprehensive approach by categorising both human and non-human factors to identify those most critical to improving safety outcomes.

This study adopted a mixed-methods approach to examine the role of human factors in shaping H&S outcomes. It started by developing a comprehensive definition of human factors—encompassing organisational systems, job design, and individual characteristics that influence behaviour at work. The study expanded existing definitions by showing that human factors extend beyond only individual behaviours. A structured questionnaire was completed by 164 construction professionals from the UK and Saudi Arabia. Their responses were statistically analysed to test four research hypotheses (RH1–RH4), comparing the influence of human

factors against non-human elements such as economic, environmental, technological, and regulatory conditions. The quantitative phase was informed by an earlier qualitative stage.

The findings confirm that human factors are the dominant drivers of H&S outcomes in both countries. Organisational dimension, job design, and individual capabilities each showed statistically significant influence, while non-human factors had minimal impact. Regulatory influences played a notable secondary role. Despite different regulatory frameworks, the rankings of human factor dimensions were consistent between the UK and Saudi Arabia.

These results carry substantial implications. For practitioners, they emphasise the need to design jobs that match workers' abilities, foster safety culture, and invest in worker development and supervision. Theoretically, the study extends understanding of human factors in construction, beyond individual behaviour to systemic influences.

Ultimately, improving construction health and safety relies less on external systems and more on how people—organisations, teams, and individuals—interact with them. A human-centred approach, backed by regulation, offers the best path to safer construction environments.

Keywords: Human factors, health and safety, construction industry, UK, Saudi Arabia, organisational dimension, job dimension, individual dimension, comparative study.

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CHAPTER I:

INTRODUCTION

1.1. Introduction

Human factors play a significant role in the health and safety (H&S) of construction projects. This paper discusses these factors, emphasizing their dimensions and underpinning critical aspects in the management of H&S in construction projects, and points out that safe construction practice will be incomplete unless proper attention is given to these factors. The research will define appropriate and detailed human factors and their dimensions.

This research investigates factors affecting health and safety in construction, with a comparative focus on the United Kingdom and Saudi Arabia. It compares and contrasts these factors with particular emphasis on locating human factors among them. From the literature review, it became clear that human factors should be considered central to understanding overall health and safety management practices. Therefore, this research focuses on establishing which dimensions of human factors are more critical in determining the safe execution of construction projects.

The ultimate goal is to understand the definition of human factors and their impact on health and safety (H&S) across many regions and develop informed recommendations for enhancing H&S practices. Therefore, through the study, a contribution can be made toward understanding how human factors may be managed effectively, subsequently raising the construction safety standards.

1.2. Problem Statement:

While there has been considerable advancement in safety management in the construction sector, enhanced by technological progress, utilising new methodologies and more advanced heavy and sensorised machinery, and the enforcement of stringent health and safety

(H&S) regulations in the construction industry, high accident rates continue to be a significant global concern. This enduring issue is emphasised by Buniya et al. (2021) and Rivera et al. (2021) who noted the persistence of high accident rates despite these advancements. Similarly, Ashebir et al. (2020) observed that even with recent improvements in safety measures, China continues to experience a noteworthy number of construction accidents. According to Othman et al. (2017), despite reductions in the rate of injuries and accidents particularly in large-scale projects, over the twenty years, the construction sector remains one of the most hazardous industries.

Although a lot of research has been conducted on H&S in the construction industry, there is still a significant gap in our understanding and knowledge of human factors, their definition, dimensions, and impact on H&S performance. Most of these factors are not well understood and therefore ignored by workers within the construction profession. The primary purpose of this research will be to explain and emphasize these factors to point out their relevance in both a developed country (UK) and a developing country (Saudi Arabia). By identifying and contrasting the general factors that influence H&S in these regions, this study will pinpoint the position and influence of human factors among these factors. It further discusses which factors of the human element impact H&S management the most within these regions to provide truly targeted recommendations for improvements in the safety outcome in the construction industry.

1.3. Research Aim and Objectives:

Aim:

To comprehensively assess the various factors influencing health and safety (H&S) in construction, clearly define human factors and their significance within this broader context

and investigate the importance of the three dimensions of human factors (organisational, job, and individual) in both developed and developing countries.

Objectives:

1. Provide a general understanding of factors affecting H&S in construction in different regions within developing and developed countries, specifically focusing on human factors.
2. Define and clarify the concept of human factors influencing health and safety (H&S) in the construction industry.
3. To categorise all factors influencing health and safety (H&S) in construction into human (organisational, job, individual) and non-human dimensions, and to assess the relative impact of each category on H&S outcomes.
4. To determine which dimension of human factors (organisational, job, or individual) plays the most influential role in shaping H&S practices in construction projects in the UK and Saudi Arabia.
5. To provide recommendations and suggestions for enhancing H&S practices in construction by focusing on the most critical human factor dimension(s) in each country.

1.4. Research Hypotheses and Variables

Hypotheses:

1. **RH1:** Human factors (organisational, job, and individual dimensions) significantly influence H&S outcomes in construction and have more prominent impact than non-human factors in the UK and Saudi Arabia, though their relative importance varies between the two countries.
2. **RH2:** In Saudi Arabia, all three dimensions of human factors (organisational, job, and individual) significantly influence H&S performance in construction, with the

organisational dimension demonstrating the most pronounced influence, primarily due to less robust regulatory frameworks and inconsistent enforcement.

3. **RH3:** In the UK, while all three dimensions of human factors (organisational, job, and individual) significantly influence H&S performance in construction, the job-related and individual dimensions exhibit the most substantial influence.

4. **RH4:** There is a statistical difference between the UK and Saudi Arabia in the distribution of the influence of human factor dimensions on H&S outcomes.

Variables:

Independent Variables:

- Human factor dimensions (organisational, job-related, and individual).
- Non-human factors: such as technological tools, economic factors, environmental conditions, and regulatory factors.

Dependent Variable:

Perceived Effectiveness of Health and Safety Practices through the aggregation of Likert-scale responses to specific questionnaire items. The items evaluate the degree of implementation of key safety practices which represent the respondent's general view of H&S effectiveness at work.

1.5. Significance of the Study

As construction continues to be one of the most hazardous industries worldwide, despite advancements in technology and regulatory frameworks, the persistently high rates of accidents and injuries underline the need for deeper exploration into the root causes. In this context, the significance of the research will be its potential contribution to filling in the gaps in our comprehension of the human factors and their dimensions that influence health and safety (H&S) management in the construction industry, taking into account the different effects and

practices of these factors in developed and developing nations. While exploring a broad spectrum of factors affecting H&S, the key objective is to identify and analyse the critical human factors that significantly impact health and safety outcomes. This research endeavours to contribute to the general discussion on construction health and safety by focusing specifically on human factors, which have been underestimated compared to other non-human factors, and to underline their importance within the broader context of H&S practices.

In developed countries, where rigorous regulatory systems and advanced health and safety management systems are dominant, the study aims to identify which specific human factors continue to pose challenges to H&S. Exploring the dimensions of these factors may provide an understanding of how, even in advanced and well-regulated environments, human elements can undermine health and safety practices.

In contrast, in developing countries, where regulatory frameworks may be less robust and resources more constrained, the study's significance highlights human factors' critical role in an environment where economic pressures often overshadow health and safety concerns. By comparing the impact of human factors between developed and developing countries, the research will enlighten how these factors interface with different regulatory, cultural, and economic contexts. This comparative approach is vital for developing tailored and customised recommendations that can improve health and safety outcomes in diverse backgrounds.

Ultimately, the significance of this study is its possible input to provide a better understanding of human factors that may influence health and safety. This understanding will enable the construction industry to move beyond generic health and safety measures and towards more human-centred approaches that address the underlying causes of unsafe practices, accordingly, promoting a better, safer, and more sustainable construction environment.

1.6. Overview of the Research Design:

To achieve the aim and objectives of the research, a mixed-method strategy that combined qualitative and quantitative approaches, as well as primary and secondary research methods was employed as follows:

- **Secondary Research and Qualitative Approach:** The first part involved reviewing existing literature and studies to define human factors and their significance among other factors influencing health and safety (H&S) in construction. This phase helped categorise these factors into organisational, job-related, and individual dimensions and laid the groundwork for forming hypotheses.
- **Primary Research and Quantitative Approach:** In the second part, the study collected new data through questionnaires sent to construction and H&S professionals in the UK and Saudi Arabia. This data covered a wide range of factors influencing health and safety (H&S) in construction. Statistical analysis revealed the critical role of human factors within this broader set of influences, eventually highlighting their significant contribution to the overall health and safety performance in construction.

1.7. Focus on Root Causes

This study considered the root causes of accidents to investigate health and safety (H&S) challenges in the construction industry. While much of the existing literature in health safety management research addresses direct causes of accidents - such as falls from height, slips and trips, electrical shock, etc - this research deliberately centres on the systemic root causes that underlie these incidents. These include factors such as poor organisational culture, insufficient training, inadequate job design, lack of regulatory frameworks or weak enforcement.

The aim of addressing root causes is to provide long-term, sustainable solutions which help us understand how accidents happen and why unsafe practices develop in the first place. Since direct causes are often the result of the root causes, thus, studying them offers a more comprehensive view of construction safety. Essentially, by focusing on root causes, we are addressing the foundation of the problem, which inherently covers all other contributing factors.

1.8. Summary

Chapter 1 introduces the importance of human factors and the necessity to highlight its role in health and safety (H&S) management within the construction industry. For this reason, this research will try to review those factors in developed and developing countries. The UK and Saudi Arabia will be the main points of reference.

Key points from the chapter include:

1- **Problem Statement**: Despite technological advancements and stricter regulations, the construction industry continues to experience high accident rates globally, highlighting the necessity to study the impact of human factors on health and safety (H&S).

2- **Research Aim**: To comprehensively assess factors influencing H&S in construction, with a particular focus on defining and understanding the significance of human factors and their dimensions.

3- **Research Objectives:**

- Provide a general understanding of factors affecting H&S in different regions.
- Define and clarify the concept of human factors in construction H&S.
- Categorize factors within the three dimensions of human factors and non-human factors.
- Determine the most significant human factor dimension in the UK and Saudi Arabia

- Provide recommendations for enhancing H&S practices

4- **Research Hypotheses**: Four hypotheses were formulated to guide the study, focusing on the significance of human factors and their dimensions in both developed and developing countries

5- **Significance of the Study**: The research aims to fill gaps in understanding human factors in H&S in construction, potentially contributing to more effective, human-cantered approaches to safety management.

6- **Research Design**: A mixed-method approach combining qualitative and quantitative methods, including literature review and questionnaires, to achieve the research objectives.

As will be revealed in subsequent chapters, human factors play a crucial role in improving health and safety (H&S) outcomes and could be considered the most important factors affecting health and safety, regardless of the cultural or economic context in which construction work takes place. However, the foundation for analysing the factors affecting H&S in the construction industry is laid in this chapter, with a particular emphasis on the significant impact of human factors.

CHAPTER II:

LITERATURE REVIEW

2.1. Introduction

This literature review assesses the different factors that affect health and safety (H&S) performance in the construction industry in developed and developing countries with a specific focus on human factors. Human factors have usually been seen as individual attributes and characteristics, but this review broadens the concept to include three important dimensions of human factors: organisational; job; and individual.

The primary purpose of this literature review is to clarify the definition of human factors and their huge position in managing H&S in the construction field and to lay the foundation for a comparative examination of H&S practices in the UK and Saudi Arabia. Through investigating the literature on H&S across different developed and developing country, this overview identifies and analyses the unique roles that human elements play within those various contexts.

The layout of this literature review begins with an exploration of the influences on health and safety practices in different nations emphasising the importance of human elements. It then transitions to an examination of how construction health and safety are managed in both the United Kingdom and Saudi Arabia. This method allows for a comparison of health and safety procedures while also laying the groundwork for comprehending the unique human factors that impact these practices in each country.

2.2. Importance of the Construction Industry

The construction sector has a significant impact on the economy. By building structures and infrastructure this industry plays a role in supporting a country's economic progress,

industrial growth, efficient transportation of goods, sustainable development and urban expansion (Alaloul et al., 2021).

Hamdan et al. (2023) highlighted the crucial impact of construction activities on the economy and a country's Gross Domestic Product (GDP). The construction industry plays a crucial role in creating essential infrastructure, such as roads, bridges, and buildings, which is vital for the expansion of economic activities. This sector not only generates significant employment opportunities but also boosts demand in interconnected industries like manufacturing and retail and enhances trade capabilities. For instance, in India during 2011-2012 the construction industry played a role in boosting the economy by contributing 308 billion dollars to the national GDP, which accounted for around 19% and employed more than 35 million people (Murali and Kumar, 2019). Additionally, according to Boadu et al. (2020), it was observed that in the year 2017, the construction sector in Ghana played a role in boosting the country’s GDP accounting for a substantial 13.7% of the total GDP. This placed it as the largest contributor to the GDP just behind the agricultural industry. Moreover, this industry also made an impact on employment by providing job opportunities for over 600,000 individuals, which accounted for approximately 7% of Ghana’s working population.

In China, the world's second-largest economy, the construction sector comprised approximately 6.9% of its total GDP in 2022. Real estate development and infrastructure projects have a significant impact on Chinese economic growth. Chinese policymakers frequently use increased infrastructure investment to boost economic activity when faced with economic recessions (Zhang, 2023).

Another example from developed countries is the European Union, where the European Commission (2014) reported that the construction industry constituted 10% of the Gross Domestic Product (GDP) and provided employment for around 20 million individuals. In the

United Kingdom as reported by Rhodes (2019) the construction sector contributed £117 billion to the economy, accounting for 6% of total economic output. This field employs 2.4 million workers representing 7% of total employment in the UK.

The construction industry contributes to the economy by creating job opportunities. Various positions are available in this labour-intensive sector, ranging from entry-level roles to engineering and high managerial positions. According to the McKinsey Global Institute (2017), 7% of the world's workforce is employed in construction. Notably, with an expenditure of around $10 trillion on construction-related products and services this industry contributes about 13% to the global GDP. Additionally, the construction industry offers job opportunities not only on construction sites but also in related service industries, which include the manufacturing and distribution of materials and parts. In developed countries, individuals working in this sector account for 5 to 10 per cent of the workforce, and a larger percentage in developing countries according to the International Labour Office (2015).

Murali and Kumar (2019) explored the significance of the construction industry beyond just building structures, revealing its deep connections to socio-economic improvement. Similarly, Ashebir et al. (2020) articulated how this sector is fundamental in enriching the social economy and improving living standards through vital infrastructure and facilities. These insights collectively underscore the construction industry's pivotal contribution to societal progress, emphasising its significance beyond mere physical structures.

It is worth noting that despite the fact that construction undoubtedly plays a pivotal role in driving economic growth, contributing significantly to the GDP, and generating employment, it has some disadvantages:

- Construction has a negative effect on the environment causing issues like sediment pollution in water bodies that harm aquatic life, impact drinking water quality, and lead

to flooding. This industry interference with habitats leads to the loss, fragmentation and degradation of ecosystems affecting species on land and in water. Additionally, construction activities play a part in climate change by consuming a huge amount of energy, emitting gases, and generating waste from demolition and construction materials that end up in landfills (Miller, 2020).

- Resource scarcity, heightened competition, and rising costs are all consequences of the construction industry's extensive resource use, posing challenges to sustainable development. The World Green Building Council (2023) stated that buildings worldwide contribute to 40% of energy and CO2 emissions, consume half of all extracted materials, one-third of water resources, and produce 35% of waste. Furthermore, the environment is affected through resource depletion, air, water, and soil pollution, and loss of biodiversity. The significant environmental footprint of the construction sector emphasises the urgent need for sustainable practices.

2.3. Overview of Health and Safety in the Construction Industry

While the construction industry, as previously mentioned, significantly contributes to a nation's economy and gross domestic product (GDP), it is also well-known for its strenuous and hazardous work environment. Workplace accidents, including severe injuries, disabilities, and fatalities are quite common in this sector (Shamsuddin et al., 2015; Hamdan et al., 2023)

Construction sites are active and constantly evolving environments, bustling with a range of simultaneous activities. They involve a large number of workers, utilise heavy machinery, employ complex procedures, use extensive materials and equipment, and incorporate advanced building techniques. The dynamic complexity, combined with the physically demanding nature of construction work, substantially increases the risk of accidents

and injuries. Consequently, the construction industry is often regarded as one of the most hazardous sectors (Othman et al., 2017).

For instance, in Great Britain, the Health and Safety Executive HSE (2023) reported that in 2023 around 1.8 million workers suffered from work-related illnesses. This included 875,000 cases of stress, anxiety or depression and 473,000 cases of musculoskeletal disorders. Additionally, there were 2,268 deaths related to previous exposure to asbestos and 135 fatalities from work-related accidents. Furthermore, these H&S issues have a negative financial impact, as the cost of these injuries and health issues was estimated to be £20.7 billion for the year 2021-2022.

In Nigeria, the construction sector witnessed a rise in on-site accidents making up 39.24% of fatal accidents from 2014 to 2016, according to a study by Adetunji et al. (2024). Similarly, Malaysia's construction sector showed a trend between 2017 and 2021, ranking fifth in accident rates and having the highest number of fatal workplace injuries compared to other industries as highlighted by Hamdan et al. (2023).

On a global scale, the International Labour Organisation ILO (2015) reported that approximately 108,000 workers are fatally injured on construction sites annually, representing about 30% of all occupational death incidents worldwide.

Because of the hazardous nature of the construction industry, it is critical to ensure adherence to H&S practices and to safeguard the well-being and livelihoods of workers while also aiming to minimise work-related accidents. Almalki and Ammar (2019) highlighted that many factors may increase the rate of construction accidents. Studying these factors will contribute to reducing these rates, thus, reducing the negative effects from them. By prioritizing health and safety, construction companies can establish a safer working environment

substantially decrease the chances of accidents and injuries and considerably enhance overall productivity in the long term.

The numerous accidents occurring within the construction field impact more than just cost and physical safety; they ripple out to touch the lives and futures of workers and their families, causing real social strain. These accidents affect the stability of the families and their well-being, creating a cycle of hardship. Beyond individual cases, the industry's repeated safety failures tarnish its overall image and threaten its future health and that of its employees. This highlights an urgent need, as Rivera et al. (2021) pointed out, for a holistic safety plan that embraces not only the financial but also the human and environmental facets of construction work.

Abas et al. (2020) and Kukoyi and Adebowale (2021) highlighted the negative impacts of poor health and safety (H&S) performance on project outcomes, such as increased cost, project delays, and reduced productivity. Furthermore, poor health and safety (H&S) performance generates a negative impression on the construction company. Similarly, Othman et al. (2017) stated that accidents will take place if construction H&S management is not properly followed, which will have negative consequences on the country’s economy.

Apart from the advantages, prioritising the well-being and safety of workers also greatly impacts the reputation and trustworthiness of the construction sector as a whole, as emphasised by Abas et al. (2020). A strong commitment to health and safety demonstrates concern not only for employees but for the entire workforce and community. This approach boosts the industry’s image, attracting skilled individuals who prefer working in an environment that values their safety and actively protects it. Adetunji et al. (2024) noted that hazardous working environments can impact employees in various ways. The prevalence of high occupational accidents can instil fear among employees; therefore, it is crucial for organisations to

proactively assess and address potential risks before beginning any construction activities. Moreover, this sincere dedication to workers' health and safety cultivates an environment of confidence among employees, clients, and other stakeholders. It sends a message of professionalism, accountability, and genuine care for those who passionately contribute to the growth and success of the construction industry. Arachchige and Ranasinghe (2015) stated that certain accidents have the potential to alter a company's strategic objectives and goals, or they might even make the firm less competitive within the industry.

There are three primary reasons and drivers for the effective management of H&S as highlighted by Hughes and Ferrett (2016), those drivers are moral, legal and financial. The moral driver comes from the duty of employers to protect their workers and all people who may be affected by their work. Legally, it involves following the criminal and civil laws that outline the employer's duty of care. Lastly, the financial reason, which comes from the cost of noncompliance, which can lead to fines, compensations, increment in insurance premium, and in severe cases, imprisonment.

According to Adetunji et al. (2024), there are notable differences in the implementation of H&S practices between developed and developing countries. They observed that developed countries have shown progress in prioritising occupational H&S over the years, mainly through the introduction of advanced management techniques, the creation of new legislations, and the enforcement of rigorous standards. In contrast, developing countries lag in implementing measures to prevent accidents on construction sites.

Developed nations generally demonstrate better H&S performance in construction compared to less developed countries. However, they still have a high number of injuries, and consequently high financial losses (Benny and Jaishree, 2017). A study by Choi et al. (2019) highlighted that fatal accidents in the construction field continue to be a concern across various

countries such as the USA, South Korea, and China. Amongst these countries, China stated the highest number of fatalities with 2,328 cases, followed by the United States with 881 fatalities and South Korea with 53.

Table 1 highlights the significant differences in occupational fatality and accident rates between developed and developing regions, as pointed out by Hämäläinen et al. (2006). Regions were categorised based on World Bank classifications. A key concern raised is the absence of standardized information regarding occupational accidents. This issue is more noticeable in developing nations which face a challenge due to insufficient record-keeping and reporting systems resulting in unreliable workplace accident data.

Table 1: Occupational accidents by regions

Region	Fatality rate (per 100,000 workers)	Accident rate (per 100,000 workers)
Established Market Economics	4.2	3240
Former Socialistic Economies	12.9	9864
India	11.5	8763
China	10.5	8028
Other Asia and Islands (excluding China and India)	21.5	16434
Sub-Saharan Africa (Including South Africa)	21.0	16012
Latin America and the Caribbean	17.2	13192
Middle Eastern Crescent	18.6	14218
Singapore	9.8	7452
South Africa	19.2	14626

Source: Hämäläinen et al. (2006).

Beyond these statistics, researchers have also compared countries directly to explain gaps in H&S performance. For example, Teo Ai Lin et al. (2008) conducted an examination exploring the discrepancies and variations in H&S performance in construction, employing South Africa and Singapore as the foundation for their case studies. Their study identified

management commitment, supervisory environment, and the level of training and competence as key factors contributing to the disparities in H&S performance across these countries.

Alkilani et al. (2013) pointed out another significant factor that impacts health and safety (H&S) awareness and performance in developing countries: a notable lack of government commitment. This deficiency is evident in the form of regulatory, policy, and legal constraints that restrict the efficiency of government agencies responsible for H&S oversight and monitoring, further obstructing the enhancement of H&S standards.

Expanding on this point, Buniya et al. (2021) highlighted the strides made by developed countries in enhancing health and safety (H&S) practices, which have resulted in tangible progress and improved safety outcomes. In contrast, developing countries often continue to lag behind their developed counterparts, as their primary focus often tends to lie on economic priorities over H&S issues. Similarly, Shamsuddin et al. (2015) stated that duration, quality, and cost are always considered more important than safety, and safety matters always receive less priority in construction. Building on this topic, Rashid et al. (2023) pointed out that managing H&S in construction poses unique challenges in developing countries, where limited resources make it more difficult to prioritize and implement effective H&S measures.

In a related discussion, Boadu et al. (2020) pointed out that construction practices in developing countries often mirror outdated systems from former colonial forces. For example, some African countries still use old standards and regulations that are mismatched with local cultural and administrative needs, contributing to poor project and H&S performance.

2.4. Importance and Definition of Human Factors in Construction Safety

The role of human factors in H&S management in the construction industry is essential. While some might argue that external factors or technological advancements are more influential in ensuring safety and efficiency, the prevailing research narrative suggests

otherwise. George and Renjith (2022) refuted the notion that technology and improved supervisory and management practices alone suffice to improve H&S's performance. They pointed out that accidents continue to occur despite these enhancements, mainly because of human factors. Similarly, Mohamed (2003) underscored that construction companies are becoming aware that reducing accidents requires more than just controlling physical aspects and hazards, and that more consideration must also be directed toward managerial, organisational, and human factors.

Ye et al. (2018) highlighted the importance of human errors as major factors and contributors to accidents, and they underscored that addressing these can significantly enhance H&S performance. Similarly, Arachchige and Ranasinghe (2015) stated that human factors are the primary contributors to accidents, though they are not the sole cause of all incidents. Complementing this viewpoint, Hughes and Ferrett (2016) stated that human error is responsible for approximately 90% of accidents and suggested that proactive management interventions could prevent around 70% of these accidents. In line with these observations, Fabiano et al. (2019) stressed that human factors persistently play a crucial role in the occurrence of workplace accidents. They suggested that learning from past failures forms the basis of the contemporary approach to risk management. Likewise, the Health and Safety Executive HSG48 (1999) in the UK reinforced these insights, noting that as technology has advanced, the focus has increasingly shifted towards the human-related causes of accidents. They reported that human actions or inactions contribute to around 80% of accidents, at least to some extent.

The transition in focus towards human factors in health and safety (H&S) underscored their importance in the work environment. By considering these factors, we can enhance workplace communication and teamwork within their technical and social work environments.

Vogt et al. (2010) suggested that such improvements can produce great benefits for businesses, including increased efficiency and a decrease in accidents and injuries.

In understanding human factors within the H&S in the construction industry, it is essential to start with a comprehensive definition that extends beyond mere individual characteristics. Misconceptions persist that human factors are limited solely to personal attributes or characteristics, overlooking the broader range of elements and factors influencing the behaviour of individuals and their interactions in the construction environment.

For instance, Almalki and Ammar (2019) confined human factors to the construction worker's personality domain, which is relatively stable within an individual, encompassing aspects of their history, family background, personality, education level, experience, and training. This perspective overlooks or disregards other influential factors that may significantly shape individual behaviour, consequently narrowing the concept of human factors in the construction environment. Similarly, Rivera et al. (2021), when categorising factors affecting H&S, restricted human factors to aspects related to attitude risk-taking, risk perception, training and skills of workers, and how they interact with their supervisors and coworkers. The narrow focus in Almalki and Ammar (2019) and Rivera et al. (2021) definition of human factors highlighted the need to broaden our understanding of human factors in H&S in construction. By adopting a holistic and comprehensive approach, we can better address the complexities involved, leading to enhanced safety and efficiency on construction sites.

Vogt et al. (2010) broadened this perspective by highlighting that ‘human factors’ in H&S cover all aspects affecting individuals and their behaviours in safety-critical situations, incorporating environmental and organisational factors such as shift work, alongside individual traits such as ability and motivation. Likewise, Thevendran and Mawdesley (2004) emphasised that ‘human factors’ include a range of individual, team, and organisational elements that

impact people's actions and decisions. Fabiano et al. (2019) defined ‘human factors’ as the study of all elements that facilitate performing tasks correctly, which depends on the interaction between humans, the tools and equipment used in the workplace, and the work environment itself. Expanding upon these definitions, Stranks (2007) stated that ‘human factors’ in H&S refer to the abilities of people and how they interact with the workplace and work environment, how equipment and system design affect performance and organisational factors that influence safety behaviour.

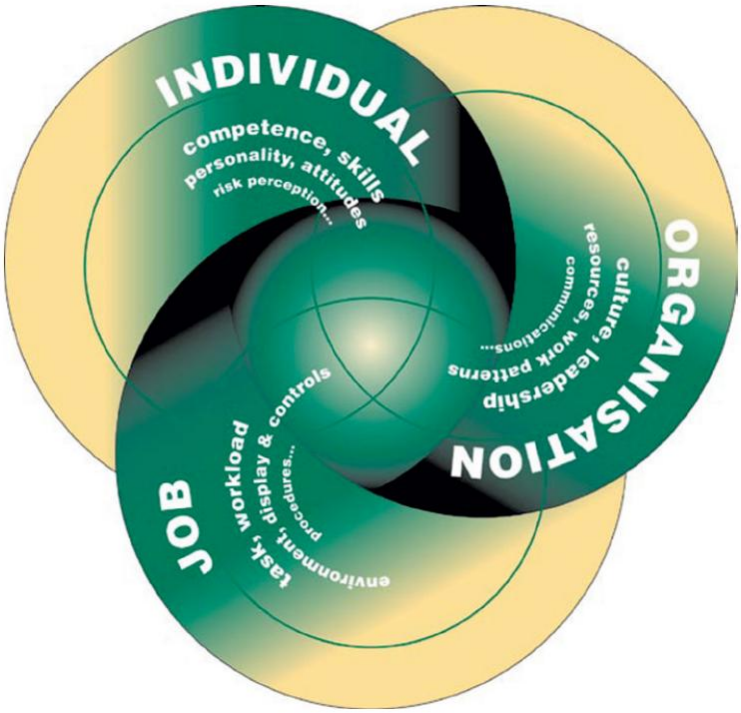
The Health and Safety Executive (HSE), the national regulator for workplace health and safety in the UK, highlighted in its HSG48 (1999) document that ‘human factors’ are a key component of effective H&S management. It provided an inclusive and comprehensive definition, identifying 'human factors’ as environmental, organisational, and job factors, along with human and individual characteristics that influence behaviour at work in a way that can impact health and safety.

Put simply, Hughes and Ferrett (2016) noted that health and safety at work are influenced by three key dimensions:

• The organisation. • The job. • Individual traits.

These elements are known as "human factors" because each involves human input. While individual traits are part of the human factors, they’re not always the most critical component.

Figure 1: Human factors in Occupational H&S



Source: Health and Safety Executive HSG48 (1999)

The job dimension focuses on task design that aligns with ergonomic principles and considers human physical and mental capabilities. The individual dimension focuses on personal characteristics like attitudes, personality, competency, skills, and habits. The Organisational dimension emphasises the crucial importance of workplace culture in promoting safety practices, advocating for a safety-promoting culture and employee involvement at all levels.

The three dimensions of 'human factors' will be discussed in detail.

1- The Organisation

In general, when accidents happen on construction sites, they're often due to gaps in the company's safety management system. These issues usually arise from a combination of

diverse factors, such as including technical, technological, organisational, and other elements (Titas, 2013).

Hughes and Ferrett (2016) highlighted the critical role of organisations in overseeing health and safety (H&S) to cultivate a safe work environment. This involves: Developing clear policies and H&S organisational structure, defining explicit H&S goals and standards (benchmarks), proactively supervising safety protocols, implementing a robust accident reporting system, continuously monitoring H&S outcomes and motivating managers to proactively improve and enhance H&S performance.

Estudillo et al. (2023) emphasised the importance of organisational factors in establishing strong H&S performance. Accordingly, managers must prioritise commitment to H&S and enhance communication around H&S practices. Additionally, integrating these efforts with effective management of work-life balance can significantly boost the H&S outcomes for workers.

The Health and Safety Executive HSG48 (1999) stated that organisational factors have a major impact on individual and group behaviour. However, despite their critical role in shaping these behaviours, the HSE document highlighted that these elements are frequently overlooked during the design and planning of work tasks and in the investigation of accidents.

2- The Job Dimension

The job has a considerable impact on how workers behave, and it should be designed to align with the physical and mental capabilities of the workforce. Health and safety performance of the workforce would be improved through job design that considers workers' strengths and accommodates their limitations. Key considerations include site layout, workload, and the working environment (HSE, 2024).

Hughes and Ferrett (2016) highlighted that, in risky construction jobs, a job safety assessment is crucial to ensure that all safety measures are in place to reduce the likelihood of accidents. There should be a detailed job description, and safe work system designed to meet the specific job requirements. Operators must review this job description before starting work and receive training on safe procedures to be well-prepared for potential risks.

The Health and Safety Executive (HSE), in its guidance HSG48 (1999) emphasised the importance of designing tasks ergonomically. This will ensure that tasks are designed based on human capabilities to prevent overload and improve productivity in the workplace. Furthermore, potential human error may arise from the disparities between job design and worker's abilities.

Kelly (2023) defined ergonomics as the subject area focused on designing and arranging elements, tasks, tools, and workspaces to align with the abilities and limitations of the human body. This perspective aligned with Hughes and Ferrett (2016), who described ergonomics as the science of matching equipment, machines, and processes to workers, rather than the opposite.

While the aforementioned definitions stressed designing the workplace based on human capabilities, Refocus Safety Ltd (2023) argued that the concept of ergonomics extends beyond just design workplace’s elements. They emphasised that a critical component of ergonomics in construction involves providing training and information to workers on safe and efficient work practices.

The International Ergonomics Association (IEA, 2000), in its triennial report, defined ergonomics as the field of science that studies how people engage with other parts of a system, and the profession that applies theories, principles, data and methods to improve human well-being and the effectiveness of the whole system. Stranks (2007) claimed that ergonomics is a

cross-disciplinary science, that combines principles from health, engineering, and social sciences to improve workplace well-being and efficiency, focusing on the interaction between people and their work environments.

To put it simply, according to Health and Safety Executive (HSG48,1999; INDG90, 2013) ergonomics aims to create a balanced "fit" between people and the things they use. By understanding variances between people, ergonomics ensures that workplaces, equipment, tasks, and the environment fit all workers.

There is some confusion around the definitions of the terms 'human factors' and 'ergonomics'. Salvendy (2012) noted that over the last 60 years, ‘human factors’ has often been used synonymously with 'ergonomics’. Similarly, HSE INDG90 (2013) stated that ergonomics, in some industries, is also called ‘human factors’. UC Berkeley (2020) stated that traditionally, the two terms are often differentiated based on the consideration of human physical and psychological aspects. Psychological abilities are usually associated with human factors, while physical qualities are usually associated with ergonomics. Nonetheless, in the end, these terms are used interchangeably.

From the above definitions of the two terms, we can conclude that there are subtle differences between them. While ergonomics primarily deals with designing and arranging objects, tasks, tools, and workspaces to fit the capabilities and limitations of the human body, aiming to enhance safety and efficiency, human factors have a broader scope. Human factors not only include ergonomic considerations but also delve more into environmental, organisational, and individual characteristics that impact behaviour at work as defined before (Fabiano et al., 2019; HSG48, 1999; Hughes and Ferrett, 2016; Vogt et al., 2010).

In essence, while all ergonomic issues can be considered as part of human factors, focusing primarily on physical aspects, not all human factors issues are ergonomic. For

instance, improving communication between team members, refining H&S policies and standards, or modifying a company's safety culture falls under human factors issues but is generally not considered part of ergonomics.

3- Individual Dimension

Human errors substantially contribute to accidents within the construction sector. According to Ye et al. (2018), addressing these errors is crucial for enhancing H&S outcomes.

As indicated in the Health and Safety Executive HSG48 (1999) guidance, individuals bring personal attitudes, skills, and inherent characteristics, like personality, to their roles, influencing health and safety (H&S) performance. While fixed traits, such as personality, are not easily modified, skills and certain attitudes can be developed through appropriate training. However, HSG48 (1999) highlights that job design may not always fully mitigate the complexities related to the individual differences, emphasising the importance of matching tasks with both physical and mental capacities of workers. This perspective suggests that exploring the role of training in shaping individuals' behaviours, and how job design can accommodate a range of individual capabilities is essential.

Individual Factors, as outlined by Hughes and Ferrett (2016) encompass any condition or characteristic inherent to an individual that might lead them to behave unsafely. They stated that individual factors can be physical, cognitive, or psychological.

- **Physical factors:** As discussed by Stranks (2007) physical factors relate to the body's condition and how it affects safety and performance at work. This includes health, fitness, age, strength, and stamina. An individual's physical abilities or constraints can greatly affect their ability to perform work tasks safely.
- **Cognitive factors:** Eysenck and Keane (2015) defined Cognition as a term that, broadly, refers to the mental processes of perception, attention, memory, learning, problem-solving

and decision-making. Eskandar et al. (2019) stated that cognition is how construction workers interpret information and make decisions to act in certain ways. Stranks (2007) distinguished between cognition and behaviourism. In behaviourism, individuals only react to outside influences. However, in Cognitive psychology, individuals are considered active participants with their ideas, plans, and innovations, perceiving the world through their unique mental frameworks and master plans, instead of just reacting to events and circumstances.

- **Psychological factors:** Stranks (2007) stated that these factors encompass aspects of individual ability, interests, aptitude, attitude, and personality. He noted that individual differences in these areas can significantly impact behaviour and safety practices in the workplace, altering the likelihood of accidents or mistakes. Furthermore, Idrees et al. (2017) stated that many studies concluded that other psychological factors such as workload, mental stress, organisational relationships, and job satisfaction crucially affect workers' safety.

Despite debates over categorising individual factors as physical, mental, or psychological, Hughes and Ferrett (2016) observed that these groups are difficult to separate because they are closely interlinked. They noted that studies have identified the most common individual factors contributing to accidents as low skill and competence levels, fatigue, boredom, low morale, and medical issues of individuals.

The figures below include examples of often-cited causes of human failures in accidents and a Checklist for human factors in the workplace:

Figure 2: Commonly referenced reasons for human failures leading to accidents

Source: (HSG48, 1999; Hughes & Ferrett, 2016).

Figure 3: Checklist for human factors in the workplace

Source: (HSG48, 1999; Hughes & Ferrett, 2016).

2.5. Factors Influencing Health and Safety in Construction: A Focus on Human Elements in Developing Countries:

This section begins by acknowledging the H&S risks inherent in the construction industry, which are especially pronounced across various regions facing distinct safety challenges. As discussed earlier, the situation is particularly acute in developing countries, where construction projects often face resource limitations and insufficient health and safety regulations, making the likelihood of accidents and injuries more apparent.

Adetunji et al. (2024) have contributed to the existing knowledge by focusing on the Nigerian construction industry. They aimed in their research to enhance health and safety (H&S) performance in this sector and identify factors and approaches that could strengthen H&S practices in the Nigerian construction industry. This is important for grasping H&S's obstacles and potential remedies concerning H&S within this context. Their findings to improve H&S in the Nigerian construction sector along with their categorisation are presented in Table 2 below:

Table 2: Factors to improve H&S in the Nigerian Construction sector.

Factor	Discussion	Category
Establishment of the Nigerian Construction Industry Development Board	This can be categorised under Regulatory factors as it relates to establishing a governing body that could enforce standards and regulations and developing the country's H&S plan.	Regulatory
Technical assistance, and collaboration among construction professionals	Within the context of this research, this factor primarily falls under the organisational dimension due to its focus on enhancing organisational capabilities, fostering a collaborative environment, and promoting knowledge sharing.	Human factor-organisational dimension
Skill development in the management and communication of (H&S)	This factor falls under both the individual and organisational dimensions, as it involves personal competency in safety practices while also being influenced by the organisation's commitment to training, communication structures, and safety culture.	Human factor-individual & organisational dimensions

Awareness-raising and advocacy on H&S	This could be seen as a combination of organisational and Regulatory factors, depending on the source of the advocacy. However, Within the context of this research, it focuses on internal initiatives, and it could lean more towards the organisational dimension.	Human factor-organisational dimension
Use of the International Labour Organisation (ILO) mechanism on (H&S)	This is a Regulatory factor, as it relates to international standards and mechanisms that impact local practices.	Regulatory
An international collaboration with other professional bodies on (H&S)	Within the context of this research, this factor falls under the organisational dimension. However, they also incorporate elements of Regulatory and Global/International factors due to the nature of the collaborations and their objectives.	Human factor-organisational dimension Regulatory
Proper monitoring and recording of all injuries	This is an organisational factor, as it involves the implementation of systems and processes within an Organisation to track and manage H&S incidents and to ensure compliance with H&S policy.	Human factor-organisational dimension
Adequate allocation of resources (human, financial, and technology) on H&S	This can be categorised under organisational factors, as it deals with how resources are distributed and utilized within the organisation to support OHS initiatives. Adequate resource allocation can support better job design, training, and establishing a safety-focused culture within an organisation.	Human factor-organisational dimension

Source: Adetunji et al. (2024).

Findings from Adetunji et al. (2024) indicate that the primary factors for improving health and safety (H&S) are within the regulatory and organisational dimensions of human factors. This aligns with previous discussions in section 2.3 about the lack of robust H&S regulations in developing countries leading to poor organisational safety practices and structures. The deficiency in strict and enforced regulations often results in poor safety protocols, awareness deficits, and insufficient H&S resource allocation within organisations. This finding also aligns with insights from Alkilani et al. (2013), who identified that the lack of government commitment, reflected through inadequate regulations, policies, and legal structures, significantly obstructs the advancement of effective H&S practices.

In another study also carried out in Nigeria, Kukoyi and Adebowale (2021) ranked the impediments to effective H&S performance in the construction sector. Their findings, along with their categorisation, are presented in Table 3.

Table 3: Impediments to effective H&S performance in Nigeria.

Factor	Discussion	Category
Inadequate legislation and regulation	This falls under the Regulatory category. It concerns the external legal and regulatory framework that governs H&S practices in the workplace.	Regulatory
Inadequate H&S officers	This factor can be classified under both organisational and Individual factors. Organisationally, it points to the lack of resources allocated to H&S roles; individually, it may reflect on the qualifications of the H&S professionals.	Human factor-organisational & individual dimension
Corruption	This is generally considered a broader regulatory issue, but it also affects the organisational dimension in how businesses conduct themselves and adhere to H&S standards.	Regulatory Human factor-organisational dimension
Poor H&S monitoring	This falls under organisational factors, highlighting weaknesses in the systems and processes established by organisations to ensure ongoing adherence to H&S standards.	Human factor-organisational dimension
Poor H&S awareness	This can be attributed to Individual factors, as it deals with the knowledge and consciousness of H&S among workers, but also reflects Organisational shortcomings in educating employees.	Human factor-organisational & individual dimension
Inadequate H&S training	This is an Individual factor since it involves the personal development and skills of each worker. It also touches on the Organisational factor, as it relates to the provision of training by the employer.	Human factor-organisational & individual dimension
Workers' low levels of education	This is an individual factor, as it pertains to the workers' background and capabilities. However, it can also be considered organisational in terms of how companies adapt to and compensate for varying educational levels in the workforce through training and support.	Human factor-individual & organisational dimension

Source: Kukoyi & Adebowale (2021)

In reviewing the findings, notable similarities emerge between Adetunji et al. (2024) and Kukoyi and Adebowale (2021), strengthening the reliability of their results. The

investigation conducted by Kukoyi and Adebowale (2021) reinforced the importance of the regulatory and organisational dimension in enhancing and improving H&S outcomes. Furthermore, they expanded the discussion by emphasising the significance of the individual dimension of human factors, suggesting that training and education are key elements in the health and safety (H&S) equation.

While Adetunji et al. (2024) and Kukoyi and Adebowale (2021) offer valuable insights into the impact of the regulatory and organisational dimension of human factors on health and safety outcomes, their analysis may be critiqued for omitting critical economic factors. However, their studies lack a thorough consideration of economic factors, which are essential in the developing countries' context. As discussed earlier in section 2.3, research by Buniya et al. (2021), Shamsuddin et al. (2015), and Rashid et al. (2023) underscored that developing nations often prioritize economic concerns over H&S initiatives, and factors like resource constraints, project timelines, and cost limitations can significantly influence a company's ability to prioritise and implement robust safety measures.

In a study carried out in Ghana, Boadu et al. (2020) identified and ranked factors affecting health and safety (H&S) within the construction industry. Their research explored the characteristics of the industry that impact H&S management. By examining these factors, the study aimed to provide a better understanding of the unique challenges faced in ensuring H&S standards in construction projects in developing countries. These findings, along with their categorisation, are presented in Table 4:

Table 4: The impact of Ghana's construction industry characteristics on H&S management

characteristics	Discussion	Category
The lack of skilled and educated workforce	Primarily, this is an Individual factor, as it relates to the workers' background and capabilities. However, it can also be considered organisational in terms of how companies adapt to and compensate for the educational levels of their workforce through training and support.	Human factor-individual & organisational dimension
Reliance on labour-intensive methods	Ghana's construction industry relies heavily on labour-intensive methods due to the high cost of equipment and limited access to financing. Labour is relatively cheap, making it a more economical choice, especially for smaller contractors. However, this approach increases the number of workers per activity, exposing more individuals to H&S risks. Categorisation: - **Economic**: Cost-driven reliance on labour over equipment. - **Regulatory:** Limited enforcement of H&S standards specific to labour-heavy sites.	Economic factor Regulatory factor
Lack of a single regulatory authority	The absence of centralised oversight impacts the enforcement and consistency of H&S standards.	Regulatory factor.
The huge number of informal sector participation	Ghana's construction industry is split between a formal sector, regulated and taxed, and an informal sector, which operates without registration, contracts, or H&S protections. Informal sector projects are typically small-scale, with workers lacking legal protections and often uninformed about safety laws. The government has little oversight or influence in this sector, making it difficult to enforce H&S standards. Categorization: - **Regulatory:** Minimal enforcement of H&S laws in the informal sector. - **Organisational:** The informal sector lacks formal structures and H&S practices. - **Economic:** Low-cost, small-scale operations prioritise affordability over safety.	Regulatory factor Human factor-organisational dimension Economic factor
Large number of small contractors	Ghana's construction sector mainly comprises small, family-run firms with low entry barriers, often struggling with competition and H&S management due to limited resources. This results in higher accident rates and a focus on survival over safety standards. Categorisation: - **Economic:** Limited financial resources prevent small firms from investing in H&S, or hiring large firms. - **Organisational:** Small contractors lack structured H&S management systems.	Regulatory factor Human factor-organisational dimension Economic factor

	- **Regulatory:** Low entry barriers allow under-resourced firms to enter the market without strict H&S requirements.	
Procurement system	In Ghana, the British-influenced traditional procurement system is still the most popular procurement method but is criticized for inefficiency and poor Health and Safety (H&S) integration. The competitive tendering process, mandated by the 2003 Public Procurement Act, focuses on price, leading to underpricing and reduced investment in H&S. Categorisation: - **Regulatory**: Due to following poor inherited procurement system. - **Organisational**: Due to a focus on tender price rather than H&S. - **Economic**: As cost-driven tendering affects pricing strategies and Health and Safety (H&S) investment.	Regulatory factor Human factor-organisational dimension Economic factor
Reliance on temporary labour force	In Ghana, construction firms depend largely on temporary labour due to industry competition and fluctuating workloads. These workers face higher risks from limited H&S training, lack of union support, and a sense of being disposable, which discourages them from seeking safer conditions. Categorization: - **Economic:** Cost-saving reliance on temporary labour reduces H&S investment. - **Organisational:** Firms prioritise temporary hires but often neglect H&S training. - **Regulatory**: Limited regulations protect temporary workers' rights, allowing firms to overlook their safety needs.	Regulatory factor Human factor-organisational dimension Economic factor
The colonial influence	The Ghanaian construction industry derives its practice from the old British construction industry. Old standards and methods are mismatched with local cultural and administrative needs. This factor relates to the Regulatory factor.	Regulatory factor
Fragmented industry	Ghana's construction industry is fragmented, with a clear separation between design and construction roles, often leading to adversarial relationships and poor communication. This lack of coordination impacts project outcomes and limits the early identification of H&S risks. Categorisation: - **Regulatory**: Traditional systems reinforce the separation of roles without requiring H&S integration at the design stage. - **Organisational**: Fragmented structures and poor collaboration increase project complexity and H&S risks.	Regulatory factor Human factor-organisational dimension Economic factor

	- **Economic**: Fragmentation leads to inefficiencies, rework, and potential cost overruns, impacting overall project safety investment.	

Source: Boadu et al. (2020)

When comparing the research findings of Boadu et al. (2020) with previous studies conducted by Adetunji et al. (2024) and Kukoyi and Adebowale (2021), a common agreement emerges regarding the importance of regulatory and organisational aspects of human factors. However, Boadu et al. (2020) extends this perspective by emphasising the critical role of economic factors in shaping H&S practices within the construction industry in developing countries. This additional perspective provides a more holistic view, especially about the earlier discussions on economic influences in developing nations. Furthermore, Boadu et al. (2020) highlighted how historical colonial legacies continue to impact the regulations governing Ghana and other African nations, offering insights into how past heritage can have adverse effects on current H&S standards.

It is evident from the above studies that there is a direct relationship between the presence of strong regulatory frameworks and the strength of the organisational dimension. Strong regulatory frameworks form the backbone of effective organisational structures and practices. When a regulatory system is well-established and effectively enforced, it creates a powerful impact, empowering organisations to build resilient frameworks, adopt best practices, and foster a robust health and safety (H&S) management system.

In Asia, Ashebir et al. (2020) identified the key determinants influencing health and safety (H&S) management within the construction sector in Hengyang, a rapidly expanding industrial city and a key transportation centre in the Hunan province, which is currently experiencing swift infrastructural growth in China. Health and safety policy, work environment, and health and safety inspection were ranked as the first three important factors affecting H&S management in construction sites.

Ashebir et al. (2020) findings fit within the realms of Human Factors, specifically within the Organisational and Job dimensions. Here's how:

- **Health and Safety Policies**: This point mainly corresponds with the organisational dimension of human factors. It involves the development of a framework and set of guidelines that govern the management of health and safety within the workplace.
- **Work Environment**: This point relates to the job dimension. It covers the environment in which workers operate, which should be designed according to ergonomic principles and human capabilities.
- **Health and Safety Inspections**: This factor mainly pertains to the organisational dimension of human factors. Regular inspections ensure H&S policies are followed and adhered to, assessing the job and work environment compliance.

Following a similar investigative path, Othman et al. (2017) explored methods to enhance H&S performance in Malaysia's construction sector. Their research outcomes, categorised for clarity, are detailed in Table 5 below:

Table 5: Factors Affecting Effective / Improper Safety Management in Malaysia

Factor	Discussion	Category
Safety training and awareness	This is an Individual factor since it involves the personal development and skills of each worker. It also touches on the organisational factor, as it relates to the provision of training by the employer.	Human factor- individual & organisational dimensions
Worker's attitude towards safety	It also falls under the individual dimension; this factor involves personal perceptions and behaviours regarding safety practices on the job.	Human factor- individual dimension
Availability of safety equipment	This is associated with the job dimension, as it involves ensuring the necessary tools and protective equipment are provided to perform tasks safely.	Human factor- Job dimension
Safety inspections	This factor mainly pertains to the organisational dimension of human factors. Regular inspections ensure H&S policies are followed and adhered to, assessing the job and work environment compliance.	Human factor- organisational dimension

Organisation safety policy	This point mainly corresponds with the organisational dimension of human factors. It involves the development of a framework and set of guidelines that govern the management of health and safety within the workplace.	Human factor-organisational dimension

Source: Othman et al. (2017)

It is evident from Ashebir et al. (2020) in China and Othman et al. (2017) in Malaysia that all factors affecting H&S in construction were human factors. However, there was a difference: in China, the human factors were limited to organisational and job-related aspects, while in Malaysia, all three dimensions of human factors —organisational, job-related, and individual— were deemed critical. Additionally, none of the studies referred to other regulatory or economic factors.

To further underscore this point, Shamsuddin et al. (2015) emphasised that accidents within the construction sector in Malaysia stem from a complex interplay of factors, predominantly attributed to workers' carelessness, deficiency of workers to follow work procedures, work at high elevation, running equipment without safety appliances, inadequacy of site management, tough work operation, poor understanding and low workers' skill, failing to use personal protective equipment, and poor workers H&S attitude. It is observed that all factors in Shamsuddin et al.'s (2015) study fall predominantly within the individual and job dimensions of human factors.

By comparing the above results, we find that in Africa, the primary factors influencing H&S are rooted in the regulatory and organisational dimensions of human factors, with a notable acknowledgement of the individual dimension and economic factors. Conversely, studies from China, such as Ashebir et al. (2020), and Malaysia, as reported by Othman et al. (2017) and Shamsuddin et al. (2015) primarily emphasised human factors across the three dimensions — organisational, individual, and job— without significant mention of economic or regulatory factors. This difference could be attributed to the more developed regulatory and

economic conditions in China and Malaysia, which may not present significant challenges to H&S in construction as they do in African countries.

In India, occupational health and safety standards are considered to be below global standards, as pointed out by Samanta and Gochhayat (2023). They outlined the primary challenges in this area in Table 6.

Table 6: Major Challenges for Health and Safety in India

Factor	Discussion	Category
Lack of proper communication	This is an organisational dimension, as effective communication strategies and systems are fundamental organisational responsibilities that influence safety culture and procedures.	Human factor- organisational dimensions
Non-use of personal protective equipment and safety measures	This factor relates to the individual dimension, as it implies personal behaviour and decision-making in following H&S instructions. Also, this could be considered a job dimension, particularly where the issues are tied to task-specific factors, like the use of inappropriate equipment or poorly designed PPE.	Human factor- individual & job dimension
Workplace ergonomics	This is a job dimension since it directly relates to the design of the job and how work is organised, impacting the physical health of workers.	Human factor- job dimension
Lack of training	This is an individual factor since it involves the personal development and skills of each worker. It also falls under the organisational factor, as it relates to the supplying of training by the employer.	Human factor- individual & organisational dimensions
Psychological factors such as stress and burnout.	This is an individual dimension that focuses on the mental and emotional aspects that affect an individual worker's H&S.	Human factor- individual dimension
Lack of safety orientation and culture	This is an organisational dimension, as it concerns the overall safety policy, practices, and environment created by the organisation.	Human factor- organisational dimension
Issues lying in compliance with appropriate legislation	In the context of this research, many H&S regulations exist in India, the challenge primarily exists in following and enforcement of these regulations. Also, it could be categorised categorise it under the organisational factor because of the failure of companies to comply with H&S regulations.	Regulatory factor Human factor- organisational dimension

Source: Samanta and Gochhayat (2023)

Similar to the previous studies in Asia, Samanta and Gochhayat (2023) emphasised the significance of human factors in their three dimensions. Furthermore, they introduced an additional regulatory factor, which is not about the availability of these regulations but in their enforcement. Despite India's extensive (H&S) regulations, enforcement remains a significant challenge, particularly in the unorganised sector, where applying these laws proves difficult.

The challenges highlighted by Samanta and Gochhayat (2023) for occupational health and safety (H&S) in India align closely with broader trends observed across South Asia, including India, Nepal, and Bangladesh, where Bajracharya et al. (2023) similarly emphasized that despite existing regulations and safety measures, construction sites in the region continue to experience frequent accidents and injuries. The key findings of Bajracharya et al. (2023) are included in the table 7 below:

Table 7: key factors contributing to H&S issues faced by construction workers in South Asia

Factor	Discussion	Category
Lack of investment in training and education programmes	Insufficient organizational commitment to worker development and safety awareness programs	Human factor - organizational dimension
Weak regulatory oversight	Inadequate enforcement of safety measures despite regulatory frameworks.	Regulatory factor
Lack of awareness,	Reflects gaps in both individual understanding of safety protocols and organizational failures to effectively communicate safety priorities.	Human factor - individual & organizational dimensions
Inadequate training	Insufficient training programmes for workers reflect both individual skill gaps and organisational shortcomings.	Human factor - individual & organizational dimensions
Poor working conditions	Unsafe and unhealthy environments directly affect task performance and safety.	Human factor - job dimension

Source: Bajracharya et al. (2023)

Both Samanta and Gochhayat (2023) and Bajracharya et al. (2023) highlighted similar challenges across South Asia, emphasizing inadequate training, unsafe working conditions, organizational failures in implementing effective training and raising H&S awareness, as well as weak regulatory enforcement.

In summary, in developing countries, the organisational dimension of human factors and regulatory framework dominate in Africa, with a lack of regulations and poor organisational practices being the most critical barriers, compounded by economic constraints such as resource limitations and reliance on informal labour, which further undermine safety practices. In Asia, H&S challenges primarily span the three dimensions of human factors—organisational, individual, and job—. While economic factors are less emphasised due to relatively stronger regulatory and resource frameworks in most parts of the region, weak enforcement of existing regulations presents a challenge in some countries, such as India and South Asia.

Overall, the Organisational Dimension is a prominent factor in both regions, but Africa emphasises regulatory gaps, while Asia addresses a broader range of human factor dimensions.

2.6. Factors Influencing Health and Safety in Construction: A Focus on Human Elements in Developed Countries:

Hide et al. (2003) conducted a study at Loughborough University and Manchester Centre for Civil and Construction Engineering for the Health and Safety Executive, supported by contributions from construction companies. Researchers analysed 100 construction accidents and conducted focus groups with industry stakeholders to explore how project design, work organisation, task factors, and individual behaviours influence safety. Key findings are summarised in Table 8 below.

Table 8: Causal factors in construction accidents in the UK

Discussion	Category
Problems arising from workers or the work team, especially worker actions or behaviour and worker capabilities, were judged to have contributed to over two-thirds (70%) of the accidents. This points to inadequate supervision, education and training.	Human factor-individual dimensions & organisational dimension
Poor communication within work teams contributed to some accidents, due to the physical distance between work colleagues or high levels of background noise.	Human factor-job dimension
In many cases, the accident occurred when those involved were not performing a construction task but moving around the site.	Human factor-job dimension
Workplace factors, most notably poor housekeeping and problems with the site layout and space availability, were considered to have contributed to half (49%) of the accident studies. Standards of housekeeping and workplace layout concerning safety are low in construction when compared with other industrial sectors.	Human factor-job dimension
Shortcomings with equipment, including PPE, were identified in over half (56%) of the incidents. Poor equipment design and inappropriate use of equipment for the task were prominent aspects of this. Designers, suppliers and purchasers of equipment appear to give insufficient attention to the safety of users.	Human factor-job dimension
Deficiencies with the suitability and condition of materials, including packaging, featured in more than a quarter (27%) of incidents. The operation of the supply/purchase chain at present appears to act as a barrier to innovation as far as safety is concerned.	Human factor-job dimension External factor/ Supply chain
Originating influences, especially inadequacies with risk management, were considered to have been present in almost all (94%) of the accidents	Human factor-job dimension
Frequently, no risk assessment had been undertaken covering the circumstances involved in the accident. Where a risk assessment had been carried out, it was often found to be superficial and unlikely to have prevented the accident.	Human factor-job dimension
It appears that PPE is relied upon habitually as a substitute for risk elimination or reduction at source	Human factor-job dimension
It was judged that up to half of the 100 accidents could have been mitigated through a design change and it was found that, many designers are still failing to address the safety implications of their designs and specifications.	Human factor-job dimension
Accident investigation by employers or supervising contractors is frequently superficial and of little value as far as improving safety is concerned. It appears that HSE investigations generally focus on safety failures in the activity being undertaken, without capturing the upstream influences upon these.	Human factor-organisational & individual dimension
Many of the incidents were caused by commonplace hazards and activities that will continue to occur on-site whatever design changes might be made. The widespread presence of the many generic safety risks accompanying construction needs to be tackled before the benefits of design improvements will be realised.	Human factor-job dimension

Source: Hide et al. (2003)

The study by Hide et al. (2003) identified the job dimension as the most significant factor influencing health and safety (H&S) in the UK construction industry. Issues such as poor communication and housekeeping, inadequate site layout, equipment and material deficiencies, and superficial risk assessments were linked to most accidents, highlighting how task design and environmental factors play a critical role in safety outcomes.

Workers' behaviour and capabilities, such as carelessness and lack of training, contributed to over 70% of accidents, highlighting the role of the individual dimension. The organisational dimension, including inadequate supervision and superficial accident investigations, also contributed to accidents, but their impact appeared less pronounced. This reduced impact is likely due to the availability of numerous H&S regulations and Health and Safety Executive (HSE) guidelines in the UK, which have noticeably enhanced organisational practices. The study also underscored the importance of education and training in improving the safety culture in construction. Furthermore, it was found that bad weather has a low impact on safety as may be expected.

In another comprehensive study carried out by Tutesigensi and Reynolds (2008), an exhaustive analysis was performed on the causative factors behind construction accidents, gauging them based on the number of workdays lost, within a prominent construction companies in the UK between April 2004 and March 2007. This research studied major contracting organisations in Great Britain, managing major construction sites nationwide, with a workforce exceeding 3,400 employees and annual revenues of over £400 million. The investigation revealed a strong correlation between construction site accidents and the attitudes of workers towards H&S. The research pinpointed the primary causes of accidents within the contractor's sites as follows:

- Workers' errors, accounting for 1108 days lost, predominantly reflecting the individual dimension of human factors.
- Work method, accounting for 356 days lost, related to the job dimension of human factors.
- Use of poor-quality equipment, resulting in 170 days lost, related to the job dimension of human factors.

Similar to Hide et al. (2003), Tutesigensi and Reynolds (2008) advocated for an enhancement in H&S awareness among employees, achievable through consistent, effective training programmes.

Adding further insights, Saeed (2017) identified several common factors contributing to high rates of construction accidents in the UK, which are predominantly related to the job and individual dimensions, with minor contributions from the organisational dimension. These factors include inadequate safety training, poor construction planning, flawed design, risky worker behaviour, and insufficient knowledge of site rules. The findings emphasise the significance of job design, training, and individual worker behaviour on H&S outcomes, echoing the focus on the job and individual dimensions highlighted by Hide et al. (2003) and Tutesigensi and Reynolds (2008).

In comparison, the studies by Hide et al. (2003), Tutesigensi and Reynolds (2008), and Saeed (2017), all highlighted the significance of the job and individual dimensions of human factors in influencing health and safety (H&S), with most factors primarily related to these dimensions. While the organisational dimension was acknowledged, its role was less prominent in these studies. Hide et al. (2003) and Tutesigensi and Reynolds (2008) also underscored the importance of enhancing workers' training, attitudes, and H&S awareness to improve safety outcomes.

While the organisational dimension was underemphasised in these studies, Meekel et al. (2011) explored the relationship between organisation size and compliance with H&S practices. Their findings revealed that larger organisations demonstrated higher compliance with H&S procedures and regulations, whereas medium-sized organisations showed a decline in their commitment to H&S practices, and small organisations reported even lower compliance levels. These variations underscore the critical role of organisational factors, particularly in smaller companies, where limited resources and reduced oversight may impede effective H&S management.

This variance in H&S compliance and practice across different organisational sizes provided the basis for the study by Aboagye-Nimo et al. (2011), which delved into H&S within small construction firms in the UK. Contrasting with Tutesigensi and Reynolds (2008) who focused on a major construction company with a presumably robust organisational management system, Aboagye-Nimo et al. (2011) found that in smaller firms, H&S heavily depends on the safety culture cultivated by workers, influenced by company owners. In this context, the crucial role of education, effective leadership, management, and on-site communication practices becomes evident.

Reinforcing the insights of Tutesigensi and Reynolds (2008), Hide et al. (2003), and Saeed (2017), which underscored the job and individual dimension of human factors as key factors affecting H&S in the UK, Abdelhamid and Everett (2000) had earlier developed the Accident Root Causes Tracing Model (ARCTM) in the USA to refine construction accident investigations. Their philosophy could be summarised in three major points:

- Workers who do not have the appropriate training or knowledge of their job should not be expected to recognise and avoid all unsafe conditions surrounding their job and avoid accidents.

- If the workers have training and knowledge, their attitude will decide whether to work safely or unsafely.
- Management practices should be planned to proactively detect and eliminate hazardous situations, and management should always reinforce the importance of safety between workers.

Similar to Tutesigensi and Reynolds (2008) and Hide et al. (2003), Abdelhamid and Everett (2000) emphasised the importance of workers' training and attitude in avoiding accidents. Even when addressing the importance of management role, they underscored its responsibility to reinforce the importance of H&S among workers.

2.7. Overview of H&S Management in Construction in the UK

Health and safety (H&S) in construction is significantly more regulated in the UK than in other parts of the world, this is demonstrated through the implementation of key regulations such as the Health and Safety at Work Act 1974, the Management of Health and Safety at Work Regulation 1999, and the Construction (Design and Management) Regulations 2015. These frameworks were instrumental in building strong guidelines to ensure workplace safety. With more strict enforcement and a proactive attitude toward safety compared to nations with less mature regulatory conditions, the UK has been rewarded with significant reductions in accident rates and better compliance.

In 2023, the Health and Safety Executive HSE (2023) reported significant progress, noting a reduction in recent decades in both fatal and non-fatal workplace injuries. This points out a notable advancement in H&S practices within the construction industry in the UK.

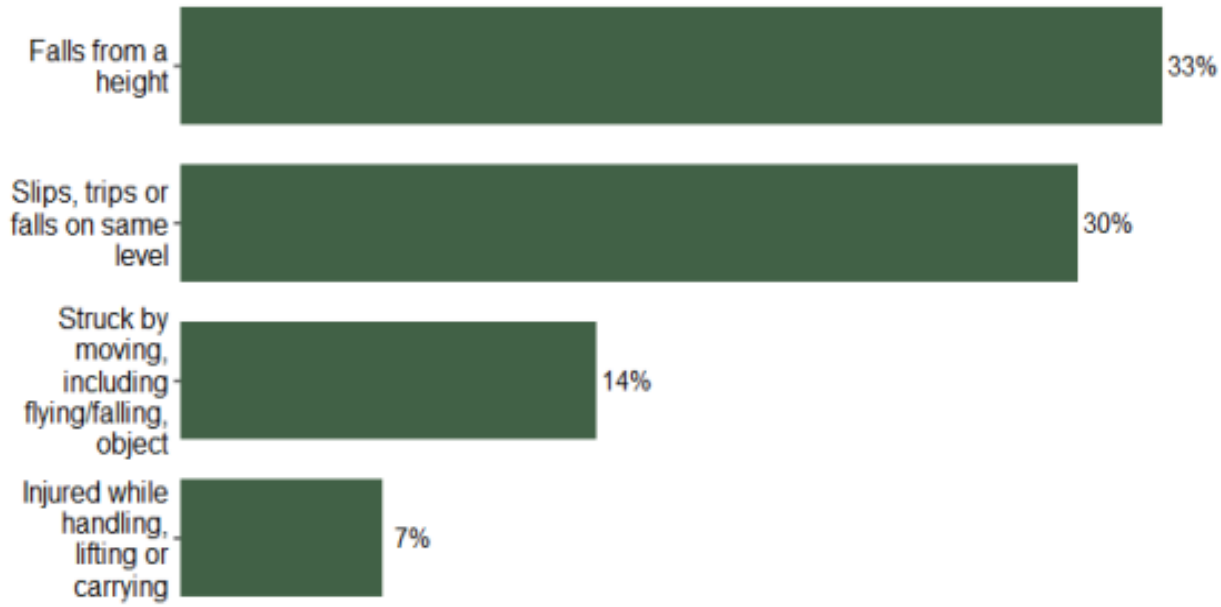
Similarly, a study by Duryan et al. (2020), found that accidents and fatalities have decreased in the construction industry in the UK in recent decades. They attributed this tendency to the improvements and enhancements made in the H&S management system.

However, they also noted that despite these improvements, H&S statistics have now plateaued, which indicates the need for further advancements in H&S management practices. This pressing call for action was emphasised by a report from the Institution of Engineering and Technology (IET, 2016), which highlighted a concerning fact: although construction workers make up 5% of the UK's workforce, they contribute to 31% of all work-related fatalities showcasing the disproportionate risks faced by those employed in the construction field.

As evidence of the H&S improvement in the UK, HSE (2023) in its statistics in the UK compared with European countries stated that the UK's performance in H&S is viewed positively in Europe. The country had one of the lowest rates of work-related fatalities in 2018 at 0.61 per 100,000 workers, which is much better results compared to countries like France, Italy, Spain and Poland although slightly behind Germany. Additionally, in 2020, the UK's rates of non-fatal workplace injuries and illnesses were lower compared to many European countries. Furthermore, HSE (2023) referred that Surveys conducted by Eurofound and the European Agency for Safety and Health at Work EU OSHA indicated that UK workers have a good level of confidence in their job safety. Moreover, UK businesses are more inclined to implement H&S protocols and conduct risk assessments compared to their European counterparts.

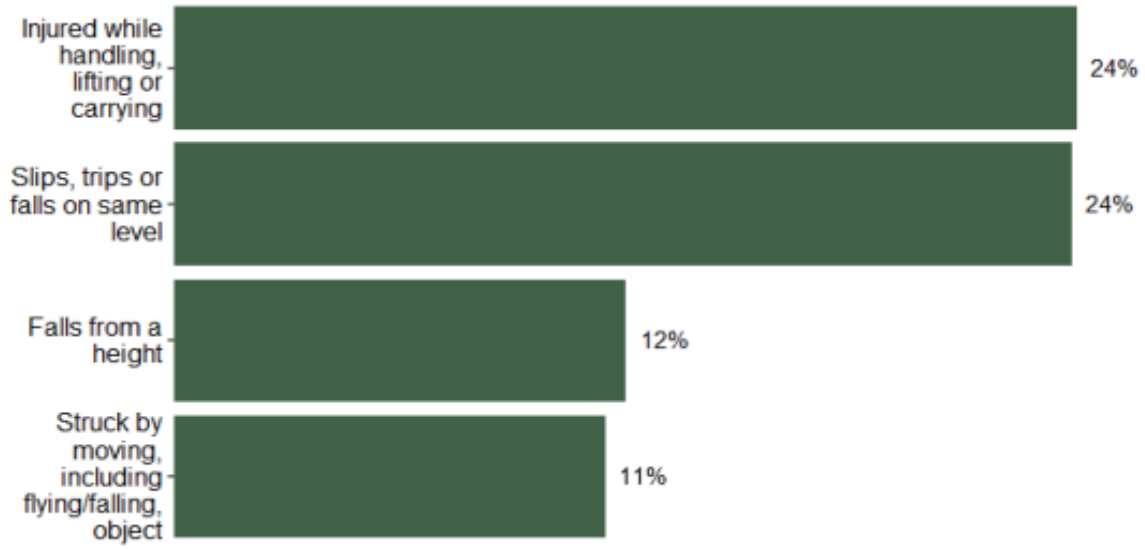
According to the HSE (2023), the construction sector in the UK reported 4,038 non-fatal injuries to workers. Of these, 1,539 (38%) were specified injuries, (specified injuries including fractures, amputations, significant loss or reduction in sight, serious burns, any scalping requiring hospital treatment, loss of consciousness, and injuries sustained from working in an enclosed space). The remaining 2,499 (62%) were injuries that incapacitated a worker for more than seven days. The direct causes of these accidents are detailed in Figures 4 and 5 below.

Figure 4: Percentage of non-fatal work-related specified injuries by accident kind in Construction in the UK



Source: HSE (2023).

Figure 5: Percentage of non-fatal work-related injuries resulting in incapacitation of a worker for over seven days by accident kind in Construction in the UK

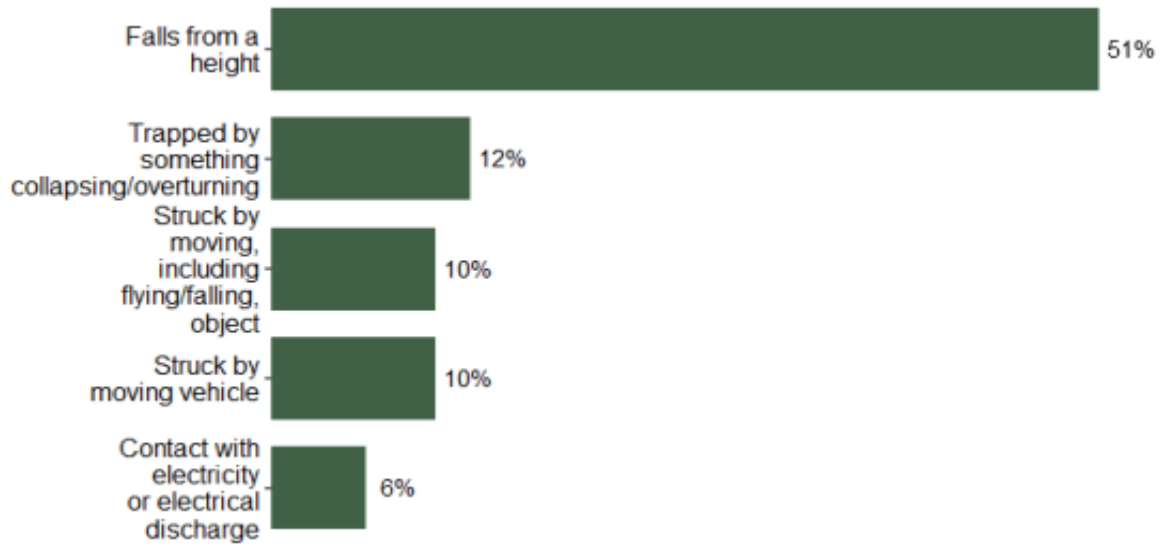


Source: HSE (2023).

Concerning ill health, according to HSE (2023), 69,000 workers sustained work-related ill health (new or long-standing) over the three years 2020/21-2022/23. Of these, 54% were cases of musculoskeletal disorders, 24% were work-related stress, depression or anxiety, and 5.8% involved Lung disorders. The remaining cases pertained to other conditions.

Lastly, according to the Health and Safety Executive HSE (2023), the construction industry recorded 45 fatalities in 2022/23p, exceeding the five-year annual average of 37 fatalities. Additionally, three members of the public lost their lives, compared to the annual average of four fatalities between 2018/19 and 2022/23p. Figure 6 illustrates the primary direct causes contributing to these fatalities:

Figure 6: Percentage of fatal injuries by accident kind in Construction in the UK



Source: HSE (2023).

Section 2.6 revealed that the root causes of health and safety (H&S) accidents in the UK construction sector are primarily related to the job and individual dimensions of human factors. These results were supported by the research of Hide et al. (2003), Saeed (2017), and Tutesigensi and Reynolds (2008), who highlighted the importance of education, training, and raising H&S awareness among workers as key strategies for improving H&S performance.

Health and Safety Legislative Framework the UK Construction Industry

Health and safety (H&S) in the UK construction industry is not a stand-alone issue, it is an integral part of the broader legal framework, governed by an act and various regulations to ensure compliance and enforcement. The Health and Safety Executive (HSE) is Britain's national authority overseeing workplace health and safety regulation (GOV.UK, 2024). Key legislative instruments shaping H&S practices in construction include The Health and Safety at Work etc Act 1974 (HSWA 1974), The Management of Health and Safety at Work Regulations 1999, and The Construction (Design and Management) Regulations 2015 (CDM 2015).

The Health and Safety Executive (HSE), as underscored by EHS Insight Resources (2020), is an independent body set up under The Health and Safety at Work etc. Act 1974 (HSWA1974) and is responsible for enforcing workplace H&S legislation. The HSE has powers to enforce employers' duties, impose penalties for non-compliance with their responsibilities, and ensure compliance with all current H&S regulations and laws. The executive also has the authority to carry out relevant H&S research, follow up on concerns regarding dangerous working conditions and investigate significant accidents. In severe cases, they are empowered to halt activities and take legal action against those who break the rules.

The Health and Safety at Work etc Act 1974 (HSWA1974) is an Act of Parliament in the UK. As stated by Hughes and Ferrett (2016), it is the cornerstone of British H&S law. It places a duty of care on all parties involved in the work process, including employers, workers, owners, occupiers, designers, suppliers, and producers of goods and materials used in the workplace. The Act also applies to self-employed individuals. The HSWA1974 Act is an enabling Act, which allows the Secretary of State to make supplementary laws which are known as Regulations. Table 9 includes the list of Regulations under the HSWA1974:

Table 9: Chronological list of H&S Regulations in the UK

Year	Title	Year	Title
1977	Safety Representatives and Safety Committees Regulations	2002	Dangerous Substances and Explosive Atmospheres Regulations
1981	Health and Safety (First Aid) Regulations	2002	Control of Substances Hazardous to Health Regulations
1989	Electricity at Work Regulations	2004	Control of Substances Hazardous to Health (Amendment) Regulations
1989	Health and Safety (Information for Employees) Regulations	2005	The Fire Scotland Act
1992	Health and Safety (Display Screen Equipment) Regulations	2005	The Hazardous Waste (England and Wales) Regulations
1992	Manual Handling Operations Regulations	2005	Work at Height Regulations
1992	Personal Protective Equipment at Work Regulations	2005	The Regulatory Reform (Fire Safety) Order
1992	Workplace (Health, Safety and Welfare) Regulations	2005	Control of Vibration at Work Regulations
1996	Health and Safety (Safety Signs and Signals) Regulations	2008	The Supply of Machinery (Safety) Regulations
1996	Health and Safety (Consultation with Employees) Regulations	2008	European Regulation on Classification, Labelling and Packaging of Substances and Mixtures (CLP Regulation)
1997	Confined Spaces Regulations	2010	The Control of Artificial Optical Radiation at Work Regulations
1998	Provision and Use of Work Equipment Regulations (except Part IV – Power Presses)	2011	The Waste (England and Wales) Regulations as amended 2012
1998	Lifting Operations and Lifting Equipment Regulations	2012	The Health and Safety (Fees) Regulations (Regs 23–25)
1998	Employers Liability (Compulsory Insurance) Regulations	2012	The Control of Asbestos Regulations
1999	Control of Substances Hazardous to Health Regulations	2013	The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
1999	Ionising Radiations Regulations	2013	The Health and Safety at Work etc. Act 1974 (Civil Liability) (Exceptions) Regulations
1999	Management of Health and Safety at Work Regulations	2015	Construction (Design and Management) Regulations

Source: Hughes and Ferrett (2016).

The Construction (Design and Management) Regulations 2015 (CDM 2015) are the main set of regulations governing the management of health, safety and welfare in construction projects in the UK. These regulations were first introduced in 1994. Have since undergone

multiple updates with the most recent revision taking effect on April 6, 2015. They outline the requirements for every phase of a construction project from initial planning to completion as well as the responsibilities assigned to each duty holder (Client, Designers, Principal Designers, Contractors, Principal Contractor), ensuring projects are executed in a manner that maintains health and safety.

The key elements that led to significant improvements in H&S as a result of the Construction (Design and Management) Regulations (CDM) include the effective management of hazards through the application of the general principles of prevention, the timely appointment of competent individuals and organisations, and ensuring that all workers receive the necessary information, training, and supervision for safe work practices. CDM also requires duty holders to work together effectively and to consult with workers to actively promote health, safety, and welfare measures (HSE, 2015).

Despite recognising the advantages of CDM 2015 regulations for health and safety (H&S) management, there are some critiques. Hide et al. (2003) pointed out a problem: clients often lack sufficient influence over H&S in construction, even though CDM 2015 assigns duties to them. Furthermore, they found that half of the 100 accidents they examined could have been prevented by following appropriate measures during the design stage. This showed that, despite CDM 2015 assigning duties on designers, many still struggle to incorporate H&S considerations into their designs and specifications. The perception, among clients and designers, that their obligations under CDM are merely paperwork has resulted in a lack of understanding and enforcement of these regulations. Additionally, there is a perception that these regulations transfer responsibility onto clients, who have traditionally been seen as the duty of contractors.

2.8. Overview of H&S Management in Construction in Saudi Arabia

Saudi Arabia, the world's leading oil exporter, has experienced robust economic growth, particularly impacting its construction sector which has witnessed considerable expansion (Husein, 2014). According to the chairman of the Saudi Contractors Authority, the sector is valued at over SAR 255 billion ($68 billion), representing 6% of the Kingdom's gross domestic product (Arab News, 2023). Construction is an important driver of the Saudi's economic growth and urban development. According to GlobalData (2024) in 2024, Saudi Arabia's construction industry is expected to grow by 4.6% pushed by investment in key sectors such as transportation, energy, and housing. The Saudi government plans to increase its 2024 budget by 12.3% to SAR 1.3 trillion ($333.6 billion), focused on healthcare, education, and infrastructure projects. As the construction sector is projected to grow annually by 5.2% from 2025 to 2028, major initiatives such as the NEOM project and the government's National Investment Strategy are set to boost industry growth and support the goals of Saudi Vision 2030, enhancing economic diversification and increasing employment.

Mahboob (2023) emphasised the significant role of Saudi Arabia's construction industry in driving the nation's economic development. The value of awarded contracts rose from SAR 106 billion in 2016 to over SAR 192 billion in 2022, reflecting robust growth in the sector. Moreover, The Arab Gulf Cooperation Council (GCC) countries collectively have projects valued at more than $2.6 trillion, with Saudi Arabia leading the region with projects worth over $1.6 trillion.

Saudi Arabia's construction sector is one of the country's largest private employers, accounting for 41% of the private-sector labour force, with over 2.174 million workers as reported by Moosa et al. (2020). However, this sector has also been plagued by significant safety challenges. In 2018 alone, it accounted for nearly half (48%) of all workplace injuries in

the Kingdom, totalling 32,557 incidents. Alarmingly, these figures may not fully reflect the true scale of the problem. According to Moosa et al. (2020) many construction workers are unregistered or lack proper work permits, meaning official statistics likely underestimate the actual accident rates.

Al Haadir and Panuwatwanich (2011) emphasised that despite the growth of Saudi Arabia's economy and its rise as a leading economy in the Middle East, the performance of health and safety (H&S) in the construction sector remains inadequate, with overall H&S standards in Saudi construction are relatively low. Research conducted by Alasamri et al. (2012) compared H&S performance in three developed countries (the United States, the UK, and Australia) and five Arab nations (Saudi Arabia, Kuwait, Bahrain, Jordan, and the United Arab Emirates). Their findings indicated that Saudi Arabia displayed poor H&S performance, particularly regarding fatalities and severe injuries. In line with these concerns, Abukhashabah et al. (2020) noted that while the construction industry in Saudi Arabia has been expanding significantly over the past several years, it continues to host some of the most hazardous workplaces in the country, with accident rates in the construction sector surpassing those in other industries. More recently, Baghdadi (2024) highlighted that Saudi Arabia's construction boom, driven by Vision 2030, has also led to the sector having the highest workplace injury rates, further underscoring the persistent challenges in ensuring worker safety.

In recent years the Saudi construction sector has witnessed an improvement in health and safety (H&S) trends driven by government initiatives and heightened awareness of the significance of workplace safety. Under Vision 2030, the Saudi government has made improving H&S standards a priority in all industries including construction. The need for a safe and sustainable working environment is in line with the Vision 2030 ambition, focusing on international best practices (Vision 2030, 2023).

Building on this foundation, Saudi Arabia has become a regional leader in occupational safety and health (OSH), taking significant steps to enhance safety in workplace and reduce work-related incidents. Key initiatives under Vision 2030 include the 'Occupational Safety and Health Cadres' programme, which trains professionals, and the 'Establishment of the Centre for Studies, Research, and Innovation in Occupational Safety and Health' in collaboration with Umm Al-Qura University. Projects like 'Occupational Health Services' and 'Regulation of Work in High-Risk Occupations' aim to protect workers and align with global standards (Human Resources and Social Development, 2024).

These efforts have yielded tangible results: injury rates dropped from 416.1 to 287.8 per 100,000 workers, and fatality rates decreased from 3.828 to 1.12 per 100,000 workers over six years. Awareness programmes on occupational safety and health have reached 79% of workers, fostering a safety culture. The Kingdom also participates in global OSH initiatives, such as World Safety and Health Day and the Saudi International Conference on Occupational Safety and Health, which is an integral part of ongoing efforts to promote safety and health in the workplace and achieve sustainable development (Human Resources and Social Development, 2024).

Major governmental organisations in Saudi Arabia have also contributed to this progress. ARAMCO, for example, has maintained a strong safety culture through advanced safety management systems, extensive training programmes, real-time monitoring technologies, developed customised tools to track contractor safety performance, and strengthened emergency preparedness. In 2023, the company reported in its sustainability report that it delivered over 9 million hours of training and achieved a 16% reduction in total recordable case rates (Aramco, 2023).

Similarly, ENGIE has set new benchmarks in workplace safety at its PP11 power plant in Saudi Arabia, achieving 4,000 days without a Lost Time Accident (LTA) and surpassing 3 million accident-free work hours. This achievement is attributed to ENGIE's "No Life at Risk" policy, which prioritises accident prevention, rigorous HSE training, daily safety inspections, and contractor safety audits (ENGIE, 2022).

The Saudi Electricity Company (SEC) has also demonstrated a strong commitment to H&S, as outlined in its 2023 annual report. Through its HSE transformation programme, SEC has significantly improved workplace safety, achieving a 24% reduction in work-related accidents, a 53% decrease in lost-time injuries, and a 48% drop in vehicle accidents. The company has also intensified safety monitoring efforts, increasing safety tours by 280% and reducing traffic violations by 28% (Saudi Electricity Company, 2023).

Despite notable advancements in health and safety (H&S) led by major governmental organisations, regulatory gaps persist in Saudi Arabia's construction industry. Moosa et al. (2020) highlighted that the government does not directly regulate construction safety; instead, responsibility falls on construction companies, many of which fail to adhere to standard safety protocols.

Another issue is the disparity between large-scale government-backed projects and those in the private sector. While the former has made significant progress in safety, the latter often falls short. Mosly (2015) found that the private sector is the primary source of workplace accidents, particularly in small-to-medium-sized projects where safety measures are frequently overlooked or poorly implemented.

Almalki and Ammar (2019) investigated the reasons for the poor health and safety (H&S) performance in Saudi Arabia. They identified the top five most critical factors contributing to this issue, which are categorised and presented in Table 10:

Table 10: Most important factors affecting H&S performance in KSA

Factor	Discussion	Category
Safety Management	Safety management encompasses creating and implementing H&S policies, setting clear targets, and ensuring that H&S culture is prioritised across the Organisation. It involves the overall management of health and safety at every level within the company.	Human Factor-organisational dimension
Providing safety equipment and clothing	This is directly related to the specific requirements of the job. Providing safety equipment and clothing is essential to ensure that the physical requirements of the job do not endanger the H&S of the employees. It's about adapting the job to human needs, fitting into ergonomic considerations.	Human Factor-job dimension
Providing a site safety supervisor	The role of a site safety supervisor pertains to the Organisational structure of H&S management. This position is crucial for monitoring daily operations and ensuring compliance with safety standards, thus representing an Organisational commitment to health and safety.	Human Factor-organisational dimension
Provide safety training	The categorisation of safety training can be seen from two perspectives: as an Individual Factor and as an organisational factor. - The provision of safety training reflects the Organisation's commitment to health and safety. It is a crucial part of the safety management system, where the organisation is responsible for ensuring that all employees are adequately trained according to their roles and the risks associated with those roles. - Safety training is also categorised under individual factors because it directly impacts the skills, knowledge, and competence of each worker. Training equips individuals with the necessary information and abilities to perform their tasks safely and effectively, thereby, reducing the potential for human error and enhancing their safety practices.	Human Factor-organisational dimension Individual dimension
Providing safety administration	Safety administration involves the organisation's structural and procedural approach to managing H&S, including the monitoring, recording, and analysis of safety performance and incidents. This factor is integral to maintaining a proactive approach to health and safety within the organisational framework.	Human Factor-organisational dimension

Source: Almalki and Ammar (2019)

Almalki and Ammar (2019) noted that the key factors influencing health and safety (H&S) performance in KSA primarily fall within the scope of human factors with its three dimensions. Among these, the organisational dimension was notably predominant. The study

highlights those deficiencies in safety management, supervision, training, and administration—core organisational elements—are the leading contributors to poor H&S outcomes. However, they pointed out an important factor considered an individual factor that plays a significant role, as much of the construction workforce consists of immigrant workers from diverse backgrounds, often with limited training and language barriers, which further undermines safety performance.

The findings of Almalki and Ammar (2019) partially align with those of Al Haadir and Panuwatwanich (2011), who previously identified key factors in the successful implementation of construction safety programmes in Saudi Arabia, all of which fall within the dimensions of human factors. Al Haadir and Panuwatwanich (2011) focused primarily on organisational and individual factors, identifying seven critical factors that contribute to 80% of successful safety programme implementations in construction companies: (1) management support; (2) clear and reasonable objectives; (3) personal attitude; (4) teamwork; (5) effective enforcement; (6) safety training; and (7) suitable supervision. The study highlighted the predominance of organisational factors such as management support, clear objectives, effective enforcement within the organisation, supervision, and safety training. However, it also recognised the role of individual factors, particularly workers' personal attitudes and teamwork, in shaping safety outcomes.

Corroborating the findings of Almalki and Ammar (2019), Moosa et al. (2020) identified three primary factors contributing to accidents, which include inadequate leadership at the top of the firm (Organisational dimension), a lack of training (Organisational and Individual dimensions), and reckless operation of equipment (Job dimension). Their survey results underscore the pivotal role of managerial attitudes and broader human factors as the most critical safety issues, echoing patterns noted in recent literature. Furthermore, Moosa et al. (2020) emphasised the point made before by Almalki and Ammar (2019) that the Saudi

construction industry is heavily reliant on unregistered foreign workers who come from diverse backgrounds, which contribute to the rising accident rate.

Another relevant study by Abukhashabah et al. (2020) examined accident causes in Jeddah city in the Western Province of Saudi Arabia. Their findings generally align with those of Almalki and Ammar (2019), particularly in highlighting the pivotal role of human factors, though with a more even emphasis across organisational, job, and individual dimensions in influencing health and safety (H&S) outcomes. The study identified key causes of accidents and injuries, which are summarised in Table 11.

Table 11: Causes of accidents and injuries in Jeddah City

Factor	Discussion	Category
Lack of awareness and experience	This involves individual capabilities such as knowledge, experience, and awareness. Lack of awareness and experience affects how individuals perceive and react to risks. However, it's also an organisational issue because it reflects the company's effectiveness in recruiting qualified individuals and providing ongoing professional development and training.	Human factor-individual & organisational dimensions
Machinery defects and errors	This mainly pertains to the job environment and the tools and equipment used. Machinery defects and errors are directly related to the job's physical aspects, including the maintenance and proper functioning of equipment essential for safe operations.	Human factor-job dimension
Lack of training	Similar to point 1	Human factor-individual & organisational dimensions
Lack of personal protective equipment PPE	This is directly related to the specific requirements of the job	Human factor- job dimension
No safety and health officer or supervisor and an unsafe work environment	- **Organisational Factors**: The absence of a dedicated safety officer or supervisor and the presence of an unsafe work environment are clear indicators of Organisational failings. - **Job Factors:** An unsafe work environment also pertains to the job itself, as it relates directly to the conditions under which the job is performed. This includes everything from the physical layout and maintenance of the work area to the operational procedures in place.	Human factor-organisational dimension Job dimension

Source: Abukhashabah et al. (2020)

It is evident from the study by Abukhashabah et al. (2020) that all three dimensions of human factors—individual, organisational, and job-related—play a significant role in influencing health and safety (H&S) outcomes. While Almalki and Ammar (2019) stressed the predominance of organisational factors, Abukhashabah et al. (2020) offered a more balanced perspective, attributing equal importance to each of the three dimensions.

In another recent study carried out by Al-Otaibi and Kineber (2023) to find out the impediments to the implementation of the safety programme in Saudi Arabia, they found four barrier factors which are included in Table 12:

Table 12: Main impediments to the implementation of the safety programme in Saudi Arabia

Factor	Discussion	Category
The absence of a safety management programme, for example, is a sign of inadequate governance	**Organisational Factors:** This factor indicates a systemic failure within the Organisational governance and structure. The absence of a formal safety management programme reflects a lack of Organisational commitment and oversight, which is crucial for maintaining safety standards across the company.	Human factor-organisational dimension
Lack of safety awareness, which is supported by inadequate safety training, and knowledge, especially among senior management levels	- **Organisational Factors:** The failure to provide sufficient safety training and to cultivate safety awareness, especially at senior management levels, points to an Organisational deficiency. - **Individual Factors**: At an individual level, this manifests as a lack of knowledge and awareness about safety, which can affect behaviour and decision-making related to safety practices.	Human factor-organisational dimension Individual dimension
Unfavourable work environment due to lack of resources, and a lack of commitment and accountability for safety	- **Organisational Factors**: This factor is deeply rooted in the Organisation's approach to safety, where there is a clear deficit in allocating resources for safety measures and enforcing accountability for safety practices. Lack of commitment from the Organisation leads to an environment where safety is not prioritised.	Human factor-organisational dimension
Emphasis on speed and cost over safety standards	- Organisations prioritise project deadlines and budgets at the expense of safety. Additionally, gaps in regulatory enforcement contribute to weak industry standards.	Human factor-organisational dimension Non-Human Factor/ Regulatory Factor

Source: Al-Otaibi and Kineber (2023)

Al-Otaibi and Kineber (2023) concurred with previous studies, particularly Almalki and Ammar (2019), that the key factors influencing health and safety (H&S) performance in Saudi Arabia primarily fall within the scope of human factors, with a predominance of the organisational dimension. They also highlighted a critical issue related to the gap in the Saudi regulatory framework, which fails to compel companies to implement robust safety measures. This observation aligns with Moosa et al. (2020), who noted that the government in Saudi Arabia does not regulate safety in the construction industry, leaving the responsibility solely to the construction companies themselves. This lack of enforced regulations will result in poor organisational H&S culture and allow companies to prioritise productivity over safety.

A similar study by Sanni-Anibiri et al. (2018) investigated H&S conditions in the Eastern Province of Saudi Arabia and identified several key factors affecting health and safety:

- Poor communication between workers and supervisors. (Organisational and job dimensions of human factors)
- Prioritising productivity over safety. (Organisational dimension - Non-Human Factor/ Regulatory)
- Lack of employee involvement in developing safety policies. (Organisational dimension)
- Lack of morale and motivation among workers. (Individual dimension)
- Untested emergency procedures. (Organisational and job dimensions of human factors).

The findings of Sanni-Anibiri et al. (2018) broadly align with previous research, particularly that of Almalki and Ammar (2019) and Al-Otaibi and Kineber (2023) in emphasising the critical role of human factors—especially the organisational dimension—in influencing health and safety (H&S) outcomes. Furthermore, they agreed with Al-Otaibi and

Kineber (2023) and Moosa et al. (2020) that poor regulatory enforcement leads employers to prioritise productivity over H&S concerns.

Health and Safety Legislative Framework in the Saudi Arabian Construction Industry

The Saudi Labour Law 2005 which was created through Royal Decree No. M/51 issued on 23/8/1426H (27 September 2005), forms the cornerstone of health and safety legislation in Saudi Arabia. The Ministry of Human Resources and Social Development (HRSD) is responsible for issuing supplementary ministerial resolutions, providing updates, and offering implementation guidelines to ensure the law remains relevant and effective (rivermate, 2024).

Unlike the UK, where - as discussed earlier - the primary health and safety legislation is the Health and Safety at Work etc Act 1974 (HSWA 1974), supplemented by a comprehensive set of regulations (see Table 9), and the Health and Safety Executive (HSE) acts as an independent regulator responsible for enforcing workplace H&S legislation and developing a vast library of health and safety guidance documents, the Saudi Arabian approach to H&S is embedded within a broader employment framework. Specifically, only Chapter 8 of the Labour Law (Articles 121–148) directly addresses occupational hazards, major industrial accidents, and work-related injuries (HRSD, 2005).

These articles impose explicit duties on employers under the Labour Law, such as:

- Article 121: Maintaining safe and hygienic work environments.
- Article 123: Providing protective equipment and training.
- Articles 125–126: Ensuring fire safety, emergency planning, and public hazard mitigation.
- Articles 133–138: Reporting and compensating for work-related injuries and occupational diseases.

- Articles 142–148: Offering medical and social services, especially in remote or high-risk locations.

Furthermore, Saudi Arabia does not have a single dedicated H&S regulator that directly mirrors the HSE in the UK. Instead, the task of establishing standards and guidelines concerning issues related to workplace health and safety, including those in the construction sector, is entrusted to the Ministry of Human Resources and Social Development (HRSD).

Additionally, according to Khoja (2023), Saudi Arabia currently lacks a codified law defining offences related to workplace accidents, allowing the Saudi Shariah Court extensive discretion in assigning criminal liability across various situations. Consequently, the determination of responsibility for health and safety incidents rests solely with the criminal authorities, guided by Shariah principles.

2.9. Gaps in Literature

Despite plenty of research on health and safety (H&S) in the construction sector, notable gaps remain, particularly concerning the holistic understanding of human factors. While personal elements have been considered an impactful factor on H&S in many studies, the comprehensive definition of human factors, as outlined in this chapter, remains underdeveloped in the literature. This research addresses the following critical gaps:

- **Narrow and Misconceived Definition of Human Factors**

Many existing studies have introduced individual characteristics as impactful elements among other influencing factors on health and safety (H&S). Elements such as worker attitudes, physical capabilities, and compliance with H&S standards are undoubtedly important. However, this narrow view has often overlooked the broader scope of human factors, particularly how organisational and job dimensions influence human behaviour.

While organisational aspects (e.g., management systems, leadership commitment) and job design (e.g., ergonomic task structuring, workload management) are discussed in the literature, they are rarely framed explicitly as components of human factors. This omission limits their role from being considered, in terms of shaping worker behaviour and contributing to H&S outcomes. This research redefines human factors - to integrate organisational and job factors in addition to individual characteristics - to fill a major gap in the literature about how individual, job and organisational characteristics work together to influence H&S performance.

- **Fragmented Categorisation of Factors Affecting H&S, and Lack of Comprehensive Comparative Studies Between Developed and Developing Countries**

Most construction health and safety (H&S) literature lacks an integrated framework to comprehensively understand the diverse factors influencing H&S. Instead, the focus is often narrowed to specific or isolated elements, leaving significant gaps in the identification and categorisation of all factors affecting H&S. This approach often excludes critical influences, hindering the development of a holistic understanding of all relevant factors.

Furthermore, without an adequate classification of these factors, comparative research between developed and developing countries remains limited. It is challenging to accurately compare the role of various factors across different cultural, economic, and regulatory contexts without a properly structured framework.

This study addresses these gaps by, in its later stages, classifying and incorporating all factors that can affect H&S—both human and nonhuman—into an integrated framework. It then examines how these factors differ between developed and developing countries. In doing so, the study provides a comprehensive understanding of H&S impact and sector-specific insights to enhance safety practices in both contexts.

2.10. Summary

Construction sector plays a substantial role in economies, boosting GDP, generating jobs, and improving infrastructure. Nevertheless, it is known for its physically tough nature making it one of the most dangerous industries. This poses threats of accidents and deaths impacting both developed and developing countries. Prioritizing (H&S) is crucial for moral, legal, and financial reasons.

Human Factors in Construction H&S:

Human factors are pivotal in managing health and safety (H&S) in the construction industry. They encompass organisational, job-related, and individual dimensions:

- **Organisational Dimension**: Involves policies, supervision, accident reporting, and promoting a safety culture.
- **Job Dimension**: Focuses on the ergonomic design of tasks and the work environment, ensuring they align with human capabilities to prevent physical and mental strain while promoting safety.
- **Individual Dimension**: Considers personal traits, personality, attitude, skills, cognitive abilities, and psychological state impacting safety behaviour.

Factors Affecting H&S in Developing Countries

There are notable differences in the factors influencing health and safety (H&S) across developing countries and between developing and developed regions.

- **In Africa:** The key factors influencing health and safety (H&S) in construction primarily lie within the regulatory and organisational dimensions of human factors. In Nigeria, inadequate legislation, insufficient H&S training, poor awareness, and weak monitoring systems pose significant challenges. Similarly, in Ghana, while regulatory and

organisational dimensions remain critical, economic factors also play a crucial role in shaping H&S outcomes.

- **In Asia:** Human factors are the primary determinants of health and safety (H&S) in construction, encompassing the organisational, job-related, and individual dimensions. In China, the emphasis is on the organisational and job dimensions, while in Malaysia, all three dimensions are considered equally critical. In India and across South Asia, human factors remain significant, with the additional challenge of weak regulatory enforcement.
- **In Saudi Arabia:** Health and safety challenges in construction remain primarily driven by human factors, especially within the organisational dimension. Although significant progress has been made in large-scale, government-led projects under Vision 2030 — including improved training, safety culture, and enforcement — smaller private sector projects continue to suffer from inadequate safety management. Regulatory frameworks themselves remain underdeveloped and are coupled with weak and inconsistent enforcement. The industry's reliance on minimally trained foreign labour, language barriers, and a persistent emphasis on productivity over safety compound these risks.

Factors Affecting H&S in Developed Countries

In developed countries, the job and individual dimensions of human factors are paramount due to the robust regulatory framework which is reflected in strong organisational aspects. However, improving training, attitudes, and awareness remains critical despite strong organisational practices.

Comparative Analysis: UK and Saudi Arabia

The UK's construction industry has a solid, well-structured health and safety (H&S) system in place. The regulations are clear, industry-specific, and strictly enforced by the Health

and Safety Executive (HSE). Consequently, workplace accidents have dropped steadily over time. However, recent statistics show that progress has plateaued, and more improvements are required on addressing deeper human factors, particularly within job and individual dimensions of human factors.

In contrast, Saudi Arabia's regulatory framework for H&S, while developing, remains less specialised. Although general regulations exist under the Labour Law and are managed by the Ministry of Human Resources and Social Development (HRSD), enforcement is inconsistent, and there is no dedicated regulatory body for construction. That said, Major governmental organisations - especially those driven by Vision 2030 - have made notable progress, adopted international standards and improved outcomes through stronger management systems and safety initiatives.

A key difference lies in how the two countries manage risk. The UK benefits from a unified regulatory system that applies industry-wide, while Saudi Arabia depends more on individual companies to implement and monitor their health and safety measures. As a result, safety performance is uneven, particularly in smaller or privately funded projects where formal systems are often lacking.

In both countries, human factors remain central to safety performance. In the UK, the challenges are largely tied to job-related and individual dimensions of human factors. In Saudi Arabia, the most significant issues are organisational, often made worse by a heavy reliance on undertrained foreign workers and the absence of strong enforcement in parts of the sector.

CHAPTER III:

METHODOLOGY

3.1. Introduction

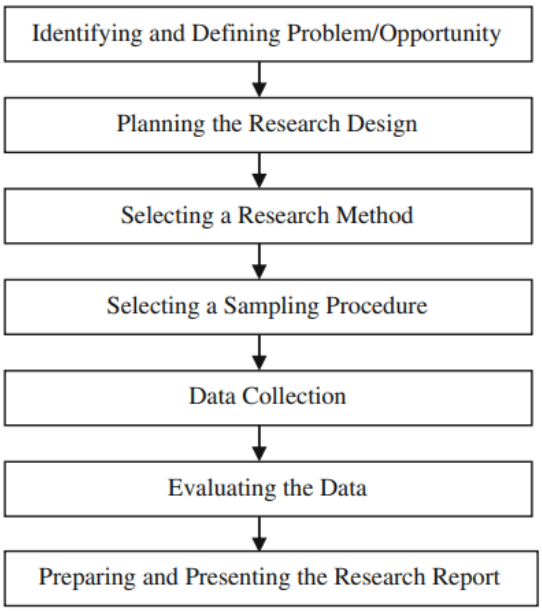
After the research question had been identified, selecting an appropriate research methodology became necessary and crucial. This chapter described the methodical approach taken to achieve the goals and objectives of the study, focusing on understanding and comparing human factors affecting health and safety in the construction sector in the UK and KSA. It detailed the chosen methodological approach, including using primary or secondary data, and research approach whether qualitative, quantitative, or mixed approach, and covered data types, collection methods, and analysis procedures. Furthermore, it addressed factors affecting data reliability and validity. By clearly describing the research design, sampling procedures, and data collection instruments, this chapter enhanced the reliability and validity of the study, ensuring accurate procedures and facilitating replication.

3.2. Research Process

Research, as defined by Rajasekar et al. (2006), is a systematic and rational pursuit of new and useful information on a specific subject. It is not restricted to one branch of knowledge but includes all disciplines. The main objective of the research is to solve a question, reveal new information, develop theories and concepts, verify and test significant facts and analyse a process, event, or phenomenon to understand the cause-and-effect relationship. Similarly, Bacon-Shone (2022) defined research as a systematic and impartial means to solve a problem.

Figure 7 below illustrates the basic steps which are necessary for any good research:

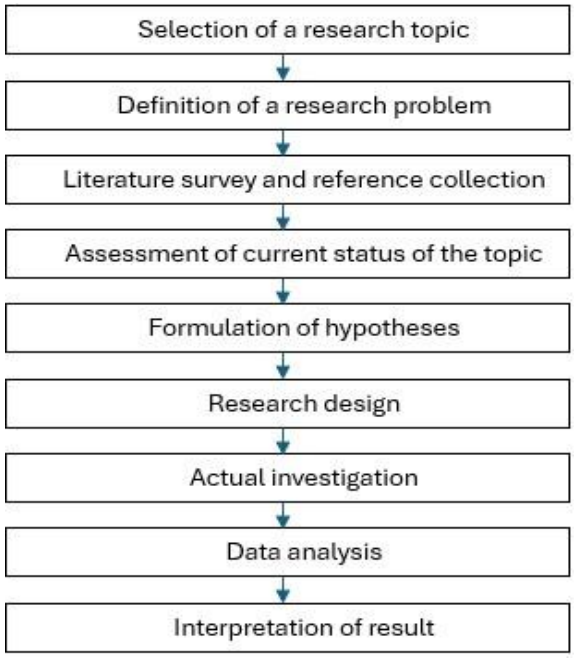
Figure 7: Research Process



Source: Sreejesh et al. (2014)

Rajasekar et al. (2006) similarly suggested another detailed and general set of successive elements of research, which includes the following:

Figure 8 : Research Elements



Source: Rajasekar et al. (2006)

The first step, the selection of a research topic, has been addressed in the initial chapter of this research, focusing on the persistence of high accident rates in the construction industry despite technological advancements and stringent regulations. The second step, the definition of a research problem, underscored the need to accurately define the human factors that affect health and safety (H&S) in construction. The conducted literature review emphasised the importance of human factors in the field of H&S. As a result, hypotheses were formulated to determine their significance and identify which of their dimensions (organisational, job, or individual) has the most significant impact on H&S in construction projects in both developed and developing countries.

The next sections thoroughly covered the remaining aspects of the research process such as designing the research, choosing a sampling method, collecting data, analysing the data and preparing and delivering the research findings.

3.3. Research design

The design of this research was a mixed-method strategy that combined qualitative and quantitative approaches, as well as primary and secondary research methods. An in-depth literature review to define human factors and their dimensions was part of the qualitative phase, drawing on previous knowledge and insights from previous existing literature. Online questionnaires aimed at construction and H&S professionals in the UK and Saudi Arabia were used for primary data collection in the quantitative phase. The literature review was essential to the formulation of hypotheses and the creation of a comprehensive definition of human factors because it took advantage of the existing knowledge. On the other hand, the primary data collection made it possible to get firsthand, fresh, real-time data that was specifically tailored to the goals of the research which contributed to the reliability and validity of the outcomes. Statistical tools enabled the identification of patterns and correlations between

human factor dimensions and H&S outcomes, contributing to a deeper understanding of their relations. Additionally, the quantitative approach made it easier to collect data from a large and diverse sample, contributing to a better generalisability of the findings. The research problem was addressed comprehensively and robustly by combining qualitative and quantitative methods, ensuring statistical validity and depth of comprehension.

A concise description of these techniques is provided in the following sections:

3.3.1 Primary and Secondary Research Methodologies

When collecting data, primary and secondary research stand out as two methods, each, with its set of traits, benefits and drawbacks.

Primary research is a method by which researchers collect new and raw data directly rather than based on existing data collected from prior research. Technically, they "own" the data. Research is primarily conducted to address a problem that requires only detailed analysis (Bhat, 2024). Hox and Boeije (2005) stated that primary data are collected for the specific research problem, and it fits and is designed to meet the unique and specific needs of the researcher. The research process included data collection through interviews, surveys, focus groups, and observations. Primary research is a focused study aimed at providing concrete answers to a research problem.

Despite the great advantages of primary data collection methods, such as being tailored to specific research questions, ensuring accuracy and reliability giving the researcher more control over the collection process, thus minimising biases and inaccuracies, and helping to solve novel research problems, primary research has significant drawbacks namely costly and time-consuming (Hox and Boeije, 2005).

On the other hand, secondary research, as explained by Bhat (2023), uses existing data to gain insights and arrive at conclusions without gathering additional data, hence the success

of secondary research heavily relies on the quality of research already done by the previous primary research. Unlike time-consuming primary research, secondary research is time efficient as it can save time and cost and build on existing knowledge and expertise. Secondary research utilises data which is already collected by other researchers, government agencies, consulting firms and associations and data published in readily accessible formats such as newspapers, journals, reports, blogs, books, and online resources. However, the downside of this approach is that it can be challenging to find the exact information needed. Furthermore, when conducting secondary research there is a possibility of encountering inaccurate or outdated data prompting researchers to verify its validity and precision against other data sets or hypotheses. Another point to consider is the limited control researchers have over the data-gathering process, which may result in inaccuracies, partiality and prejudices. Additionally due, to the accessibility of secondary data there is a risk of research findings being duplicated and lacking originality (Qualtrics, 2022).

The main differences between primary and secondary research are outlined in Table 13:

Table 13 : Key Differences between Primary Research and Secondary Research

Primary Research	Secondary Research
Research is conducted first hand to obtain data. Researcher "owns" the data collected.	Research is based on data collected from previous researches.
Primary research is based on raw data.	Secondary research is based on tried and tested data which is previously analyzed and filtered.
The data collected fits the needs of a researcher, it is customized. Data is collected based on the absolute needs of organizations or businesses.	Data may or may not be according to the requirement of a researcher.
Researcher is deeply involved in research to collect data in primary research.	As opposed to primary research, secondary research is fast and easy. It aims at gaining a broader understanding of subject matter.
Primary research is an expensive process and consumes a lot of time to collect and analyze data.	Secondary research is a quick process as data is already available. Researcher should know where to explore to get most appropriate data.

Source: Bhat (2023b)

Justification for Using Primary and Secondary Data for Dissertation on Human Factors

As discussed in Chapter 2, there was a need to clearly define human factors with its three dimensions and understand their significance among other factors influencing health and safety (H&S) in construction. To accomplish this goal, it was deemed appropriate to utilise a mix of primary and secondary research methods.

- **Justification for Using Secondary Data to Define Human Factors and create Hypotheses:**

  Secondary data, particularly through a literature review, was utilised to define human factors and their three dimensions for several key reasons:

  1. **Comprehensive Definition:** The literature review allowed for the identification of a comprehensive and well-established definition of human factors, grounding the research in recognised definitions.
  2. **Efficiency and Depth:** Secondary research provided a time-efficient way to gather and wrap up existing knowledge on the definition of human factors which allowed to use and build on the previous work made by other researchers and institutions, ensuring that the definition used in this dissertation is strong and detailed.
  3. **Unsuitability of Primary Data for Definition:** Defining human factors through primary data collection, such as surveys or interviews, is unsuitable because it may lead to fragmented and inconsistent definitions. Primary data collection methods adequately explore particular experiences and perceptions rather than determine comprehensive definitions. The existing literature provided validated definitions of human factors in H&S that were more reliable and comprehensive than those that could be derived from primary data alone.

- **Justification for Using Primary Data for Hypothesis Testing**

As mentioned above primary research provided several critical benefits that align perfectly with the aims of this dissertation. Primary research was chosen for the following reasons:

1- **Tailoring and Specificity**: Primary research enabled data collection directly relevant to the research questions and objectives, particularly in understanding which dimension of human factors has the most significant impact on H&S in both the UK and Saudi Arabia.

2- **Accuracy and Reliability**: The researcher ensured the data's accuracy and reliability by overseeing the collection process reducing biases and errors by using other's data.

3- **Novel Insights:** Primary research has provided new insights and viewpoints in the context of comparing developed and developing nations. This has introduced knowledge to the field in elucidating distinctions, among regions, in terms of human factors.

4- **Ownership of Data:** Using primary research method allowed to own the collected data, permitting unrestricted and thorough analysis and interpretation.

Conclusion

To sum up, the research approach employed for this research integrated the benefits and merits of gathering primary and secondary data. Secondary data through the literature review was critical for defining human factors and formulating hypotheses. This step ensured the study was grounded in accepted ideas and offered a strong framework for further research. Primary data collection was then used to test these hypotheses, providing standardised, realistic and up-to-date insights into the impact of human factors on health and safety (H&S) in construction. This mixed methods approach helped to obtain high-quality and impactful research results.

3.3.2 Research Approach: Qualitative and Quantitative Research

In any research, the researcher must count things or talk to people. Research methods, as highlighted by Macdonald and Headlam (2008) can be divided into two main types: Quantitative and Qualitative.

Quantitative research is about measuring and counting things. It is trying to answer questions like “how many” or “how much” and as a result to generalise findings from a sample to a larger population. This method often involves surveys or experiments to gather numerical data.

Qualitative research, however, focuses on the quality of information. It delves into the motivations behind actions and individuals’ perspectives on their encounters. The goal is to gain an understanding of the issue by investigating motives and interpretations through interviews or observations.

Before justifying why one of them was chosen in this study, it is important to describe each one along with their strengths and weaknesses briefly.

Quantitative research is defined as “the numerical representation and manipulation of observations to describe and explain the phenomena that those observations reflect” (Sukamolson, 2007; Babbie, 2010) . The researchers also described quantitative research as generating and analysing data as an empirical statistical process. Similarly, Rajasekar et al. (2006) highlighted that quantitative research focuses on measuring quantities and amounts and noted that it is characterised by the following:

- Quantitative research is non-descriptive and uses numbers and statistics.
- Results are often displayed in tables and graphs.
- Aims to provide conclusive findings.
- Explores decision-making aspects like what, where, and when.

As said above, quantitative research uses data in the form of numbers so the results will be presented in the form of tables, graphs, charts or any other statistical forms. Thus, statistical results help validate or disprove the hypotheses, offering a meaningful conclusion backed by empirical evidence. Babbie (2010) stated that following the quantitative research will make our observation more explicit, and easier to compare, aggregate, summarise, and use the benefits of numbers over words in measuring some qualities. Despite this benefit, he said it has a disadvantage in the possibility of losing the richness of meaning.

The second approach is the qualitative approach, while the quantitative method tries to quantify things, the qualitative one as highlighted by Macdonald and Headlam (2008) focuses on understanding the underlying reasons and motivations for actions and how people interpret their experiences and the world around them. It provides insights and perception into the context of a problem and helps generate ideas and hypotheses that can be more accurately tested with quantitative research (Tenny et al., 2022). According to Babbie (2010) the qualitative data analysis technique is defined as "The non-numerical examination and interpretation of observations, to discover underlying meanings and patterns of relationships".

Rajasekar et al. (2006) highlighted some of the characteristic features of qualitative research/method:

- It is non-numerical, descriptive, uses reasoning, and relies on words.
- Its goal is to understand meaning, capture feelings, and describe situations.
- Qualitative data cannot be represented in graphs.
- It is exploratory in nature.
- It explores the why and how of decision-making.

Table 14 below outlines the main advantages, disadvantages, and applications of qualitative and quantitative research:

Table 14: Qualitative vs Quantitative research

Approach	Pros	Cons
Qualitative Research	- Produces rich, in-depth insights into problems, issues, and phenomena. - The research findings often contain meaning that explores the 'why', 'how', and 'what' behind processes, behaviours, thoughts, feelings, attitudes, and experiences. - Qualitative research also focuses on real-life settings and people, which can provide a more accurate representation than laboratory-based experiments. - The inductive approach of qualitative research allows new possibilities to be discovered and explored.	- The subjective nature of qualitative research makes it hard to replicate. Researchers are also key instruments in the process which further reduces replicability. This limits how reliable qualitative findings are. - Qualitative research can also be time-consuming, especially during data analysis. Despite using a small sample, there are often large amounts of data to prepare and analyse. - Smaller samples can also make it harder for researchers to generalise their findings beyond their current participants.
Quantitative Research	- Quantitative research follows structured, unambiguous, standardised processes that can be easily replicated. This improves the reliability of the study, allowing it to be replicated and proven using the same approach. - Unlike qualitative research, quantitative research can be both quick and scientifically objective. - Researchers can study phenomena in a timely manner, and utilise sophisticated software for rapid, statistical analyses. This allows researchers to process large amounts of data efficiently and produce generalisable findings.	- If researchers cannot obtain an adequate sample size, or end up with data that cannot be used, this limits the accuracy and generalisability of the findings. - Researchers also require statistical expertise to conduct statistical analyses accurately. - Quantitative research can lack meaning and be subject to confirmation bias. That is, researchers can miss emerging phenomena because they are focused on testing a theory of hypothesis
	When to use	**Research Methods**

Qualitative Research	Quantitative research is best used when we want to: - Extract rich, in-depth, and meaningful insights into problems and topics - Understand how people perceive their own experiences - Explore a person's thoughts, feelings, and behaviours - Gain insight into the social realities of specific individuals, groups, and cultures - Examine controversial social issues and topics - Generate new research ideas and possibilities - Learn about attitudes, beliefs, and opinions	- Surveys - Interviews - Focus groups - Observations - Secondary data
Quantitative Research	Quantitative research is best used when we want to: - Measure or quantify data - Establish trends and relationships between variables - Test existing hypotheses and theories - Describe and predict casual relationships - Investigate correlational relationships - Understand the characteristics of a population or phenomena - Produce visual displays of information, such as graphs or tables	- Experiments - Surveys - Observations

Source:Khan (2023)

- **Justification for Using a Qualitative Approach for Defining Human Factors:**

As mentioned above, Rajasekar et al. (2006) and Khan (2023) noted that the qualitative approach is exploratory, descriptive, and non-numerical, extracting rich, in-depth, and meaningful insights into problems and topics aiming to understand meanings and definitions. Tenny et al. (2022) also stressed that the qualitative approach helps to create and generate ideas and hypotheses that can be more accurately tested later with quantitative research. In the context of this study, as referred to in the literature review chapter, it was noted that there was a misunderstanding of the definition of human factors among professionals in the construction field. This proposed that a quantitative approach might not have effectively picked up the

detailed and accurate definitions and concepts of human factors. Therefore, the qualitative approach was deemed more suitable for defining human factors and creating hypotheses. Using the literature that was already available provided an in-depth understanding of the definitions and dimensions of human factors that affect H&S in construction. This method ensured that the definitions were embedded in both academic and practical knowledge.

- **Justification for Using a Quantitative Approach to Test Hypotheses:**

After Human factors were defined and hypotheses created using the qualitative approach, the quantitative approach was used to test, prove or disprove of these hypotheses (Tenny et al.,2022).

Given these characteristics of the quantitative approach mentioned above by Rajasekar et al. (2006) and (Khan, 2023), it was particularly suitable for this research to test the hypotheses. Here are the specific reasons:

1- **Structured and Replicable Processes:** As noted by Khan (2023), quantitative research followed clear and standardised processes that could be easily replicated. In this research, structured surveys targeting construction professionals in the UK and Saudi Arabia provided consistent and comparable data across both regions.

2- **Objective Measurement:** Quantitative research allowed for the collection of numerical data that could be analysed statistically, which provided the objectivity needed to test hypotheses on the effect of human factors on H&S performance in different countries. Such results were presented in tabular, graphic, and chart forms to make clear and understandable comparisons.

3- **Validation and Efficiency:** Quantitative research was efficient. Using statistical analysis tools allowed the processing and dealing of large amounts of data more than the qualitative approach allowed. Online questionnaires gathered data from a large sample

of construction professionals, ensuring that the outcomes represented the broader population in the UK and Saudi Arabia. Furthermore, using statistical methods allowed for the empirical testing and validation of hypotheses.

4- **Generalisability:** By obtaining data from a larger sample size, quantitative methods enabled the generalisation of findings to the broader population of construction projects in the UK and Saudi Arabia.

5- **Identification of Patterns and Correlations:** Quantitative analysis identified patterns, correlations, and associations between various human factor dimensions and H&S outcomes.

6- **Conclusive Findings:** Quantitative research aimed to provide conclusive findings. Using numerical data, the results validated or disproved the hypotheses, offering conclusions backed by empirical evidence. As Babbie (2010) noted, quantitative research enhanced explicitness, comparability, aggregation, and summarisation of observations, though it sometimes lost the richness of meaning inherent in qualitative data.

Conclusion

In sum, the quantitative approach was relevant to this research in that it facilitated a structured, objective, and fairly efficient way of hypothesis-testing concerning human factors in H&S within construction. This would allow the collection and analysis of such data, enabling reliable, generalisable, and statistically validated results.

3.4. Data collection and instrumentation

3.4.1 Research Instrument

The instrument used to collect data was a questionnaire administered to construction professionals in the United Kingdom and Saudi Arabia. The questionnaire was developed and tailored to provide quantitative data on factors affecting H&S. It included some closed-ended

questions using Likert scales, which were useful for measuring respondents' perceptions and experience. the questionnaire was distributed via e-mails and social media platforms, as these were timely and convenient for both regions.

The questionnaire, as defined by Bhat (2023b) and Mcleod (2023), is a research tool consisting of a set of questions for the respondents to fill out. The questions are either open-ended or closed-ended in nature and used to collect qualitative and quantitative data. Mcleod (2023) highlighted the great benefit offered by this tool, which is inexpensive, quick, efficient, and allows researchers to get a large amount of data from a large sample.

The quantitative questionnaire with closed-ended questions was used to validate the hypotheses in this research. Closed-ended questions, as defined by Bhat (2023b) and Mcleod (2023), required specific, limited responses and could be categorised nominally (data that can be positioned into categories) or ordinally (data which can be ranked). This approach was selected because it can efficiently generate substantial research findings and support statistical evaluations. Additionally, the standardised nature of closed-ended questions ensured that all respondents were asked the same questions in the same order, allowing for easy replication and reliability checks. While open-ended questions were more suitable for qualitative approaches as they allowed people to explicit what they think in their own words, it is time-consuming to collect and analyse data, and requires higher skills and a stronger ability to speak one's feelings verbally, the focus of this study in hypothesis testing on quantitative data called for the use of closed-ended questions to systematically analyse and support the study's hypotheses.

Table 15 below outlines the main advantages and disadvantages of the questionnaire:

Table 15: Advantages and Disadvantages of Questionnaire

Advantages	Disadvantages	How the Disadvantages in this Dissertation Were Addressed
Large-scale data collection: Questionnaires are a great way to collect information from a lot of people at once.	**Limited depth of information**: Questionnaires typically rely on structured and predefined response options, which can constrain participants' ability to provide in-depth responses.	- Using a Mixed-Methods Approach: Combined qualitative methods, such as a literature review, to define and explore human factors, while using quantitative methods to validate hypotheses and measure their impact on H&S. - Comprehensive Questionnaire Design: Developed the questionnaire based on thorough research and expert input to ensure it captured all relevant factors affecting H&S, and cross-verified data from multiple sources to enhance the depth and accuracy of the findings.
Standardised responses: This method simplifies analysis and improves data reliability, allowing researchers to identify patterns and draw meaningful conclusions.	**Response bias:** Response bias refers to systematic errors in how participants interpret and respond to questionnaire items, leading to biased results.	- In the questionnaire design, questions were carefully worded to be neutral, avoiding any leading language. Clear and straightforward instructions were provided to minimise confusion and ensure respondents understood the questions. - A pilot test was conducted with a small sample to identify and address any ambiguities or potential biases before the full-scale implementation. - The questionnaire was distributed only to trusted professionals who were interested in the outcome of the research.
Anonymity and confidentiality: In questionnaires, honest responses are encouraged by protecting respondents' identities and personal information.	**Low response rates:** Low response rates can lead to non-response bias, reducing the representativeness and reliability of the data, which may compromise the study's validity.	- The research purpose and significance were communicated to encourage participation. - Optimized Questionnaire Design: Shorter, focused questionnaires were designed to minimise respondent burden and improve response rates.
Cost-effectiveness & Time efficiency	**Misinterpretation of questions:** Misinterpretation of questions can lead to inaccurate responses due to unclear wording or ambiguous phrasing, compromising the reliability and validity of the data collected.	- The questionnaire was pilot tested with a small group representative of the target population to identify ambiguities or areas of confusion. - Questions were carefully worded to be concise, specific, and clear. - Response options were designed to include "don't know" or "not applicable," allowing respondents to indicate uncertainty or irrelevance.
Data quantification: questionnaires assign numerical values to responses, enabling effective analysis, pattern identification, and statistical exploration.	**Inability to capture non-verbal cues:** The inability to capture non-verbal cues in questionnaires can result in losing valuable context and emotional nuance, limiting	

	the depth and richness of the collected data.	
Flexibility: Flexibility in questionnaires allows customisation, enabling the inclusion of open-ended questions and skip patterns, which provide deeper insights and tailor the survey to respondents' needs.	**Limited engagement:** Respondents may rush, provide inaccurate responses, or show biases, resulting in low-quality data.	- Clearly articulating the purpose and significance of the questionnaire motivated participants to engage more fully. - Drawing up questions that were directly relevant to the participants' experiences enhanced their motivation to engage.
Ease of analysis: This allows for quick data processing and visualisation using statistical tools, thanks to structured responses and standardised scales.	**Difficulty in capturing complex or nuanced information:** questionnaires often struggle to capture complex information due to their reliance on structured questions with limited response options	- The questionnaire was designed based on thorough research and expert input to ensure it captured all relevant factors affecting H&S, and cross-verified data from multiple sources to enhance the depth and accuracy of the findings. - The questionnaire was pilot tested with a small group representative of the target population to identify ambiguities or areas of confusion.
Accessibility: This ensures inclusivity, reaching a diverse range of participants and maximising the representation of different perspectives	**Sampling limitations:** Questionnaires may not represent the target population if the sample is biased, such as excluding those without internet access. Self-selection bias can also lead to unbalanced data when only those with strong opinions participate.	
Ease of replication: replication ensures that other researchers can follow the same methodology and replicate the study with minimal effort and resources.	**Potential for response fatigue:** Response fatigue occurs when lengthy or repetitive questionnaires overwhelm participants, leading to rushed, random responses, or abandonment, compromising data quality.	- Questions were carefully worded to be concise, specific, and clear. - The questionnaire was distributed only to trusted professionals who were interested in the outcome of the research. - Clearly articulating the purpose and significance of the questionnaire motivated participants to engage more fully.

Source: Lindemann (2023)

3.4.2 Distribution

The research distribution method involved sharing the Google Forms questionnaire link via email and professional social media platforms such as LinkedIn with construction professionals and H&S specialists in the UK and Saudi Arabia. Potential respondents were

contacted beforehand to explain the purpose of the study and encourage their cooperation. All responses were collected electronically through Google Forms and stored securely for analysis.

3.5. Population and sample

3.5.1 Target Population

The population, as defined by McCombes (2022), is the total group that a study aims to draw conclusions about. The population of this study focused on construction professionals working in the construction industry in the United Kingdom and Saudi Arabia. This included project managers, site managers/supervisors, safety personnel, engineers and all persons involved in health and safety issues (H&S) on construction sites.

3.5.2 Sampling Method

The sample, as defined by McCombes (2022), is the particular group of individuals from whom data is collected.

Table 16 includes and explains the different sampling types, methods, and techniques:

Table 16: classification of sampling techniques

Sampling Type	Method	Description
Probability Sampling	Simple Random Sampling	Every member of the population has an equal chance of being selected.
	Systematic Sampling	Selects individuals at regular intervals from a list of the population.
	Stratified Sampling	Divides the population into subgroups and samples from each subgroup.
	Cluster Sampling	Divides the population into clusters or subgroups, but each subgroup should have similar characteristics to the whole sample and randomly selects entire clusters.
Non-Probability Sampling	Convenience Sampling	Includes individuals who are most accessible to the researcher
	Voluntary Response Sampling	Participants volunteer themselves, often leading to bias.

	Purposive Sampling	The researcher selects a sample based on his expertise to choose the most useful sample for the research.
	Snowball Sampling	Participants recruit other participants, which is useful for hard-to-reach populations.

Source: McCombes (2022)

In selecting the sampling method for this study, probability stratified random sampling was chosen due to its suitability for quantitative research, as noted by McCombes (2022). Unlike non-probability sampling, which is more commonly used in qualitative research and does not ensure that every member of the population has a chance of being included, probability sampling ensures that all members have an equal chance of selection. By using stratified random sampling, the study effectively covered all relevant strata within the target population. This method allowed the division of the target population (e.g., construction professionals) into relevant subgroups based on factors such as job role (e.g., engineers, site managers, safety officers), years of experience (e.g., 6–10 years, 11–15 years, 10+ years), and location (UK vs Saudi Arabia). Stratification ensured that each subgroup was proportionally represented in both the UK and Saudi Arabian samples, enabling a more accurate comparison of human factors influencing H&S across the two countries.

3.5.3 Sample Size and Eligibility Criteria

The planned sample size for this study was 150 participants (75 from the United Kingdom and 75 from Saudi Arabia). Time constraints, the availability of resources, and the likely response rate were all taken into account when arriving at this number. While the sample did not represent all organisations in either country, it was large enough to provide meaningful insights and allow for a comparative analysis of factors influencing H&S in construction in each country. Lakens (2022) states that resources limit the sample size practically. Even when resource constraints are not the primary justification for the sample size, researchers almost

always have limited resources; they are always a secondary justification in a study. This resource limitation consists of time, money, and the limited number of people from whom data can be gathered.

While the sample size might be considered relatively small for a study of this nature, the selection of participants with extensive experience in the construction and health and safety (H&S) domain significantly enhanced the quality and depth of the collected data which helped to mitigate the potential limitations of a smaller sample size. Participants were chosen to ensure diversity across various construction organisation sizes and regions within each country, aiming to capture a comprehensive range of perspectives. Despite the limitations to the generalisability of the findings, this sample was expected to generate valuable data for identifying key trends about factors affecting H&S, similarities and differences between the UK and Saudi Arabia.

Table 14 includes the inclusion criteria used to select participants for the study.

Table 17: Inclusion Criteria

Current Employment	Must be currently working in a large and reputable organisation in the construction industry in either the UK or Saudi Arabia.
Professional Role	Must hold a professional role such as project manager, site manager, site H&S officer, site engineer, or H&S specialist in construction
Experience	Must have at least five years of experience in the construction industry.
Informed Consent	Must be willing to provide informed consent to participate in the study.

Source: Author's own work (2025)

The actual number of completed responses exceeded the planned number, with 164 participants completed the survey. The survey included 102 participants from the UK and 62 participants from Saudi Arabia. The lower number from Saudi Arabia reflected challenges in accessing respondents, which is common in cross-country survey research. Nonetheless, the responses were adequate for meaningful comparative analysis, as presented in Chapter 4.

3.5.4 Pre-testing

The final questionnaire was pre-tested with a small sample of construction and H&S professionals before its distribution to the broader sample. The pre-testing step was necessary to identify and resolve potential issues related to question clarity, wording, and overall structure of the questionnaire. Valuable feedback on the clarity, conciseness, and effectiveness of pilot tests was provided by the participants about the questions of eliciting the necessary information needed for analysis. Based on these remarks several modifications were implemented to improve the accuracy and reliability of the questionnaire method guaranteeing it accurately captures the input data for the research.

3.6. Data Analysis and Limitations

The research data from the structured questionnaire underwent analysis through descriptive statistics, Pearson correlation, independent samples t-tests and multiple linear regression. The research methods allowed to evaluate connections between human and non-human elements and their effects on health and safety (H&S) practice effectiveness in Saudi Arabian and United Kingdom construction industries.

The questionnaire included 42 items that measured various H&S influence factors between human elements (organisational, job, individual) and non-human elements (regulatory, economic, environmental, technological). The regression analysis used a refined

set of 29 items that represented the dependent variable—perceived effectiveness of H&S practices—after multicollinearity diagnostics to ensure model validity and reliability.

The study design is robust, yet several limitations are acknowledged. The use of self-reported data may introduce response bias, and while the sample size was sufficient for comparative statistical analysis, it may constrain generalisability beyond the study's scope. These considerations are taken into account in the interpretation and discussion of findings.

3.7. Validity and Reliability

Data are gathered and produced through research, and validity and reliability must first be established before they can be trusted. Due to the researcher's interpretation of the results, personal bias can lead to deviations from research objectives, potentially affecting the accuracy of the results.

Middleton (2023) stated that validity and reliability are important concepts used to measure the quality of the research. Nicolas (2023) and Middleton (2023) described reliability as the consistency of the measurement, and validity as the accuracy of the measurement.

The concepts of validity and reliability, while well-defined in quantitative research, were approached differently in qualitative research, leading to significant debate among scholars. In quantitative research, Joppe (2000, cited in Golafshani, 2003) defined reliability as the extent to which the results of a study were consistent over time and provided an accurate representation of the entire population under study. Replication of results using a similar methodology was considered a key indicator of a research instrument's reliability. Validity, according to Joppe, refers to whether a study measured what it was intended to measure and how truthful the research results were.

In qualitative research, however, the terms reliability and validity were redefined to fit the naturalistic approach. Golafshani (2003) explained that reliability, as traditionally defined

in quantitative research, was not entirely applicable to qualitative research. Instead, qualitative research emphasised the trustworthiness of the study, which included concepts such as dependability, credibility, and transferability. The researcher who serves as the primary instrument of data collection played a crucial role in accurately presenting and interpreting findings. Accordingly, the focus transformed from the replicability of results to the thoroughness and trustworthiness of the research process.

Reliability in qualitative research was often discussed in terms of dependability, which corresponded to the notion of consistency in quantitative research. Lincoln and Guba (1985, cited in Golafshani, 2003) proposed the use of an "inquiry audit" to enhance dependability, ensuring that the research process and findings were consistent. Validity in qualitative research was not a fixed concept but rather one that was influenced by the researcher's methods, intentions, and context. It emphasised the credibility of the findings and the trustworthiness of the researcher's interpretations.

Thus, while traditional terms like reliability and validity were reinterpreted within qualitative research, they were often replaced with criteria such as credibility, transferability, dependability, and confirmability to better reflect the goals of qualitative inquiry. These criteria focused on the richness and depth of the data collected rather than on numerical accuracy, aligning with the qualitative research paradigm's emphasis on generating understanding rather than explaining phenomena in the way quantitative research did.

Noble and Smith (2015) noted that the traditional measures of validity and reliability in quantitative research are often deemed unsuitable for qualitative research. This is due to criticisms that qualitative research lacks scientific rigour, with concerns about inadequate justification of methods, shortage of transparency in analytical processes, and the potential for findings to be seen as subjective or biased. Despite these challenges, the concepts of validity

and reliability are still relevant in a broader sense in qualitative research with **validity** about the **integrity** and appropriateness of the methods used and the accuracy with which the findings represent the data, while **reliability** refers to the **consistency** of the analytical procedures applied.

Lincoln and Guba (1985, cited in Noble and Smith, 2015) identified criteria for establishing rigour in qualitative research, including truth value, consistency, neutrality, and applicability. These criteria are detailed in Table 18 below:

Table 18: criteria used to evaluate the credibility of qualitative research

Quantitative research terminology & application to qualitative research[4]	**Alternative terminology associated with credibility of qualitative research**[5]
Validity The precision in which the findings accurately reflect the data.	*Truth value* Recognises that multiple realities exist; the researchers' outline personal experiences and viewpoints that may have resulted in methodological bias; clearly and accurately presents participants' perspectives.
Reliability The consistency of the analytical procedures, including accounting for personal and research method biases that may have influenced the findings.	*Consistency* Relates to the 'trustworthiness' by which the methods have been undertaken and is dependent on the researcher maintaining a 'decision-trail'; i.e. the researcher's decisions are clear and transparent. Ultimately an independent researcher should be able arrive at similar or comparable findings. *Neutrality (or confirmability)* Achieved when truth value, consistency and applicability have been addressed. Centres on acknowledging the complexity of prolonged engagement with participants and that the methods undertaken and findings are intrinsically linked to the researchers' philosophical position, experiences and perspectives. These should be accounted for and differentiated from participants' accounts.
Generalisability The transferability of the findings to other settings and applicability in other contexts.	*Applicability* Consideration is given to whether findings can be applied to other contexts, settings or groups.

Source: Noble and Smith (2015)

3.7.1 Validity and Reliability in Phase 1: Secondary Research and Qualitative Approach

In the first phase of the research, which involved a secondary, qualitative approach, careful attention was given to ensuring validity and reliability in defining the human factors that influence construction's health and safety (H&S).

Reliability

Reliability in phase 1 was ensured by focusing on the consistency and trustworthiness of the data sources:

- **Selection of Credible Sources**: Data was drawn from reputable scientific journals with strict peer-review processes, ensuring the information's consistency and trustworthiness. This approach addressed concerns raised by Stewart (2014, cited in Olabode et al., 2019) who noted that the ease of internet publishing can lead to unreliable sources.
- **Critical Evaluation of Data:** The data collection methods and author backgrounds were carefully reviewed to ensure alignment with the research objectives, minimising the risk of using unreliable data. This step also countered the issue highlighted by Olabode et al. (2019) regarding organisations potentially producing misleading reports.
- **Awareness of Potential Biases:** Recognising potential biases within the studies themselves, such as outdated information or organisational influences, the reliability of the data was critically assessed before inclusion. This scrutiny helped maintain accuracy in the study's findings on human factors in construction H&S.

Validity

To assert the integrity and validity of this phase, the research utilised several strategies:

- **Comprehensive and Verified Literature Review:** An extensive review of existing literature was conducted, drawing from reputable journals, and government publications. The credibility of the information was carefully checked through a verification process

that involved reviewing the academic credentials of authors and their used methodologies while also confirming the currency and relevance of the data used. This approach ensured that the identified human factors affecting H&S in construction were grounded in well-established, widely accepted, and up-to-date sources.

- **Objective and Systematic Analysis:** Efforts were made to eliminate bias by adopting an objective approach throughout the review process. The research design and methodology were chosen carefully to align with the research questions, ensuring that identifying human factors affecting H&S and categorising them into organisational, job-related, and individual dimensions were based on sound theoretical foundations.

3.7.2 Validity and Reliability in Phase 2: Primary Research and Quantitative Approach

In the second phase, the quantitative approach was used through using a questionnaire that included all factors affecting H&S to explore how human and non-human factors influence health and safety (H&S) performance in construction. Ensuring the validity and reliability of this phase was essential to maintaining the integrity of the findings.

Reliability was tested using Cronbach's alpha to address reliability concerns. The reliability scores of each dimension (organisational, job-related, individual, and non-human factors) exceeded the standard threshold ($\alpha \geq 0.70$) which confirmed that each scale measured its intended constructs with consistency (George and Mallery, 2003).

Validity was established through construct and content validation processes. Building the questionnaire involved extensive literature review, expert judgment, and peer review. Content validity was further ensured by involving H&S and construction professionals in the evaluation of the questionnaire during the design stage.

In terms of construct validity, statistical methods such as correlation analysis, independent samples t-tests, and multiple linear regression demonstrated that the dimensions behaved as expected, correlating significantly with the perceived effectiveness of H&S practices.

3.8. Ethics related to human subject participation

Varied ethical aspects and factors were carefully considered to protect the rights, privacy and welfare of all participants in this research. Participants received information about the research objectives, methods, and advantages at the beginning of the online questionnaire. Proceeding to complete the questionnaire was taken as informed consent. This information clearly outlined their rights, including the right to withdraw from the study at any point, without the need for explanation.

In the research process, privacy was strictly maintained. Personal identifiers such as names, positions, names of companies and other identifiable information were excluded from the published data. In order to maintain the confidentiality of participating information, the data collected was placed in a safe environment that was only available to the research team.

3.9. Summary

Chapter 3 of this dissertation delved into the methodological approach used to investigate the factors affecting health and safety (H&S) in the construction industry. This chapter outlined the research design, which combined a mixed-methods approach, ensuring a comprehensive analysis of the subject matter.

A mixed-methods approach was employed in this study, integrating secondary and primary data, combining qualitative and quantitative methods. The study design consisted of two main parts:

1. **Secondary Research (Qualitative)**:
    - A comprehensive literature review was conducted to define human factors and categorise them into three dimensions: organisational, job-related, and individual.
    - In this phase, a theoretical framework was established, and hypotheses were formulated.
2. **Primary Research (Quantitative)**:
    - Data collection through questionnaires distributed to construction professionals in the UK and Saudi Arabia.
    - Statistical analysis of collected data to test hypotheses and compare all factors that impact health and safety in both countries.

Data Analysis

To identify significant relationships between human factors and outcomes in health and safety, quantitative data was analysed statistically. It was discussed in this chapter how to ensure data validity and reliability, including the sampling methods and criteria for selecting participants.

Ethical Considerations

Ethical guidelines were adhered to throughout the research process, ensuring that participant confidentiality was prioritised.

This chapter provided a clear framework for understanding how the research was conducted, setting the stage for the analysis and findings presented in subsequent chapters.

CHAPTER IV:

RESULTS

4.1. Introduction

This chapter presents the empirical findings of the study, which aims to assess the influence of human and non-human factors on the effectiveness of health and safety (H&S) practices in the construction sectors of Saudi Arabia and the United Kingdom (UK). The analyses compare the two countries by examining key statistical outputs in the following sequence: demographic characteristics, reliability of measurement instruments, Pearson correlation analysis among study variables, group differences based on country, and predictive modelling via multiple linear regression. Each section directly informs the study's research aim, objectives, and hypotheses.

4.2. Questionnaire Structure and Link to Research Objectives

The research objectives from Chapter One guided the development of both the questionnaire structure and content. The questionnaire included all health and safety (H&S) dimensions related to human and non-human factors which fulfilled the requirements of Objectives 1, 2 and 3. The instrument supported a complete assessment of H&S perceptions and practices through its organisation of questions into human factors (organisational, job, individual) and non-human (regulatory, economic, environmental, and technological) categories.

The questionnaire underwent expert field review followed by refinement based on feedback to achieve content validity and industry-specific construct representation. This validation process strengthened the instrument's ability to measure H&S perceptions accurately.

A total of 164 construction professionals participated in the study with 62 from Saudi Arabia and 102 from the UK to enable a comparative analysis between these two different national settings.

4.3. Demographic Analysis

The demographic characteristics of participants from Saudi Arabia and the UK were presented through frequency and percentage statistics. The frequency refers to the number of occurrences of a particular value or category in a dataset. For example, in the "Gender" category for Saudi Arabia, the frequency of "Male" is 59, meaning 59 participants identified as male. The percentage indicates the relative size of each category compared to the entire number of respondents which is displayed as a percentage value. The percentage shows the extent to which each category represents the complete dataset.

Formula to Calculate Percentage:

$$Percentages = \frac{Frequency\ of\ category}{Total\ number\ of\ respondents} * 100$$

For example, in this study the total sample size (n) is 164 in which 62 respondents from Saudi Arabia (SA) and 102 respondents from the UK. So, the percentage of the SA and UK is calculated by using the above formula is as:

$$Percentage\ of\ respondents\ in\ SA = \frac{62}{164} * 100 = 37.8\%$$

$$Percentage\ of\ respondents\ in\ UK = \frac{102}{164} * 100 = 62.2\%$$

The key variables included Age, Gender, Role in Construction Company, Experience in Organisation (in Years), Type of project, Size of organisation, and Involvement in Workplace Health and Safety Practices. The results are shown in the following table:

Table 19: Summary of Demographic Variables

Demographic Variables	Categories	Saudi Arabia			United Kingdom		
		Frequency	Percentage in SA	Percentages	Frequency	Percentage in UK	Percentages
Age	**25-34 years**	14	23%	8.5%	33	32%	20.1%
	35-44 years	22	35%	13.4%	37	36%	22.6%
	45-54 years	21	34%	12.8%	23	23%	14.0%
	55+ years	5	8%	3.0%	9	9%	5.5%
Gender	**Male**	59	95%	36.0%	82	80%	50.0%
	Female	3	5%	1.8%	20	20%	12.2%
Role in Construction Company	**Junior Engineer/Manager**	6	10%	3.7%	15	15%	9.1%
	Mid-Level Engineer/Manage	7	11%	4.3%	28	27%	17.1%
	Senior Engineer/Manager	36	58%	22.0%	31	30%	18.9%
	Supervisor	5	8%	3.0%	9	9%	5.5%
	H&S specialist/CDM	8	13%	4.9%	19	19%	11.6%
Experience in the construction industry in Years (only UK and SA)	**6-10 Years**	19	31%	11.6%	53	52%	32.3%
	11-15 Years	16	26%	9.8%	22	22%	13.4%
	16-20 Years	10	16%	6.1%	11	11%	6.7%
	21-25 Years	9	15%	5.5%	4	4%	2.4%
	+26	8	13%	4.9%	12	12%	7.3%
Type of construction project currently working	**Residential**	7	11%	4.3%	22	22%	13.4%
	Commercial	8	13%	4.9%	21	21%	12.8%
	Infrastructure	32	52%	19.5%	43	42%	26.2%
	Industrial	8	13%	4.9%	10	10%	6.1%
	All The above	3	5%	1.8%	3	3%	1.8%
	Other	4	6%	2.4%	3	3%	1.8%
Size of Organization	**Small Size (0-50 employees)**	4	6%	2.4%	30	29%	18.3%
	Mid-size (51-250 employees)	5	8%	3.0%	27	26%	16.5%
	Large size (more than 250 employees)	53	85%	32.3%	45	44%	27.4%
Involving in health and safety practices at workplace	**Yes**	54	87%	32.9%	97	95%	59.1%
	No	8	13%	4.9%	5	5%	3.0%

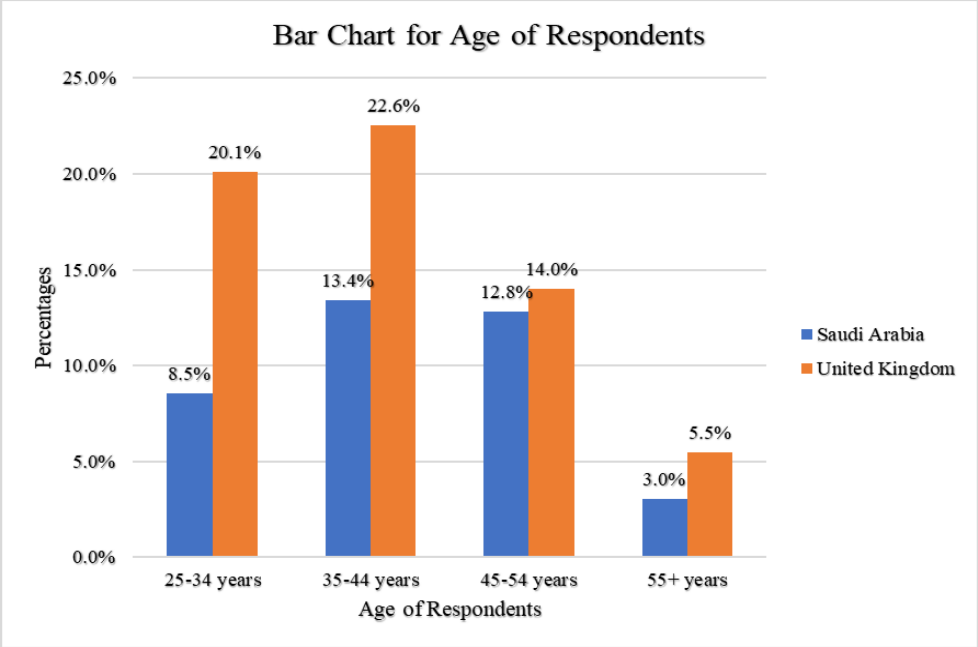
Source: Author's own work (2025)

Age

Respondents from both Saudi Arabia and the UK show a relatively balanced age distribution, with a slight lean toward middle-aged professionals. In Saudi Arabia, the largest group of respondents is aged 35–44 (35% of SA sample, 13.4% overall), followed by 45–54 (34%, 12.8% overall) and 25–34 (23%, 8.5% overall). The 55+ group is least represented at 8% (3.0% overall).

In the UK, the 35–44 group also leads (36% of UK sample, 22.6% overall), but there's a good presence of younger professionals aged 25–34 (32%, 20.1% overall). The 45–54 group accounts for 23% (14.0% overall), and the 55+ group for 9% (5.5% overall), showing slightly broader age representation compared to Saudi Arabia.

Figure 9: Bar chart for age of respondents



Source: Author's own work (2025)

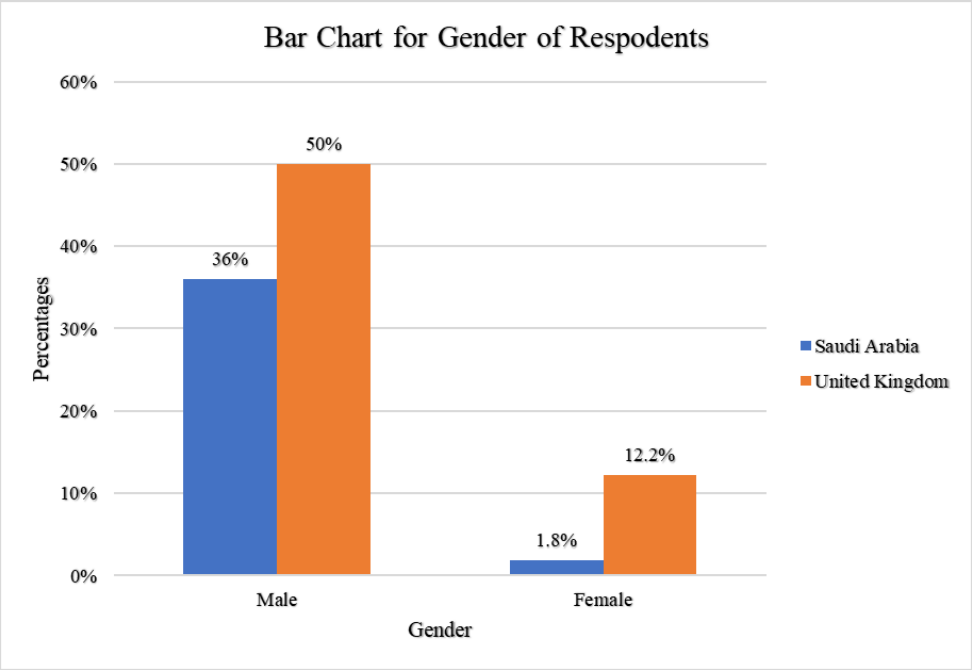
Gender

The gender distribution in Saudi Arabia is heavily skewed, with 95.2% male (59 out of 62 respondents, 36.0% of the total sample) and only 4.8% female (3 respondents, 1.8% overall),

which aligns with prevailing gender norms and workforce participation rates in the Saudi construction sector.

The UK demonstrates a more inclusive gender distribution: 80.4% male (82 out of 102 respondents, 50.0% of the total sample) and 19.6% female (20 respondents, 12.2% overall), indicating better gender representation in the construction workforce, although it remains male-dominated.

Figure 10: Bar chart for gender of respondents



Source: Author's own work (2025)

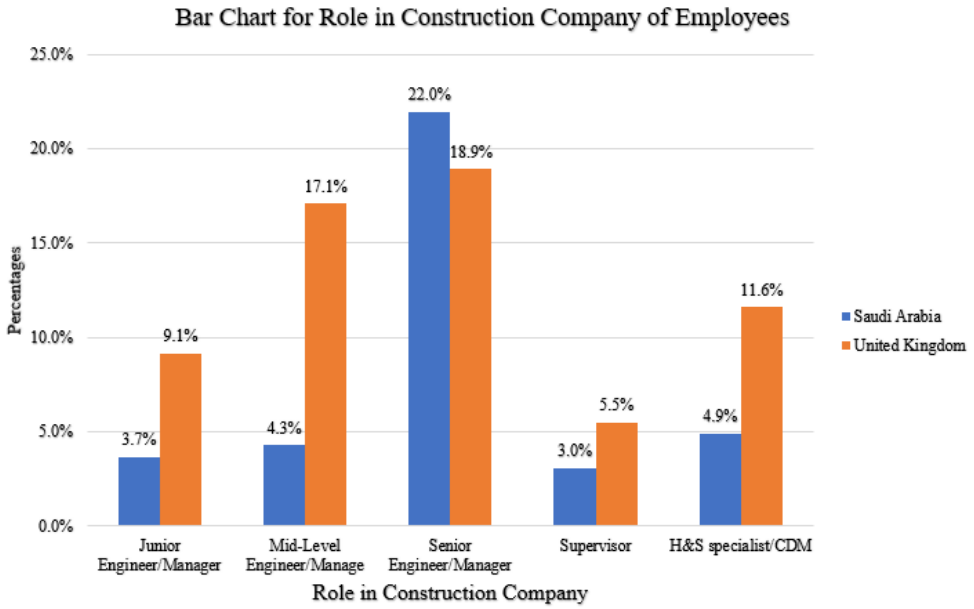
Role in Construction Company

In Saudi Arabia, most respondents are in senior roles, with 58% working as Senior Engineers / Managers (22.0% of the total sample). Mid-level roles account for 11.3% of the Saudi group (4.3% overall), while junior roles make up 9.7% (3.7% overall) and supervisors 8.1% (3.0% overall). About 12.9% are H&S specialists (4.9% overall).

The UK shows more variety. Senior and Mid-Level Engineers/Managers make up 30.4% and 27.5% of UK respondents (18.9% and 17.1% overall). There are more participants

in junior roles (14.7%, 9.1% overall), supervisors (8.8%, 5.5% overall) and in H&S/CDM specialists' roles (18.6%, 11.6% overall), reflecting a broader distribution across all job levels.

Figure 11:Bar chart for role in construction company of employees



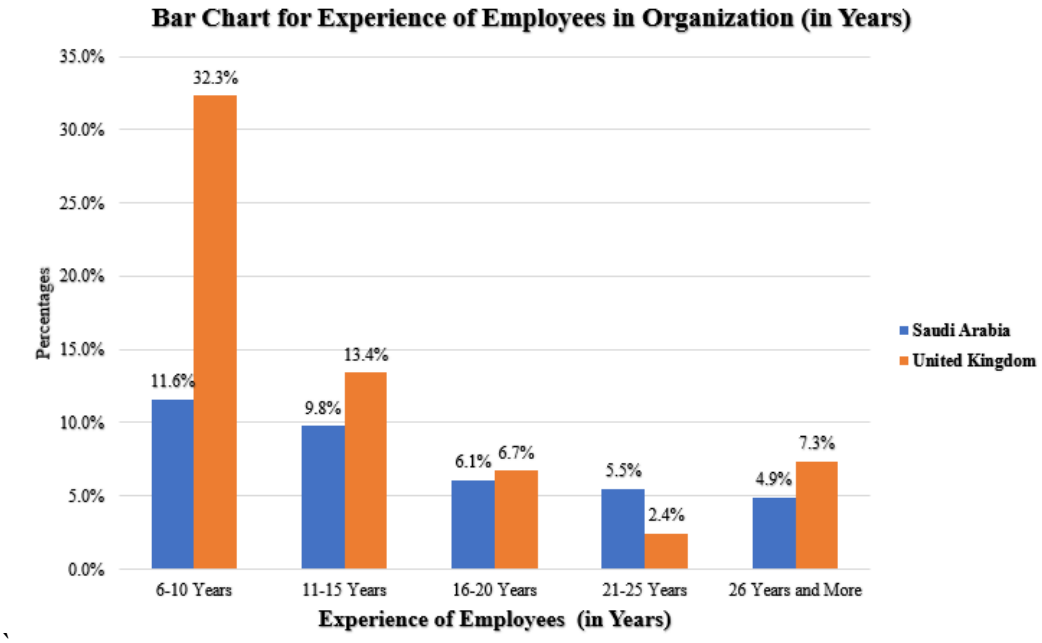
Source: Author's own work (2025)

Experience of Employees in Organization (in Years)

The majority of Saudi respondents have 6–15 years of experience, with 30.6% having 6–10 years and 25.8% having 11–15 years (11.6% and 9.8% overall, respectively). A fair number also have 16–20 years (16.1%, 6.1% overall) and 21–25 years (14.5%, 5.5% overall), and 12.9% having 26+ years (4.9% overall), reflecting respondents that are predominantly mid- to late-career.

In the UK, the largest category also drops to 6–10 years (52.0%, 32.3% in overall), followed by 11–15 years (21.6%, 13.4% in overall), and 16–20 years (10.8%, 6.7% overall). The 26+ years category takes up 11.8% (7.3% overall), with fewer in the 21–25 years category (4%, 2.4% overall).

Figure 12: Bar chart for experience of employees in organisation



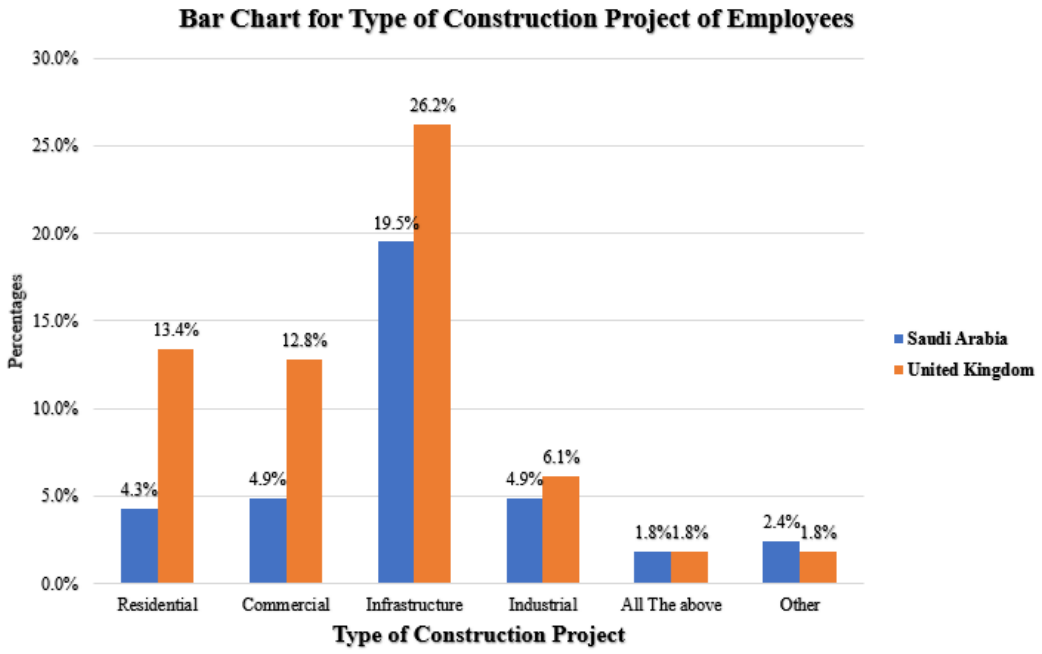
Source: Author's own work (2025)

Type of Construction Project

In Saudi Arabia, 52% of respondents work in infrastructure (19.5% of the total sample), followed by commercial and industrial projects, each at 13% (4.9% overall), residential at 11% (4.3% overall), other at 6% (2.4% overall), and multiple project types at 5% (1.8% overall).

In the UK, 42% are involved in infrastructure (26.2% overall), followed by residential (22%, 13.4% overall), commercial (21%, 12.8% overall), industrial (10%, 6.1% overall), and both other and multiple types, each at 3% (1.8% overall).

Figure 13:Bar Chart for Type of Construction Projects of Employees



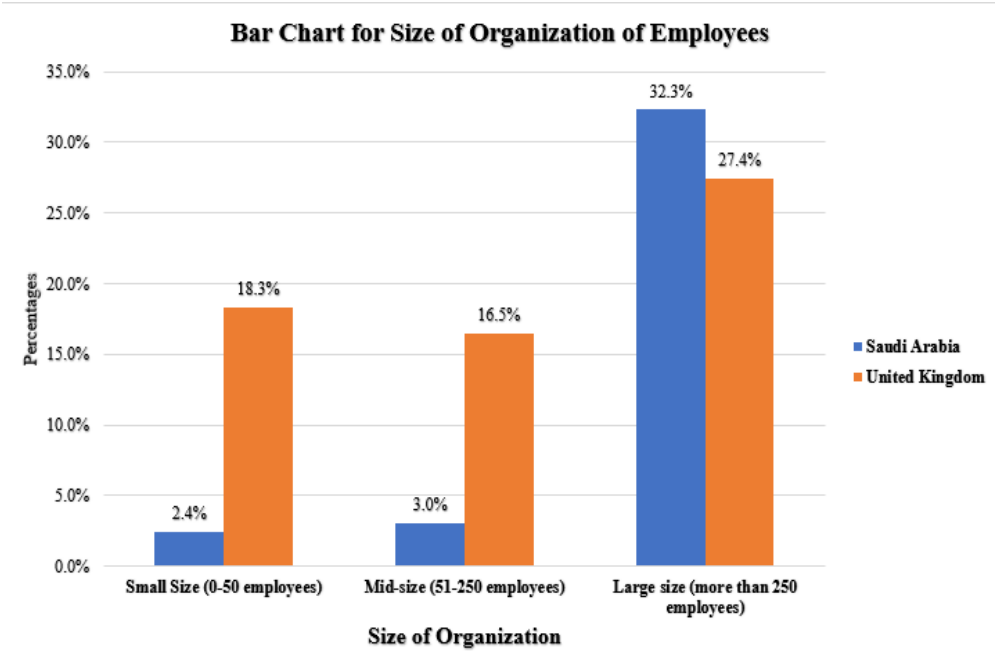
Source: Author's own work (2025)

Size of Organisation

The majority of respondents in Saudi Arabia work in large organisations with over 250 employees (85%, 32.3% of the total sample). Mid-sized and small firms are much less represented, at 8% (3.0% overall) and 6% (2.4% overall), suggesting a workforce concentrated in large-scale or government-linked companies.

The UK's representation is more balanced: 45% work in large firms (27.4% overall), 27% in mid-sized (16.5% overall), and 30% in small firms (18.3% overall).

Figure 14: Bar chart for size of organisations of employees



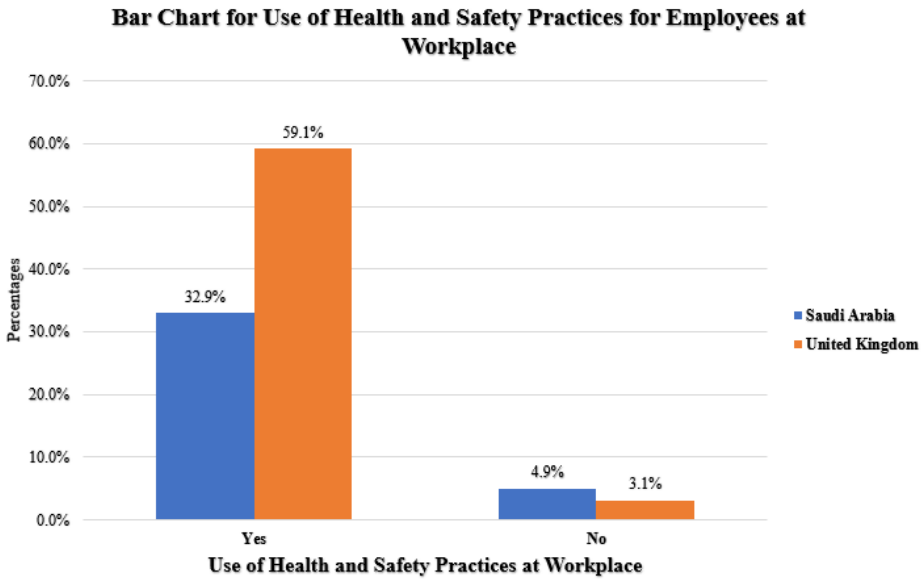
Source: Author's own work (2025)

Involvement in Health and Safety Practices

87% of respondents in Saudi Arabia (32.9% overall) are directly involved in health and safety, while 13% (4.9% overall) are not — reflecting growing attention but room for improvement.

In the UK, 95% are involved (59.1% overall), with only 5% (3.0% overall) not engaged, consistent with the UK's strong safety regulations and culture.

Figure 15:Bar chart for involvement in H&S of respondents



Source: Author's own work (2025)

4.4. Rationale for Reducing Dependent Variable from 42 to 29: Addressing Multicollinearity

The initial regression analysis included 42 questionnaire items reflecting human and non-human factors believed to influence health and safety (H&S) outcomes. However, signs of multicollinearity emerged during model testing. The presence of anomalies in regression coefficients occurs frequently when predictor variables show strong correlation which makes the results unreliable (Kutner et al., 2005).

The number of variables decreased to 29 items which were selected through statistical diagnostics and theoretical relevance. The model maintained its conceptual integrity through this reduction which also enhanced its statistical validity. Standard errors increase when there is excessive multicollinearity which simultaneously reduces explanatory clarity and causes coefficient significance to become distorted.

4.5. Reliability Analysis

Cronbach (1951) introduced Cronbach's Alpha (α) as a measure of internal consistency. This measures how closely related a set of items are as a group and is used to check the reliability of scales or questionnaires. Cronbach's Alpha values range from 0 to 1, with higher values indicating greater internal consistency and reliability.

The formula is given below:

$$\boldsymbol{\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_i^K \sigma_i^2}{\sigma_{total}^2}\right)}$$

Where:

K = number of Items

σ_i^2 = Variance of Each Items

σ_{total}^2= Variance of the total (summed) score for all items

Nunnally and Bernstein (1994) suggested a slightly stricter view on reliability standards that is a threshold of 0.70 or higher is recommended for basic research, though 0.80+ is better for applied settings. George and Mallery (2003) is one of the most widely cited sources for Cronbach's Alpha interpretation as mentioned in the following table:

Table 20: Interpretation of Cronbach's Alpha Values

Alpha Value	Interpretation	Source
≥ 0.90	Excellent	George and Mallery (2003)
0.80 – 0.89	Good	George and Mallery (2003)
0.70 – 0.79	Acceptable	George and Mallery (2003), Nunnally and Bernstein (1994)
0.60 – 0.69	Questionable	George and Mallery (2003)
0.50 – 0.59	Poor	George and Mallery (2003)
< 0.50	Unacceptable	George and Mallery (2003)

Source: Author's own work (2025)

To ensure the consistency and trustworthiness of the measurement instrument, Cronbach's Alpha (α) was used to assess the internal reliability of all scale items. Reliability was calculated separately for respondents from Saudi Arabia and the United Kingdom, as well as for the overall combined sample. This approach helps verify that each scale performs reliably within each national context and supports valid cross-country comparisons.

Table 21 below presents the Cronbach's Alpha values for each construct, along with the number of items (K), item variances (σ^2_i), and total score variances (σ^2_{total}), calculated separately for Saudi Arabia and the United Kingdom.

Table 21: Reliability Analysis by Country– Saudi Arabia and United Kingdom

			Saudi Arabia			UK		
Factors	**Dimension**	**K**	σ_i^2	σ_{total}^2	**α**	σ_i^2	σ_{total}^2	**α**
Human Factors	**Organization**	11	97.762	11.991	0.965	54.1021	8.2745	0.932
	Job-Project	10	60.8506	8.7353	0.952	34.7276	7.0553	0.885
	Individual Factors	5	17.0008	6.9664	0.738	10.0948	4.4218	0.702
Non-Human Factors	**Regulatory Factors**	7	41.8276	7.8049	0.949	20.0576	5.8151	0.828
	Economic Factors	4	14.8432	5.5809	0.832	7.6797	3.3716	0.748
	Environmental Factors	3	10.7044	4.3622	0.889	4.1302	1.9023	0.809
	Technology-Related Factors	2	3.8213	2.3199	0.786	2.6283	1.594	0.787
Dependent Variable	**Perceived Effectiveness of Health and Safety Practices**	29	477.9421	30.9717	0.969	240.9454	21.8538	0.942
	Overall	42	779.6047	47.7607	0.962	364.3902	32.4345	0.933

Source: Author's own work (2025)

Table 22 shows Cronbach's Alpha results for the entire sample (n = 164), combining both countries. The reliability coefficients remain strong across all dimensions, with all α values exceeding the acceptable threshold. This indicates that the instrument is consistently reliable when applied to the total dataset.

Table 22: Reliability Analysis– Combined Sample

Factors	Dimension	K	σ_i^2	σ_{total}^2	Cronbach's Alpha
Human Factors	**Organization**	11	70.123	9.6529	0.949
	Job-Project	10	44.8198	7.783518	0.918
	Individual Factors	5	13.13647	5.454661	0.731
Non-Human Factors	**Regulatory Factors**	7	28.45619	6.628947	0.895
	Economic Factors	4	10.86469	4.332074	0.802
	Environmental Factors	3	6.64204	2.845466	0.857
	Technology-Related Factors	2	3.061013	1.85826	0.786
Dependent Variable	**Perceived Effectiveness of Health and Safety Practices**	29	330.1225	25.41961	0.956
	Overall	42	526.6082	38.5458	0.949

Source: Author's own work (2025)

The factors wise interpretation of the reliability analysis using Cronbach's Alpha and the number of items, comparing Saudi Arabia (SA) and the United Kingdom (UK) within each paragraph:

1. Human Factors - Organisational Factors

This dimension was measured using 11 items in both countries. The Cronbach's Alpha for Saudi Arabia was 0.965, indicating excellent internal consistency, suggesting that the participants in SA showed a highly consistent understanding of organisational influences on health and safety (H&S). In the UK, the Cronbach's Alpha was slightly lower at 0.932, but still within the excellent range, reflecting similarly high reliability. These values suggest that the organisational component of human factors is reliably measured and considered critical by respondents in both regions.

2. Human Factors - Job/Project Factors

The Job-Project dimension, with 10 items in both countries, achieved a Cronbach's Alpha of 0.952 in Saudi Arabia, indicating excellent reliability. This shows that respondents had consistent views about how job-related elements affect H&S. In the UK, the reliability was

slightly lower at 0.885, which still falls within the good to excellent range. This demonstrates that, while perceptions are slightly more varied in the UK, the items still measure the concept consistently across respondents.

3. Human Factors - Individual Factors

This dimension, consisting of only 5 items, had a Cronbach's Alpha of 0.738 in Saudi Arabia, reflecting acceptable reliability, while in the UK, it dropped to 0.702, which is at the minimum acceptable threshold. The slightly lower reliability here in both countries may reflect the diverse personal attitudes and behaviours influencing H&S, which tend to vary more among individuals and are harder to measure with high internal consistency.

4. Non-Human Factors - Regulatory Factors

This non-human factor, regulatory, with 7 items for both countries, had a very high Cronbach's Alpha of 0.949 in Saudi Arabia, signifying excellent consistency in participants evaluation of laws, policies, and enforcement. In contrast, the UK showed a lower but still good reliability at 0.828, which may indicate more diverse interpretations or experiences with regulatory frameworks in the UK construction sector.

5. Non-Human Factors - Country-Related Economic Factors

This dimension included 4 items and had a Cronbach's Alpha of 0.832 in Saudi Arabia, indicating good reliability, while the UK yielded a slightly lower alpha of 0.748, which is acceptable. This suggests that country-specific economic conditions affecting H&S are perceived with acceptable consistency in both countries, though there is more variability in the UK responses.

6. Non-Human Factors - Environmental Factors

The Environmental Factors, with 3 items for both countries, showed high reliability in Saudi Arabia ($\alpha = 0.889$) and acceptable to good reliability in the UK ($\alpha = 0.809$). The small

number of items may constrain internal consistency, but both alphas suggest that respondents had relatively stable views on environmental challenges such as weather, terrain, or external physical conditions influencing H&S.

7. Non-Human Factors - Technology-Related Factors

Technology related factor had only 2 items, acceptable alpha values: 0.786 for Saudi Arabia and 0.787 for the UK. Despite the limited number of items, the near-identical scores show a consistent perception of how technological tools or systems affect safety practices in both countries. However, the small item count may limit the depth of analysis.

8. Perceived Effectiveness of H&S Practices

The Dependent Variable measuring Perceived Effectiveness of H&S practices was evaluated using 29 items. In Saudi Arabia, this dimension achieved a Cronbach's Alpha of 0.969, and in the UK, it was 0.942, both of which fall in the excellent range. This reflects very high consistency in both countries, indicating that respondents had a stable and uniform understanding of how effective current H&S measures are in practice.

9. Overall Instrument Reliability

The overall reliability across all 42 items was 0.962 in Saudi Arabia and 0.933 in the UK. Both values are in the excellent category, confirming that the entire survey instrument is highly consistent and reliable for use in both the Saudi and UK construction contexts.

10. Combined Sample

As shown in Table 22, the overall Cronbach's Alpha for the full 42-item instrument across all respondents was 0.949, indicating excellent internal consistency. This confirms that the survey tool is reliable for use in cross-country analysis involving both the Saudi and UK samples.

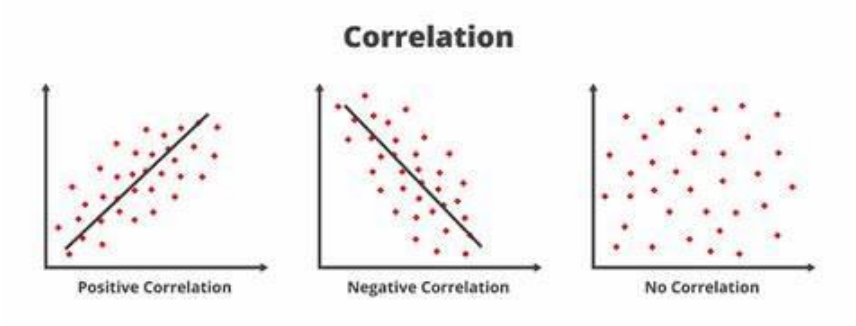
4.6. Karl Pearson's Pairwise Correlation Analysis

The Pearson correlation coefficient was developed by Karl Pearson, building on the covariance concept introduced by Francis Galton (Pearson, 1896). Pearson's work aimed to formalise correlation mathematically and apply it statistically. The Pearson correlation coefficient, denoted as r, measures the strength and direction of the linear relationship between two continuous variables. It ranges from -1 to +1:

If

- **0 < r < 1**: indicates a positive linear correlation
- **r ≅ 0:** indicates there is no linear correlation
- **-1 < r < 0**: indicates a negative linear correlation

All indications as shown below::



The formula for Pearson's r is:

$$r = \frac{n\sum x_i y_i - \sum x_i \sum y_i}{\sqrt{[n\sum x_i^2 - (\sum x_i)^2]\,[n\sum y_i^2 - (\sum y_i)^2]}}$$

Where: n = sample size, x_i = Independent variables, and y_i = Dependent variables

The strength of correlation is interpreted using cutoff values. According to Cohen (1988), the correlation coefficient can be interpreted in the following manners:

Table 23: Interpretation of Correlation Coefficient

r value	Interpretation
0.00 – 0.10	Negligible or no correlation
0.10 – 0.29	Weak correlation
0.30 – 0.49	Moderate correlation
0.50 – 0.69	Strong correlation
0.70 – 0.89	Very strong correlation
0.90 – 1.00	Extremely strong

Source: Cohen (1988)

Table 24 presents the Pearson correlation coefficients between the study dimensions and the perceived effectiveness of health and safety practices (PEHSP) in Saudi Arabia and the United Kingdom.

Table 24: Pearson Correlations with respect to SA and UK

Dimension	Saudi Arabia			United Kingdom		
	r	Strength (Cohen)	Direction	r	Strength (Cohen)	Direction
Organization <-> PEHSP	0.942	Extremely Strong	Positive	0.941	Extremely Strong	Positive
Job-Project <-> PEHSP	0.952	Extremely Strong	Positive	0.928	Extremely Strong	Positive
Individual Factors <-> PEHSP	0.739	Very Strong	Positive	0.575	Strong	Positive
Regulatory Factors <-> PEHSP	0.729	Very Strong	Positive	0.669	Strong	Positive
Economic Factors <-> PEHSP	0.225	Weak	Positive	0.221	Weak	Positive
Environmental Factors <-> PEHSP	0.253	Weak	Positive	0.156	Weak	Positive
Technology Factors <-> PEHSP	0.428	Moderate	Positive	0.162	Weak	Positive

Source: Author's own work (2025)

Interpretation of Pearson Correlations:

1. **Human Factors- Organisational Dimension:**

In both Saudi Arabia and the UK, the correlation between organisational factors and the perceived effectiveness of health and safety practices is 0.942 and 0.941, respectively, indicating an extremely strong positive relationship. This means that improvements in the organisational dimension are strongly associated with better perceptions of health and safety effectiveness among workers.

2. **Human Factors – Job Dimension:**

In both Saudi Arabia and the UK, the correlation between job dimension and the perceived effectiveness of health and safety practices is 0.952 and 0.928, respectively, indicating an extremely strong positive relationship. This suggests that a well-structured job dimension is critical for enhancing perceived safety standards.

3. **Human Factors - Individual Dimension:**

In Saudi Arabia, with a correlation of 0.739, individual factors demonstrate a very strong positive association with perceived health and safety effectiveness. This highlights the significant role individuals play in maintaining safety.

In the UK, individual factors show a strong positive correlation of 0.575 with safety effectiveness. This indicates that the attitudes, behaviour, and competencies of individual workers have a significant role in ensuring health and safety.

4. **Non-Human Factors- Regulatory factors:**

Regulatory factors show a very strong correlation in Saudi Arabia (r=0.729) and a strong one in the UK (r=0.669) — highlighting the key role of enforcement, inspections, and compliance in shaping safety perceptions in both countries.

5. **Non-Human Factors – Country-related Economic Factors:**

Economic factors show a weak positive correlation in both Saudi Arabia (r=0.225) and the

UK (r=0.221), suggesting that while economic conditions have some influence, they are not major drivers of safety perceptions.

6. **Non-Human Factors - Environmental Factors:**

Environmental factors show a weak positive correlation in Saudi Arabia (r=0.253) and the UK (r=0.156), indicating that environmental conditions have a limited impact on perceived safety effectiveness.

7. **Non-Human Factors - Technology Factors:**

Technology factors have a moderate positive correlation in Saudi Arabia (r=0.428) and a weak correlation in the UK (r=0.162), suggesting that while technology aids safety perceptions, its influence is stronger in Saudi Arabia and limited in the UK.

4.7. Independent Samples t-Test

The t-test was invented by William Sealy Gosset, an English statistician who published under the pseudonym "Student" in 1908 (Student, 1908). The independent samples t-test (also called two-sample t-test) is a statistical method used to compare the means of two independent groups to determine whether there is a statistically significant difference between them (Martin, 2025).

Example:

Used to compare the average organisational scores of construction workers between Saudi Arabia and United Kingdom.

Steps for Independent Samples t-Test:

1- **State the hypotheses**:

- Null hypothesis (H_0): $\mu_1 = \mu_2$ (the two-groups means are equal/both groups are similar)
- Alternative hypothesis (H_1): $\mu_1 \neq \mu_2$ (the two-groups means are not equal/both groups are not similar)

2- Level of significance

The level of significance, denoted by α (alpha), is the threshold used to determine whether a statistical result is statistically significant. It represents the probability of rejecting the null hypothesis when it is actually true.

α = 0.05 (5%), most commonly used level of significance. There's a 5% risk of concluding an effect exists when it doesn't.

3- Compute the t-statistic

For two independent samples:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

Where:

- $\bar{X}_1 = \frac{\sum X_{1i}}{n_1}$ and $\bar{X}_2 = \frac{\sum X_{2i}}{n_2}$ are the sample means
- $s_1^2 = \frac{(x_{1i} - \bar{X}_1)^2}{n_1 - 1}$ and $s_2^2 = \frac{(x_{2i} - \bar{X}_2)^2}{n_2 - 1}$ are the variances
- $s_1 = \sqrt{\frac{(x_{1i} - \bar{X}_1)^2}{n_1 - 1}}$ and $s_2 = \sqrt{\frac{(x_{2i} - \bar{X}_2)^2}{n_2 - 1}}$ are the standard deviations (S.D)

n_1 and n_2 are the sample sizes.

4. **Calculated the degree of freedom**

The degrees of freedom (df) represent the number of independent values that can vary in a statistical calculation without violating any constraints. For an independent samples t-test assuming unequal population variances, the degrees of freedom are calculated using the Welch–Satterthwaite equation (Satterthwaite, 1946):

$$df = \frac{(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2})^2}{\frac{(\frac{s_1^2}{n_1})^2}{n_1 - 1} + \frac{(\frac{s_2^2}{n_2})^2}{n_2 - 1}}$$

5. **Compute the p-value:**

Bevans (2023b) stated that p-value is a number that that describes how likely you are to have found a particular set of observations if the null hypothesis were true. In hypothesis testing, p-value is used to decide whether to reject the null hypothesis. A smaller p-value means your results are less likely to be random, and you're more likely to reject the null hypothesis.

Using a t-distribution software (e.g., Excel), determine the p-value from the t-statistic with degrees of freedom by using following formula:

p-value=2×P(T>|t|)

The excel formula is as follow: =T.DIST.2T(ABS(t), df)

- ABS(t) = the absolute value of t-value
- df = the degree of freedom

6. **Decision criterion on the basis of p-value to α (e.g., 0.05):**

- If p ≤ α, reject the null hypothesis.
- If p > α, fail to reject the null hypothesis.

If the absolute value of **t** is large (more than 1.96), and p-value is small (< 0.05), we reject the null hypothesis (i.e., means are significantly different) (Bevans, 2023b) .

The following table showed the results of the independent samples t-test for assuming unequal variances.

Table 25: Independent Samples t-Test Results Comparing Saudi Arabia and the UK

Dimensions	Categories	Mean	S.D	t-value	df	p-value
Organisation	Saudi Arabia	44.48	9.89	-0.166	102	0.868
	United Kingdom	44.73	7.36			
Job-Project	Saudi Arabia	40.34	7.80	1.301	103	0.196
	United Kingdom	38.84	5.89			
Individual Factors	Saudi Arabia	18.18	4.12	2.425	105	0.017
	United Kingdom	16.70	3.18			
Regulatory Factors	Saudi Arabia	28.48	6.47	1.348	97	0.181
	United Kingdom	27.23	4.48			
Country-Related Economic Factors	Saudi Arabia	12.47	3.85	2.721	99	0.008
	United Kingdom	10.94	2.77			
Environmental Factors	Saudi Arabia	8.13	3.27	1.235	90	0.220
	United Kingdom	7.56	2.03			
Technology-Related Factors	Saudi Arabia	8.58	1.95	0.339	111	0.735
	United Kingdom	8.48	1.62			
Health and Safety Practices	Saudi Arabia	115.4	21.86	0.908	99	0.366
	United Kingdom	112.5	15.52			

Source: Author's own work (2025)

t-Test Interpretation: Human Factors Dimensions

The independent samples t-test was used in order to examine if statistically important differences do exist between Saudi Arabia and the United Kingdom in perceptions of various factors which are influencing health and safety. The following are hypotheses that were tested for each dimension:

- **Null Hypothesis (H_0):** There is no significant difference between Saudi Arabia and the United Kingdom.
- **Alternative Hypothesis (H_1):** There is a significant difference between Saudi Arabia and the United Kingdom.

1. Organisational Dimension

The p-value of 0.868 is well above the 0.05 threshold, indicating no statistically significant difference between Saudi Arabia and the United Kingdom. Therefore, we fail to reject the null hypothesis and conclude that organisational factors are perceived similarly in both countries.

2. **Job-Project Dimension**

The p-value of 0.196 is above the 0.05 threshold, indicating no significant difference. Therefore, we fail to reject the null hypothesis. Respondents in both countries seem to have similar views on job-related factors.

3. **Individual Dimension**

Here, the p-value of 0.017 is below the 0.05 threshold, showing a statistically significant difference. We reject the null hypothesis. Saudi respondents rated individual factors more positively (M = 18.18) than UK respondents (M = 16.70), suggesting they see individual-level human factors as more influential compared to those in the United Kingdom.

t-Test Interpretation: Non-Human Factors

4. **Regulatory Factors:**

The p-value of 0.181 is above the 0.05 threshold, indicating that the difference between the two countries is not statistically significant. We therefore fail to reject the null hypothesis. This suggests that participants in both Saudi Arabia and the United Kingdom share similar views on how regulatory factors influence health and safety in construction.

5. **Country-Related Economic Factors**

For this dimension, the p-value of 0.008 is below the 0.05 threshold, indicating a statistically significant difference. Null hypothesis is rejected, indicating a statistically significant difference between countries. Respondents in Saudi Arabia rated economic factors

more positively, suggesting they perceive these economic conditions as having a stronger or more effective role in supporting health and safety compared to respondents in the UK.

6. Environmental Factors

The p-value 0.220 is well above the 0.05 significance level. This means we fail to reject the null hypothesis. Respondents in both countries appear to hold similar perceptions about the influence of environmental conditions.

7. Technology-Related Factors

With a p-value of 0.735, there is no statistically significant difference in how respondents from Saudi Arabia and the UK view technology-related factors. We fail to reject the null hypothesis. This suggests that both groups similarly recognise the role of tools, equipment, and digital safety technologies in supporting health and safety on construction sites.

t-Test Interpretation: Perceived Effectiveness of Health and Safety Practices

The p-value of 0.366 is well above the 0.05 significance level, indicating no statistically significant difference between Saudi Arabia and the United Kingdom. We therefore fail to reject the null hypothesis. This suggests that respondents from both countries perceive the effectiveness of health and safety practices in a similar way.

Table 26: Summary of Independent Samples t-Test Results Comparing SA and the UK

Factor	p-value	Decision	Significant Difference?
Organisational Factors	0.868	Fail to reject the null hypothesis	No difference
Job-Project Factors	0.196	Fail to reject the null hypothesis	No difference
Individual Factors	0.017	Reject the null hypothesis	Difference
Regulatory Factors	0.181	Fail to reject the null hypothesis	No difference
Economic Factors	0.008	Reject the null hypothesis	Difference
Environmental Factors	0.220	Fail to reject the null hypothesis	No difference
Technology-Related Factors	0.735	Fail to reject the null hypothesis	No difference
Perceived Effectiveness of H&S Practices	0.366	Fail to reject the null hypothesis	No difference

Source: Author's own work (2025)

4.8. Multiple Regression Analysis

Multiple linear regression (MLR) was developed as an extension of simple linear regression. While its roots are in the work of early statisticians like Sir Francis Galton and Karl Pearson, the formal development and application of multiple linear regression is generally attributed to the statistician Ronald A. Fisher (Fisher, 1922). Multiple regression analysis is a statistical technique used to examine the relationship between one dependent variable and two or more independent variables (Bevans, 2023a) . It allows to assess the combined effect of multiple predictors on an outcome and to determine the relative importance of each predictor. In this study, the dependent variable and independent variables are as follows:

Dependent variable:

- Y= Perceived Effectiveness of Health and Safety Practices

Independent Variables:

Human Factors

- X_1 = Organisational Factors
- X_2 = Job-Project Factors
- X_3 = Individual Factors

Non-Human Factors

- X_4 = Regulatory Factors
- X_5 = Country-Related Economic Factors
- X_6 = Environmental Factors
- X_7 = Technology-Related Factors

The Multiple Regression Equation is as follow:

$$Y=\beta 0+\beta 1X1+\beta 2X2+\beta 3X3+\beta 4X4+\beta 5X5+\beta 6X6+\beta 7X7+\varepsilon$$

Where:

- β0: Intercept
- β1, β2, β3, β4, β5, β6, β7: Regression Coefficients for predictors (representing the change in Y per unit change in X)
- ε: Error term (residuals)

Estimation of Regression coefficients (β):

$$\hat{\beta} = (X^t X)^{-1} X^t Y$$

Where:

- X: matrix of independent variables (with a column of 1st for the intercept)
- Y: Vector of the dependent variable
- $\widehat{\boldsymbol{\beta}}$: Vector of estimated coefficients

Steps in testing the Regression Coefficients (β's)

1- State the hypotheses:

Show the individual effect of each independent variable on the dependent variable.

- H_0: βi=0 (there is no significant effect of Xi on Y)
- H_1: βi≠0 (there is significant effect of Xi on Y)

2- Level of Significance

The level of significance, denoted by α (alpha), is the threshold used to determine whether a statistical result is statistically significant. It represents the probability of rejecting the null hypothesis when it is actually true (i.e., making a Type I error).

α = 0.05 (5%), Most commonly used level of significance. There's a 5% risk of concluding an effect exists when it doesn't.

3- Test Statistic to be used:

$$t_j = \frac{\hat{\beta}_j}{S.E\ (\hat{\beta}_j)}$$

Where $S.E\ (\hat{\beta}_j)$is the standard error of $\hat{\beta}_j$

$$S.E\left(\hat{\beta}_j\right) = \sqrt{s^2.c_{jj}}$$

Where:

$s^2 = \frac{Residual\ Sum\ of\ Square}{degree\ of\ freedom} = \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{n-k-1}$ =Mean Square Error (residual variance)

- c_{jj}= ith diagonal Element of $(\boldsymbol{X^t X})^{-1}$
- n = number of observations
- k = number of independent variables

4- Compute the p-value:

Using a t-distribution software (e.g., Excel), determine the p-value from the t-statistic with degrees of freedom, df = n-k-1, by using following formula:

p-value=2×P(T>|t|)

The excel formula is as follow:

=T.DIST.2T(ABS(t),df)

ABS(t) = the absolute value of t-value

df = degree of freedom =n-k-1

5- Decision criterion on the basis of p-value to α (e.g., 0.05):

- If p ≤ α, reject the null hypothesis.
- If p > α, fail to reject the null hypothesis.

If the absolute value of t is large (more than 1.96), and p-value is small (< 0.05), we reject the null hypothesis (i.e., means are significantly different).

In practice, all regression coefficients, t-statistics, and p-values were calculated using Microsoft Excel, which applied the standard regression functions to generate the results reported in Table 27.

Table 27: Multiple Regression Analysis Results

Saudi Arabia					
Variable	**β**	**t**	**P-value**	**95% CI**	**Significance**
Organisation	1.001	42.21	0.000	[0.953, 1.048]	Significant
Job-Project	1.018	31.22	0.000	[0.952, 1.083]	Significant
Individual Factors	0.955	24.29	0.000	[0.876, 1.034]	Significant
Regulatory Factors	0.430	17.34	0.000	[0.381, 0.480]	Significant
Country-Related Economic Factors	-0.002	-0.044	0.965	[-0.075, 0.071]	Not Significant
Environmental Factors	0.017	0.383	0.703	[-0.073, 0.107]	Not Significant
Technology-Related Factors	0.001	0.020	0.984	[-0.134, 0.137]	Not Significant
United Kingdom					
Variable	**β**	**t**	**P-value**	**95% CI**	**Significance**
Organisation	1.043	38.42	0.000	[0.989, 1.097]	Significant
Job-Project	0.969	27.01	0.000	[0.898, 1.041]	Significant
Individual Factors	0.957	23.71	0.000	[0.877, 1.037]	Significant
Regulatory Factors	0.398	12.55	0.000	[0.335, 0.461]	Significant
Country-Related Economic Factors	0.007	0.141	0.888	[-0.089, 0.103]	Not Significant
Environmental Factors	-0.001	-0.020	0.984	[-0.125, 0.123]	Not Significant
Technology-Related Factors	-0.054	-0.764	0.447	[-0.195, 0.087]	Not Significant

Source: Author's own work (2025)

Sub-Hypotheses by Factor (H_1a – H_1g)

To test the specific relationships between each group of factors and perceived effectiveness of H&S practices, the following sub-hypotheses can be formulated under H_1:

H_1a–H_1c: Human Factors

- **H_1a:** Organisational factors significantly influence the perceived effectiveness of H&S.
- **H_1b:** Job-related factors significantly influence the perceived effectiveness of H&S.
- **H_1c:** Individual factors significantly influence the perceived effectiveness of H&S.

H_1d–H_1g: Non-Human Factors

- **H_1d:** Regulatory factors significantly influence the perceived effectiveness of H&S.
- **H_1e:** Economic factors significantly influence the perceived effectiveness of H&S.

- **H_1f:** Environmental factors significantly influence the perceived effectiveness of H&S.
- **H_1g:** Technological factors significantly influence the perceived effectiveness of H&S.

Interpretation of Multiple Regression Results

1. Human Factors- Organisational Dimension (H1a)

The organisational dimension demonstrated a strong positive effect on health and safety (H&S) practice effectiveness in both Saudi Arabia and the United Kingdom. The beta coefficients for Saudi Arabia and the UK were $\beta = 1.001$ ($p < 0.001$), and $\beta = 1.043$ ($p < 0.001$) respectively. The organisational dimension's improvement leads to a corresponding rise in perceived H&S effectiveness.

The results validate the statistical hypothesis H_1a, which shows that organisational human factors strongly predict H&S outcomes in both countries. The findings validate research hypothesis RH1 which states that human factors play a more significant role than non-human factors. The strong organisational impact observed in Saudi Arabia and the UK supports RH2 and RH3 by demonstrating organisational factors' essential role in health and safety.

Note: Sampling Limitation in Saudi Arabia – Organisational Data Bias

The regression analysis strongly supports Hypothesis H1a in the Saudi Arabian context, yet these results should be interpreted in light of the sample characteristics. The 62 Saudi respondents included 53 employees from large organisations, while medium-sized firms had 5 participants, and small enterprises had 4 participants. The results may have been skewed towards more favourable perceptions of organisational human factors, which are more likely to be well-developed in large firms with robust management systems and regulatory compliance. As mentioned in the literature review chapter, large Saudi construction firms invest significantly in safety infrastructure, leadership training, and systematic procedures. On the

other hand, small and medium-sized companies are often lagging in H&S performance due to limited resources and weak enforcement (Mosly, 2015).

Therefore, while the findings accurately highlighted the positive role of organisational human factors in large companies, they may not fully do the same and spoted the challenges across small and private companies. Future studies should aim for a more proportionate sample to enhance generalisability across organisational types.

2. Human Factors- Job Dimension (H1b)

The job-related dimension established a statistically significant positive relationship with perceived H&S effectiveness in both Saudi Arabia and the United Kingdom. The beta coefficients were $\beta = 1.018$ ($p < 0.001$) for Saudi Arabia, and $\beta = 0.969$ ($p < 0.001$) for the UK. Better work environments produce significant improvements in how safety performance is perceived.

These findings validate the statistical hypothesis H_1b, which demonstrates that job-related human factors play a crucial role in determining H&S outcomes. The slightly higher impact observed in Saudi Arabia suggests that enhancing job structure yields stronger safety gains in developing contexts. The findings support research hypothesis RH1, which states the importance of all human factor dimensions in both Saudi Arabia and the UK, and RH3, which emphasizes the particularly strong influence of job-related factors in the UK. These results also validate the main research goal to determine which human factor dimensions most impact H&S practices in various national contexts.

3. Human Factors- Individual Factors (H1c)

Individual factors were found to be major predictors which affect perceived H&S effectiveness in both Saudi Arabia and the United Kingdom. The beta coefficients showed $\beta = 0.955$ ($p < 0.001$) for Saudi Arabia, and $\beta = 0.957$ ($p < 0.001$) for the UK, indicating similar

effects in both contexts. The results show that individual dimension plays a crucial role regardless of the broader national conditions.

The results confirm the statistical hypothesis H_1c, which shows how individual human factors influence health and safety promotion. The results also support research hypotheses RH1, RH2, and RH3, by confirming the overall importance of human factors (RH1), reinforcing the importance of all human dimensions in Saudi Arabia (RH2), and highlighting the strong contribution of individual factors in the UK (RH3).

4. Non-Human Factors, Regulatory Factors (H1d)

Regulatory factors were found to have a statistically significant and moderate positive impact on perceived health and safety (H&S) effectiveness in both Saudi Arabia and the UK. The beta coefficients were $\beta = 0.430$ ($p < 0.001$) for Saudi Arabia, and $\beta = 0.398$ ($p < 0.001$) for the UK. This indicates that better perceptions of regulatory enforcement led to enhanced workplace safety perceptions.

The slightly higher effect in Saudi Arabia may reflect a rising recognition of the value of effective regulation, particularly where regulatory enforcement has traditionally been less robust. The results confirm the statistical hypothesis H_1d, which proposed that regulatory factors significantly influence H&S effectiveness.

5. Non-Human Factors, Economic Factors (H1e)

The economic factors showed no statistically significant relationship with the perceived effectiveness of H&S practices in both Saudi Arabia ($\beta = -0.002$, $p = 0.965$), and the UK ($\beta = 0.007$, $p = 0.888$). The coefficients are near zero and the p-values are high, indicating that economic conditions do not have a meaningful effect on how respondents perceive safety effectiveness. These results do not support the statistical hypothesis H_1e, which stated that there is a significant relationship between economic factors and H&S outcomes. This also informs the broader research aim by showing that not all commonly assumed influences, especially

non-human ones, have meaningful impact, especially when strong human factor systems are in place.

6. Non-Human Factors, Environmental Factors (H1f)

The analysis revealed no statistically significant relationship between environmental factors and perceived H&S effectiveness. The beta coefficient for Saudi Arabia was $\beta = 0.017$ ($p = 0.703$), and for the UK, it was $\beta = -0.001$ ($p = 0.984$). The results indicate that environmental risks do not appear to have a significant effect on perceived safety outcomes. The findings do not support the statistical hypothesis H_1f, which proposed a significant influence of environmental conditions.

7. Non-Human Factors, Technological Factors (H1g)

The analysis showed that technological factors failed to establish a statistically significant connection with workers' and professionals' perceptions of H&S effectiveness in both countries. The beta coefficient for Saudi Arabia was $\beta = 0.001$ ($p = 0.984$), and for the UK, it was $\beta = -0.054$ ($p = 0.447$). The results show that advanced tools and innovations do not currently influence how safety effectiveness is perceived by workers and professionals.

The results do not support the statistical hypothesis H_1g because they show no significant impact of technological advancements. The results could be due to restricted access to such technologies in developing countries or because technology has become standard in the UK, so it does not add any additional value to their procedures.

4.9. Goodness of Fit:

Coefficient of Determination (R^2) and Adjusted R^2

The coefficient of determination (R^2) as defined by Turney (2022) assesses the predictability of a statistical model for an outcome. It Indicates the proportion of variance in the dependent variable explained by the independent variables. The values closer to 1 indicate

a stronger explanatory model. Adjusts R^2 for the number of predictors; more reliable when comparing models with different numbers of variables.

The regression models demonstrated excellent fit in both contexts. For Saudi Arabia, the R^2 was 0.9984 and the adjusted R^2 was 0.9983. For the UK, R^2 was 0.9953 and adjusted R^2 was 0.995. These values indicate that nearly all of the variation in perceived health and safety effectiveness was explained by the included human and non-human factors.

4.10. Reframing Human Factors: From Problematic Causes to Positive Enablers

While the literature review highlighted human factors as the most problematic contributors to accidents and poor H&S outcomes - emphasising their absence or deficiency as root causes of accidents - statistical analysis in this study showed that these factors act as the most influential predictors of health and safety when they are properly managed. The research shows that human factors are double-edged elements because their deficiency leads to increased risk, yet their strong presence becomes essential for achieving safety excellence. Therefore, rather than framing these factors solely in terms of negative impact, this research recognises them as the most significant determinants of H&S outcomes. The effectiveness of these factors depends on their quality and proper implementation within the organisation to determine their direction of influence.

4.11. Summary and Validation of Objectives and Research Hypotheses

Research Hypotheses

Based on the analysis of correlation coefficients, multiple regression results, and independent samples t-tests, we can now validate each of the four research hypotheses (RH1–RH4) as follows:

Table 28: Summary of Relationship Strengths and Predictive Rankings by Country and Dimension

Dimension	r KSA	r UK	Significance KSA	Significance UK	β KSA	β UK	Rank	
							KSA	UK
Organisation	0.942	0.941	Extremely Strong	Extremely Strong	1.001	1.043	2	1
Job-Project	0.952	0.928	Extremely Strong	Extremely Strong	1.018	0.969	1	2
Individual Factors	0.739	0.575	Very Strong	Strong	0.955	0.957	3	3
Regulatory Factors	0.729	0.669	Very Strong	Strong	0.43	0.398	4	4
Economic Factors	0.225	0.221	Weak	Weak	-0.002	0.007	7	5
Environmental Factors	0.253	0.156	Weak	Weak	0.017	-0.001	5	6
Technology Factors	0.428	0.162	Moderate	Weak	0.001	-0.054	6	7

Source: Author's own work (2025)

1- RH1

RH1 proposed that human factors —organisational, job, and individual dimensions — exert a more prominent influence on health and safety (H&S) outcomes in construction than non-human factors, across both the UK and Saudi Arabia. This hypothesis is supported by the data. All three human factor dimensions showed statistically significant regression coefficients ($p < 0.001$) and the highest standardised beta values in both countries, with extremely strong correlations ($r \geq 0.928$ for organisational and job dimensions). These results confirm that improvements in the three dimensions of human factors are the primary drivers of perceived H&S effectiveness. However, it is important to note that regulatory factors—while classified as non-human—also demonstrated a statistically significant influence in both countries ($\beta = 0.430$ in Saudi Arabia, $\beta = 0.398$ in the UK; $p < 0.001$) and strong correlation values ($r = 0.729$ and 0.669 respectively). This suggests that regulatory systems are an important secondary contributor. In contrast, economic, environmental, and technological factors showed weak correlations and non-significant regression results. Overall, RH1 is validated, with the

clarification that regulatory factors, although non-human, also play a measurable role in supporting H&S outcomes.

2- RH2

RH2 claimed that in Saudi Arabia, all three human factor dimensions significantly influence H&S, with organisational factors being the most influential due to weaker regulatory structures. This hypothesis is supported by data. The regression results for Saudi Arabia confirm that organisational ($\beta = 1.001$), job ($\beta = 1.018$), and individual factors ($\beta = 0.955$) were all significant. Although job factors had a slightly higher beta than organisational, the difference is marginal. Therefore, organisational factors can still be considered the primary influential dimension in Saudi Arabi where regulatory systems are comparatively weaker.

3- RH3

RH3 posited that in the UK, while all human factors matter, job-related and individual factors would be the most influential. This hypothesis is partially supported. In the UK model, all three human factors were significant predictors, with organisational factors showing the highest beta ($\beta = 1.043$), followed by job ($\beta = 0.969$) and individual ($\beta = 0.957$). However, the job dimension exhibited the second-highest correlation ($r = 0.928$) and was slightly less dominant in the regression model compared to organisational factors. Hence, while the importance of job and individual dimensions is affirmed, the organisational factor emerged as slightly more impactful than expected.

4- RH4

RH4 predicted that human factor dimensions would produce statistically significant differences in health and safety outcomes between the UK and Saudi Arabia. This hypothesis is only partially supported by the data.

The independent samples t-test demonstrated that Saudi participants rated individual factors more positively than UK participants ($p = 0.017$) among the three human factor dimensions.

The results showed no significant differences between the two countries for organisational ($p = 0.868$) or job-related ($p = 0.196$) factors.

Overall, while some variation exists across countries, statistically significant differences were limited to individual factors, resulting in only partial validation of RH4.

Research Objectives:

1- To develop an understanding of factors affecting H&S in construction:

Achieved: The research delivered a comprehensive understanding of H&S factors in construction operations between the UK as a developed nation and Saudi Arabia as a developing country. The study achieved this goal through both a comprehensive literature review and a cross-national questionnaire that measured human elements (organisational, job, and individual) and non-human elements (regulatory, economic, environmental, technological).

2- Clarifying the Concept of Human Factors:

Achieved: The research achieved its goal through a comprehensive literature review which expanded human factors beyond typical individual trait analysis to include organisational, job, and individual dimensions.

3- Categorisation and Impact Assessment of All Factors:

Achieved: The questionnaire organised all 42 items into 7 categories. The statistical analysis through regression and correlation methods measured how each category impacted H&S effectiveness and demonstrated human factors provided more predictive power. The framework enabled a full comparative analysis of each category's influence.

4- To determine which dimension of human factors plays the most influential role in shaping H&S practices:

Achieved: This objective was addressed through correlation and regression analyses and is discussed in detail in the previous section.

5- To provide recommendations and suggestions for enhancing H&S practices by focusing on the most critical human factor dimension(s)

Recommendations will be addressed in the final chapter of this dissertation.

CHAPTER V:

DISCUSSION, CONCLUSION, AND IMPLICATION

5.1. Introduction

The chapter provides a detailed evaluation of Chapter 4 findings, which address the research objectives and hypotheses presented in Chapter 1, and integrates essential findings from both literature and primary research data to establish important conclusions. The chapter also delivers practical implications for construction industry professionals, together with implementation recommendations and future research directions.

5.2. Discussion of Findings / Interpretation of Results

5.2.1 Restatement of Research Questions/Hypotheses:

This study began by addressing a key gap in the literature: the need for a clearer and more comprehensive definition of human factors in construction health and safety (H&S). Through an extensive review and synthesis of prior studies (Chapter 2), human factors were defined here as encompassing three interrelated dimensions: organisational, job-related, and individual that influence behaviour at work in a way that can impact health and safety. This definition provided the essential foundation for the next stage of the research.

Based on this, the quantitative aspect of the research aimed to test four major hypotheses (RH1–RH4) regarding the impact of human factors on H&S outcomes in construction. Specifically, the research aimed to explore:

(1) whether human factors (organisational, job-related, and individual) have more influence on H&S outcomes than non-human factors, in the UK and Saudi Arabia (RH1).

(2) which dimension of human factors is most influential in Saudi Arabia (RH2) and in the UK (RH3).

(3) whether there are statistically significant differences between the UK and Saudi Arabia in the way human factors influence H&S performance (RH4).

5.2.2 Summary of Key Findings:

The first essential outcome of this research was creating a detailed definition of human factors in health and safety in construction. The research study (Chapter 2) conducted an extensive literature review to identify and categorise human factors into three dimensions which include organisational, job-related and individual. The study expanded existing definitions by showing that human factors extend beyond individual behaviours. The improved conceptual framework established the base for the quantitative study phase and supported the interpretation of all subsequent findings.

The statistical analysis conducted in this study yielded strong and consistent results that allow each of the four research hypotheses (RH1–RH4) to be evaluated with confidence.

Firstly, the results confirmed that human factors showed a stronger and more consistent influence on health and safety outcomes than non-human factors. These patterns were consistent in both the UK and Saudi Arabia. Notably, organisational and job-related factors demonstrated the strongest predictive power, as evidenced by the regression and correlation analyses discussed in Chapter 4.

On the other hand, economic pressures, environmental conditions, and technological systems, which were categorised as non-human factors, showed weaker and limited impact on health and safety outcomes. Regulatory factors, which were classified as non-human, played a meaningful secondary role by shaping organisational behaviours and supporting formal safety frameworks. Together, these observations highlighted that the best health and safety outcomes are more deeply rooted in human-focused systems and actions rather than in outside factors or advancements.

Secondly, it became clear that both Saudi Arabia and the UK showed a remarkably consistent pattern when it came to the influence of the three key human factor dimensions on health and safety outcomes. In Saudi Arabia, both organisational (β = 1.001) and job-related factors (β = 1.018) emerged as the strongest predictors of perceived H&S effectiveness, with individual factors (β = 0.955) also contributing significantly. In the UK, organisational factors demonstrated the highest beta value (β = 1.043), followed closely by job-related (β = 0.969) and individual factors (β = 0.957). The rankings of factors were almost identical between the two countries (see Table 28), with only marginal differences in their relative influence between organisational and job-related factors.

Finally, regarding cross-country comparisons (RH4), the independent samples t-test revealed that two categories showed statistically differences between Saudi Arabia and the UK: one from human factors which is individual dimension (p = 0.017) and the other is non- human factors which is country-related economic factors (p = 0.008), with Saudi respondents rating both dimensions more positively. No significant differences were detected for organisational (p = 0.868), job-related (p = 0.196), regulatory (p = 0.181), environmental (p = 0.220), or technological (p = 0.735) factors.

Overall, while small mean differences were identified for certain dimensions, the regression and correlation analyses demonstrated a highly consistent pattern of factor influence across both countries. This suggests that, despite contextual and regulatory differences, the structure of how human factors shape H&S outcomes in construction is broadly similar in Saudi Arabia and the UK. Accordingly, these findings fully validate RH1 and RH2, partially support RH3 — as organisational factors in the UK were more dominant than expected — and offer partial support for RH4.

5.2.3 Interpretation and Explanation of Results:

The statistical results offer important insights into the role of human factors in construction H&S, and several observations can be drawn when placing these findings in the broader context of existing literature.

1. **Overall influence of human factors (RH1):**

The findings confirm previous studies (Hughes and Ferrett,2016; HSG48,1999; Fabiano et al.,2019) that human factors play a significant role in H&S outcomes. The results suggest that improvements in construction health and safety are far more likely to succeed when they prioritise human-centred interventions — particularly in how organisations structure their safety management systems and how jobs are designed and delivered on site.

It is notable, however, that regulatory factors still play a meaningful secondary role. This indicates that while human factors are the primary drivers of H&S performance, an effective regulatory environment provides an important foundation upon which such human-centred improvements can be built.

These results underline the continuing importance of human-focused strategies for enhancing H&S performance in the construction sector — a finding that appears consistent across both the UK and Saudi Arabian contexts examined here.

2. Cross-country differences in factor dimensions (RH2 & RH3):

In Saudi Arabia (RH2), it was anticipated that all human factors dimensions would be significant, with organisational factors would demonstrate the most pronounced influence on H&S outcomes, due to weaker regulatory frameworks and inconsistent enforcement. The regression results did confirm that organisational and job-related dimensions both exerted very strong influence, although the job-related dimension ($\beta = 1.018$) slightly exceeded organisational ($\beta = 1.001$), with the difference being marginal. This suggests that in practice,

both the organisational dimension and the job environment are nearly equally important for driving H&S performance in Saudi construction. In this context, a strong organisational management system and effective job design appear to compensate for gaps in external regulatory oversight.

In the UK (RH3), the hypothesis predicted that job-related and individual factors would show the strongest influence. However, the regression results showed that organisational factors ($\beta = 1.043$) remained slightly more influential than job-related ($\beta = 0.969$) and individual ($\beta = 0.957$) dimensions.

Taken together, these results suggest that in both countries, the three human factor dimensions play a significant and closely balanced role in shaping H&S outcomes. The regression coefficients for these dimensions were consistently high and showed only marginal differences in both the Saudi Arabian and UK models. This indicates that, despite differences in regulatory context, there is a broadly similar pattern of influence across the two countries — with organisational system, job design, and individual behaviour working together as key drivers of H&S performance.

Additional consideration:

It should be acknowledged that most of the sample for Saudi Arabia was biased towards large firms, where 53 of 62 respondents came from large organisations; only 5 came from medium-sized firms and 4 came from small organisations. As has been discussed, this could lead to a positive bias in the findings with respect to organisational human factors, as larger companies typically have stronger management systems, and more formalised safety procedures (Mosly, 2015). Smaller firms in Saudi Arabia often lag behind in these areas due to limited resources and weaker enforcement. As such, while the current results highlight the positive role of organisational factors in larger organisations, it may not fully capture the challenges presented in SMEs — an important area for future research.

3. Limited country differences (RH4):

Overall, the results indicated that the influence of human factors dimensions is similar between Saudi Arabia and the UK, as no significant differences were found for organisational or job-related factors.

A difference was detected for individual factors, with Saudi respondents giving higher ratings (Mean = 18.18) compared to UK respondents (Mean = 16.70; independent samples t-test, p = 0.017). This difference may reflect cultural or perceptual tendencies toward more favourable self-assessment in the Saudi context, possibly due to lower baseline expectations or less critical qualification assessment procedures.

4. Alignment with existing literature:

The research findings validated previous studies, which demonstrate human factors as essential elements in construction health and safety performance in Saudi Arabia and the UK as established in Chapter 2.

The research built upon previous studies by analysing how human factors influence different national settings. The human dimensions maintained their consistent ranking across different contexts which indicates their universal impact. The research supports the notion that safety outcome improvements are best achieved by prioritising internal management systems, job design, and worker capabilities — regardless of regional differences in regulation.

5. Unexpected findings:

- The analysis showed that technological and environmental factors had weak predictive power on health and safety in both countries. It might have been expected that these factors would have a strong impact, especially in the UK, where systems and environmental protocols

are more advanced. The respondents may have considered these as background conditions - already well managed and therefore less critical to safety outcomes.

In addition, the effect of such non-human factors is often mediated by humans. For example, how technology is used and maintained, it depends on human behaviour, so that technology cannot act as a standalone solution, but should be built into a broad human focused safety approach.

- It is also worth noting that, despite the UK's well-established regulatory environment supported by frameworks such as CDM 2015 and the Health and Safety at Work Act 1974, UK respondents did not report significantly higher perceptions of H&S compared to their Saudi counterparts. A possible explanation is that perceptual baselines vary between the two countries. In countries where formal H&S practices are still emerging or developing —such as in Saudi Arabia— respondents may consider even small or moderate efforts more favourably. While in highly regulated settings, such as the UK, expectations are higher, and professionals may be more critical of shortcomings.

5.3. Research's Implications

The findings of this study provide implications for both theoretical understanding and professional practice in health and safety in construction, particularly through the lens of human factors.

5.3.1 Theoretical Implications

This research provides a comprehensive definition of human factors that affect H&S in construction and delivers a thorough framework that categorises human factors into three interrelated dimensions: organisational, job-related, and individual. This definition extends beyond traditional views that often limit human factors only to individual behaviours, and that

organisational factors and the job environment have a substantial influence on human behaviour.

5.3.2 Practical Implications

For construction industry practitioners and H&S professionals, the findings emphasize the important need to prioritize human-centred interventions over purely technical or regulatory solutions.

Additionally, while the data showed that non-human factors like economic, environmental, and technological influences have relatively limited direct impact on perceived H&S effectiveness, this should not be seen as diminishing their value. However, their effectiveness is ultimately mediated by human use, how they are understood, adopted, and maintained on-site. Therefore, even the misuse or neglect of technology is often attributed to human factors. Technology, therefore, needs to be part of a human-centred safety approach and not be seen as a stand-alone solution.

5.4. Limitations of the Study

This study was not without limitations. While every effort was made to ensure the validity, reliability, and relevance of the results, several limitations exist:

First, the sample distribution — particularly in Saudi Arabia — may have introduced a potential bias. A large proportion of responses came from employees in large construction firms, which are more likely to have better health and safety performance. As noted in Chapter 2, this could have led to more favourable evaluations of human factors and may have underrepresented the experiences of those working in small or medium-sized companies, where health and safety practices may be less developed. A more balanced sample across company sizes might have yielded more generalisable insights.

Second, although the study aimed to compare two national contexts, it remains limited to the UK and Saudi Arabia (acknowledging that Saudi Arabia is a wealthy country, compared to other developing countries). Both countries represent different economic and regulatory environments, but they do not capture the full spectrum of global construction practices. Therefore, there is a limitation to the generalisability of these findings to other cultural or regional settings.

Third, the study used structured questionnaires to collect self-reported perceptions. This tool is impacted by social context, and individual interpretation even if it captures important subjective experience. Respondents may have rated their organisations based on optimism bias or social desirability, rather than objective conditions. This appeared more evident in Saudi responses, which were more positive than UK ones, despite differences in regulatory enforcement. Such variation may reflect differing cultural expectations or lower baseline standards in contexts where formal safety systems are still developing.

Lastly, while the mixed-method approach was valuable for both conceptualising and testing human factors, the qualitative phase was limited in scope and primarily used to refine dimensions rather than generate open-ended insights. A more extensive qualitative component — such as interviews or focus groups — might have uncovered deeper context-specific challenges or cultural interpretations.

5.5. Recommendations

5.5.1 Recommendations for Industry Professionals (H&S Teams, Project Managers, and Policymakers)

The research findings demonstrate how human elements determine health and safety results in both the UK and Saudi Arabia. The following practical recommendations are aimed at

H&S teams, project managers, and policymakers seeking to strengthen safety performance by focusing on these human dimensions:

1- Foster Strong Organisational Practices

Construction companies should improve their organisational dimension by establishing effective health and safety management systems, and suitable team structures while building a safety-first culture through specific H&S policies, clear standards, visible leadership, and open communication. Leaders need to interact with their workers while providing sufficient supervision, performing safety audits, and offering incentives for safe work practices. Robust accident reporting and learning systems, as highlighted in Figure 3, ensure safety is a core value.

2- Design Jobs with Safety in Mind (Job-Related Dimension)

Effective job design is an important determinant for health and safety performance, this study emphasises the importance of coordinating job characteristics with physical, cognitive and psychological abilities of workers. To achieve this, construction companies must use a systematic and ergonomically informed approach to task planning.

Main elements include identifying and analysing the safety-critical components of each job, evaluating workers' decision-making needs, and ensuring balanced interface between human and automated systems. The design of site layout, tools, and equipment should follow ergonomic best practices to minimize confusion and physical strain. All procedures and work instructions need to be clear, accessible, and well-presented to ensure consistent interpretation and execution.

Workplace environmental conditions should be addressed and designed to enhance completing each task safely, such as workplace accessibility, lighting, noise, ventilation, and temperature. The determination of shift patterns should also be arranged

in order to reduce fatigue, and to ensure continuity, particularly through well-planned handovers and communication practices. Each task should be risk assessed to identify and mitigate risks proactively.

3- Enhancing Worker Capabilities and Wellbeing (Individual Dimension)

Construction firms must ensure workers have the necessary knowledge, qualifications, experience, aptitude, competency, and personality to do their duties in a safe way, and these qualities should be matched to the job requirements in order to improve health and safety performance. Organisations need to confirm that workers possess the necessary abilities to perform their duties especially for safety-critical tasks through formal personnel selection procedures. An effective training system must be implemented, with programmes designed to meet cognitive and physical demands, including special considerations for vulnerable worker groups.

Continuous health surveillance programmes and monitoring of personal safety performance should be established, particularly for high-risk roles.

4- Leverage Regulations as a Backbone (Non-Human Factor)

While human factors lead, regulatory frameworks support them. Construction organisations should align their internal policies and standards with regulations, and policymakers must enforce them by conducting repeated inspections and audits. This ensures a solid foundation for human-centred safety strategies.

5.5.2 Recommendations for Future Research

1- Balanced Sample Representation

The study's Saudi Arabian sample was skewed toward large organisations (85% of respondents), potentially overemphasised the strength of organisational factors. Future research should include a more balanced representation of small and medium-sized enterprises (SMEs)

to better capture H&S challenges in resource-constrained settings, especially in developing countries where regulatory enforcement may be weaker.

2- Expand Cross-National Comparisons

The literature review examined various factors that influence health and safety in construction across different countries, but the primary data from questionnaires in this study focused on the UK and Saudi Arabia. Future research needs to broaden its empirical scope by studying additional national contexts, especially in less developed countries in Africa and Asia, to understand how human factors affect health and safety under different regulatory, cultural and economic conditions.

3- Incorporate Qualitative Insights

The research depended mainly on questionnaires which could introduce perceptual biases. The study could gain more insights by incorporating qualitative primary data methods including interviews or focus groups.

5.6. Conclusion

This dissertation set out to clearly define the human factors that influence health and safety in the construction industry and to assess their impact on overall H&S performance. Using a mixed-methods approach, combining an extensive literature review with primary data collected through a questionnaire from industry professionals, the study defined human factors as organisational and job-related factors, along with human and individual characteristics, that influence behaviour at work in ways that can impact health and safety (HSG48, 1999; Hughes & Ferrett, 2016). It then evaluated their influence in comparison to non-human factors such as regulations, economics, technology, and other external conditions.

This research showed that human factors are the main drivers of health and safety (H&S) performance in construction in both the UK and Saudi Arabia. The health and safety (H&S) regulations had a meaningful secondary role in shaping organisational systems, and other non-human factors such as economic, environmental, and technological factors, had limited influence. This suggested that human factors and behaviours are more influential on shaping health and safety than external resources or innovations. In Saudi Arabia, where regulatory enforcement is less mature, strong organisational and job dimensions appeared to compensate for regulatory gaps, and this is more apparent in large and governmental organisations. Conversely, in the UK, where regulatory compliance is high, the influence of organisational culture remained dominant, reaffirming that even in a well-regulated environment, human-centred approaches are essential.

Contribution to Knowledge: The research provided a comprehensive definition of human factors in construction health and safety which extends beyond the conventional emphasis on individual characteristics. The research presented an integrated framework which combines organisational practices with job design and worker capabilities to provide a complete understanding of how human factors affect safety results.

Practical Implications: The research findings showed that industry professionals should focus on human-centred approaches which include building strong safety cultures, designing tasks ergonomically, and empowering workers through training instead of focusing only on technology or regulations. Policymakers should strengthen regulatory enforcement to support these efforts, particularly in developing countries like Saudi Arabia, where consistent oversight can enhance organisational practices.

Limitations: The Saudi Arabian sample was skewed toward large firms, potentially overemphasizing strong organisational practices and underrepresenting challenges in

smaller companies. The use of self-reported data may introduce perceptual biases, with Saudi respondents rating factors more favourably because of lower baseline expectations compared to the UK's stricter regulatory environment. Focusing only on two countries limits broader generalisability.

Future Research Directions: Future studies should include more diverse organisation sizes, especially small and medium enterprises, to capture varied H&S challenges. Expanding comparisons to other regions, specifically poorer economies in Africa or Asia, to test the universality of human factors. Conducting interviews with construction professionals can add deeper contextual insights.

Final Statement:

An important fact was emphasised in this research: health and safety in construction is mainly a human matter, driven by how organisations lead, how jobs are structured, and how workers behave. These insights provide a road map for safer construction sites, ensuring that construction workers are supported by the management systems and cultures that prioritise their health, safety and well-being, ultimately saving lives.

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APPENDIX: The questionnaire

Factors impacting Health and Safety in Construction

Dear participant,

Thank you for considering participation in this survey. This questionnaire aims to explore factors that influence health and safety practices in the construction industry. Your insights are crucial to this research, and your honest feedback will help us identify ways to improve construction safety standards and working conditions.

Participation Details:

- Your participation is **entirely voluntary,** and responses are strictly anonymous.
- There are **no right or wrong answers**, we are interested in your honest opinions and experiences.
- The questionnaire consists of **42 questions** and takes approximately 15–20 minutes to complete.
- This survey is designed for individuals with at **least 5 years of professional experience in construction**. If you do not meet this requirement, please refrain from completing the survey.
- This questionnaire is focused on your experience in the UK or Saudi Arabia only.

Note to Respondents

The questions use two types of response scales:

- **Agreement-Based Scale**: Strongly Disagree → Disagree → Neutral → Agree → Strongly Agree
- **Impact Assessment Scale**: Strong Negative Impact → Moderate Negative Impact → Neutral (No Impact) → Moderate Positive Impact → Strong Positive Impact

For both scales, moving down the list reflects a shift from **problematic to non-problematic or positive outcomes**.

Your honest responses are critical in helping us identify and enhance health and safety practices in construction.

General Questions:

* Indicates required question

1. **1- What is your age?** *

   Mark only one oval.

   - ◯ 18-24 years
   - ◯ 25-34 years
   - ◯ 35-44 years
   - ◯ 45-54 years
   - ◯ 55+ years

2. **2- What is your gender?** *

   Mark only one oval.

   - ◯ Male
   - ◯ Female
   - ◯ Other
   - ◯ Prefer not to say

3. **3- What is your role in construction?** *

   Mark only one oval.

   - ◯ Junior Engineer/Manager
   - ◯ Mid-Level Engineer/Manager
   - ◯ Senior Engineer/Manager
   - ◯ Supervisor
   - ◯ H&S specialist/CDM

4. **4- Where is your primary professional experience in the construction industry which used in this questionnaire?** *
If your experience is outside the United Kingdom or Saudi Arabia, we kindly ask you not to proceed with the questionnaire.

Mark only one oval.

- ◯ United Kingdom
- ◯ Saudi Arabia

5. **5- How many years of experience do you have in the construction industry, specifically in the UK or Saudi Arabia? (Do not include experience from other countries)** *

Mark only one oval.

- ◯ 6-10 Years
- ◯ 11-15 years
- ◯ 16-20 years
- ◯ 21-25 years
- ◯ +26

6. **6- What type of construction project are you currently working on?** *

Mark only one oval.

- ◯ Residential
- ◯ Commercial
- ◯ Infrastructure
- ◯ Industrial
- ◯ Other: _____

7. **7- What is the size of your organisation?** *

Mark only one oval.

- ◯ Small Size (0-50 employees)
- ◯ Mid-size (51-250 employees)
- ◯ Large size (more than 250 employees)

8. **8- Are you involved in health and safety practices at your workplace? (e.g., attending safety meetings, following safety protocols, reporting hazards)** *

Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Other: _____

Human factors - Organisational Dimension 11 Questions

Please select the option that best reflects your **organisation's** practices for each question below.

9. **1- To what extent do you agree that your company has an effective health and safety system, including a positive safety culture, clear H&S policy, and a well-defined organisational structure?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

10. **2-To what extent do you agree that senior management in your company shows commitment to health and safety through clear goals and visible leadership?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

11. **3- To what extent do you agree that your company establishes, monitors, and regularly reviews documented H&S procedures, standards, and safe systems of work?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

12. **4- To what extent do you agree that your company conducts regular safety inspections to identify hazards and ensure compliance?** *

Mark only one oval.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

13. **5- To what extent do you agree that your company provides H&S supervision with the authority to address health and safety issues and support collaboration?** *

Mark only one oval.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

14. **6- To what extent do you agree that your company has an effective system for accident reporting, investigation, and learning from past incidents to prevent future occurrences?** *

Mark only one oval.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

15. **7- To what extent do you agree that your company has efficient communication system and practices at the organisational level to support health and safety?** *

Mark only one oval.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

16. **8-To what extent do you agree that your company allocates sufficient resources (e.g., time, budget, and personnel) and maintains adequate staffing levels to meet health and safety standards?** *

Mark only one oval.

- Strongly Disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

17. **9- To what extent do you agree that your company provides training programmes and actively raises H&S awareness to improve health and safety practices on construction sites?** *

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

18. **10- To what extent do you agree that work patterns at your company level are designed to promote health and safety?** *

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

19. **11- To what extent do you agree that your company considers health and safety performance as a key criterion in contractors' selection?** *

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

Human Factors, Job-Project / related Factors 10 Questions

In this section, 'Job' refers to the specific tasks and working conditions encountered during construction activities, including the physical and operational environments in which these tasks are performed.

20. **12- To what extent do you agree that health and safety risks are effectively identified and addressed during the planning and design stages of your job/project (e.g., site layout, equipment selection, access routes…)?** *

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly Agree

21. **13- To what extent do you agree that critical tasks in your job/project have been thoroughly identified, analysed, and risk-assessed to ensure safe execution?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

22. **14- To what extent do you agree that tools and equipment are chosen to fit workers' physical needs (ergonomic principles) to improve safety and comfort in your job/project?** *

Mark only one oval.

- ◯ Strongly Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

23. **15- To what extent do you agree that, in your job/project, the balance between human workers and the use of advanced tools, equipment, and materials is thoroughly evaluated to enhance health and safety?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

24. **16- To what extent do you agree that work procedures and operating instructions in your job/project are clearly developed, communicated, and presented?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

25. **17- To what extent do you agree that your working environment is effectively designed and controlled to meet health and safety guidance (e.g., layout, access routes, lighting, noise, ventilation, thermal conditions, and availability of welfare facilities)?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

26. **18- To what extent do you agree that the correct tools, materials, and equipment (including PPE Personal Protective Equipment) are provided and maintained, and workers are trained in their proper use?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

27. **19- To what extent do you agree that work patterns and shifts in your job/project are designed to minimise health and safety risks such as fatigue, stress, and overload?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

28. **20- To what extent do you agree that communication systems and shift handovers are effectively designed and managed in your job/project to ensure continuity on health and safety practices?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

29. **21- To what extent do you agree that workers' decision-making needs are evaluated and supported to ensure effective health and safety practices in your job/project?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

Human Factors / Individual Factors 5 Questions

Individual or personal factors, which affect health and safety, are any condition or characteristic of an individual that could cause or influence him/ her to act unsafely. They may be physical, cognitive or psychological.

30. **22- How have workers' physical abilities (e.g., fitness, stamina, strength, age) impacted health and safety outcomes in your projects?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

31. **23- How have workers' training, skills, competence, experience, and H&S awareness (cognitive characteristics) impacted health and safety outcomes in your projects?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

32. **24- How have workers' attitudes, risk perception, personality, and stress management (psychological characteristics) impacted health and safety outcomes in your projects?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

33. **25- How has peer pressure (following unsafe behaviour of other workers) impacted the health and safety of workers in your projects?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

34. **26- How has repetitive work (e.g., tasks that feel routine or boring) impacted workers' attention to health and safety rules in your projects?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

Regulatory Factors 7 Questions

The following questions assess the adequacy, clarity, enforcement, and impact of health and safety regulations in your country .

35. **27- To what extent do you agree that health and safety are well-regulated in your country and that H&S regulations are clear and address construction industry risks effectively?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly Agree

36. **28- To what extent do you agree that health and safety regulations in your country are well-enforced, (e.g., through penalties/fines) to improve health and safety?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

37. **29- To what extent do you agree that the health and safety regulatory body in your country provides sufficient support and guidance to construction organisations?** *

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

38. **30- To what extent do you agree that there are sufficient regulations in your country related to tendering and procurement to prevent corruption and to ensure adequate investment in health and safety measures on construction projects?** *

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

39. **31- To what extent do you agree that there are sufficient environmental protection regulations in your country (e.g., restrictions on emissions or waste disposal) to support health and safety practices on construction sites adequately?** *

Mark only one oval.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

40. **32- To what extent do you agree that your country has sufficient regulations to regulate the labour market, particularly to limit unskilled and informal workers and improve health and safety on construction sites?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

41. **33- To what extent do you agree that current health and safety regulations in your country effectively govern collaboration among various stakeholders (e.g., clients, designers, contractors) to reduce risks?** *

Mark only one oval.

- ◯ Strongly disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Strongly agree

Country-Related Economic Factors 4 Questions

This category relates to national economic conditions, not company finances, and focuses on how these external factors impact health and safety on construction sites.

42. **34- How have economic pressures in your country impacted health and safety performance, particularly in prioritising speed and cost reduction over health and safety in your construction projects?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

43. **35- How have economic pressures in your country (e.g., minimising project costs, competitive tendering, inflation and recessions) impacted investment in and allocating resources for health and safety measures on your construction projects?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

44. **36- How have rising insurance costs and the potential for compensation claims impacted investment in health and safety measures on your construction projects?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

45. **37- How has workers' private financial situation impacted their decision to work in hazardous conditions?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

Environmental Factors 3 Questions

This section examines the impact of environmental conditions—such as weather, air quality, and site location—on health and safety practices on construction sites.

46. **38- How have extreme weather conditions (e.g., heavy rain, heatwaves) impacted health and safety on your sites?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

47. **39- How have environmental issues (e.g., poor air quality, dust, noise, toxic substances) impacted workers' health and safety on your sites?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

48. **40- How have far or isolated site locations impacted health and safety due to geographic factors (e.g., long driving, material delivery, and limited access to emergency services and medical facilities)?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact

Technology-Related Factors — 2 Questions

This category examines the role of technology, including advanced tools, equipment, and systems, in enhancing health and safety practices on construction sites.

49. **41- How has the use of advanced technology (e.g., modern tools, equipment) impacted overall health and safety performance in your projects?** *

Mark only one oval.

- ◯ Strong Negative Impact
- ◯ Moderate Negative Impact
- ◯ Neutral (No Impact)
- ◯ Moderate Positive Impact
- ◯ Strong Positive Impact
- ◯ Not Applicable/Not Used