Islamic University Journal of Applied Sciences (IUJAS)
https://journals.iu.edu.sa/jesc

Volume VII, Issue II, Dec 2025, Pages 248-262

Integrating Human Factors into Safety Culture: A Strategic Framework to Reduce Accidents in Saudi Arabian Construction Sites achieving Vision 2030

Yasir Azmat [1]

[1] School of Built Environment, University of Salford, 43 Crescent, Salford, Greater Manchester, UK, y.azmat@salford.ac.uk

*Corresponding author: (Yasir Azmat), *Email Address*: yasir.azmat@hotmail.com

Abstract

The Saudi construction industry remains among the most hazardous despite recent progress under Vision 2030. This study develops an evidence-based framework for integrating human factors into safety culture and policy to reduce accidents. We analyze 86 archived accident reports from Saudi construction firms and conduct semi-structured interviews (n=23) and a survey (n=150) of industry professionals. Key findings indicate that carelessness, lack of training/awareness, and unsafe conditions are the top causes of accident. Migrant workers, who comprise almost 76% of the private-sector workforce, suffer disproportionately higher injury rates than locals. Extreme heat and cultural-language barriers further elevate risks. The results underscore the need for targeted training (in native languages), robust supervision, and organizational commitment to safety. We propose a multi-level strategic framework that aligns with Saudi Vision 2030 by embedding safety into individual, task, organizational, and regulatory domains. Recommendations include establishing a national OSH authority, ISO 45001 adoption, and sustained investment in worker training and participation. This work contributes to construction ergonomics literature and offers actionable guidance for safety management in the Middle East.

Keywords: Construction safety; human factors; Saudi Arabia; safety culture; occupational health; Vision 2030.

https://doi.org/10.63070/jesc.2025.034
Received 16 November 2025; Revised 14 December 2025; Accepted 15 December 2025.
Available online 16 December 2025.

1. Introduction

The construction sector is globally recognized as one of the highest-risk industries due to its dynamic work environment and heavy reliance on manual labor [1]. In Saudi Arabia, this risk is magnified: recent analyses indicate that approximately 51% of all private-sector occupational injuries in 2014 were linked to construction activities [2]. Compared to other sectors, construction in the Kingdom continues to report significantly higher accident and injury rates [2]. According to the International Labour Organization (ILO), unsafe working conditions and human factors remain leading contributors to global occupational accidents [3]. Similarly, OSHA guidelines emphasize integrating human factors into safety programs to minimize hazards [4], while WHO reports that nearly two million people die annually from work-related causes worldwide. These global standards underscore the importance of proactive safety management in high-risk industries.

As Saudi Arabia undertakes massive infrastructure projects (e.g., NEOM, Red Sea) under Vision 2030's Human Capability Development Program, ensuring worker safety has become a national priority [11]. This program specifically aims to enhance workplace safety and labor welfare as part of sustainable development goals. To date, Saudi authorities have established a National Council for Occupational Safety and Health and strengthened regulations, yielding notable improvements in safety performance (e.g., work-injury rates have fallen from 416.1 to 287.8 per 100,000 workers) [11]. Yet human error and organizational deficiencies remain central to accidents. This study examines how human factors—the individual, task, and organizational elements affecting worker behavior—can be systematically integrated into Saudi safety culture and policy. Using archival accident data, interviews, and surveys, we identify root causes of construction incidents and develop a strategic framework to reduce accidents in line with Vision 2030 objectives.

2. Literature Review

2.1 Accident Causation Theories and Human Factors

Accident causation research has long emphasized both active errors and latent system failures. Heinrich's Domino Theory (1931) famously attributed ~88% of workplace accidents to unsafe human acts. Building on this, Reason's Swiss Cheese Model illustrates how layered defenses (organizational procedures, training, engineering controls, etc.) may each have "holes" (latent weaknesses) that can align with active failures to allow a hazard to penetrate all defenses and cause an accident. In other words, removing a single "unsafe act" without addressing systemic vulnerabilities is insufficient; a comprehensive view of human, technical, and organizational factors is needed. Figure 1 (Swiss Cheese Model) depicts how multiple protective layers can fail in alignment. Contemporary safety research

also acknowledges models like Bird's Accident Triangle, which relates minor incidents to severe accidents, and Haddon's Matrix, which examines factors across pre-event, event, and post-event phases. Overall, these theories highlight that improving safety requires addressing human behaviors and underlying organizational conditions simultaneously.

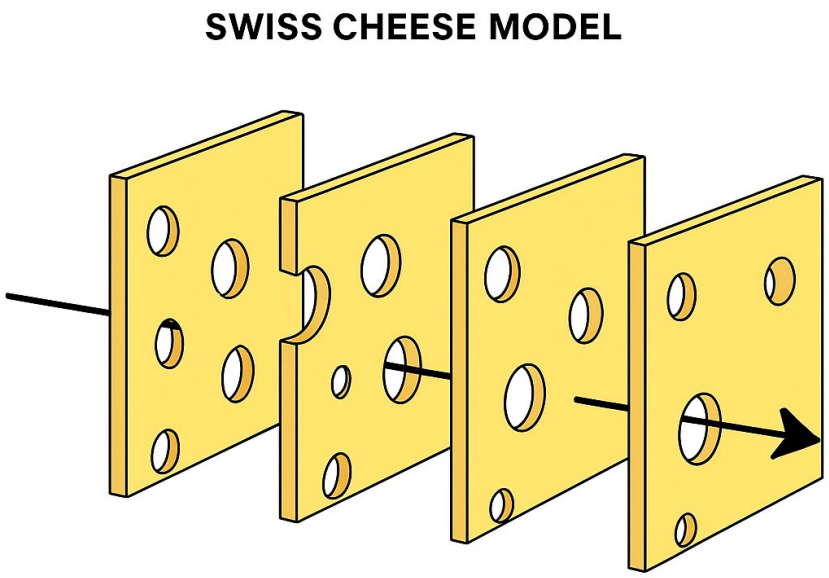

Figure 1: Swiss Cheese Model of accident causation [13]

2.2 Safety Culture, Regulations, and Vision 2030

"Safety culture" refers to the shared values, beliefs, and practices regarding safety within an organization. A strong safety culture is characterized by proactive risk management, worker engagement, and continuous improvement, whereas a poor culture leads to rule-breaking, underreporting, and high incident rates. In Saudi Arabia, historical challenges have included inconsistent enforcement, language barriers, and a lack of management commitment to safety [11]. Unlike mature systems (OSHA/HSE), Saudi firms have traditionally self-regulated, leading to variable compliance, especially among SMEs. Under Vision 2030, however, there is increasing momentum to elevate safety culture. The Saudi government has invested in OSH infrastructure: updating labour laws, strengthening inspection and audit processes, and launching training programs [11]. For example, the Ministry of Human Resources and Social Development reports a dramatic

decline in injury rates over six years, attributing this to enhanced training, stricter controls, and awareness campaigns [11]. Vision 2030's emphasis on human capital and sustainability aligns directly with these efforts [11]. Major companies (e.g. Saudi Aramco) now require ISO 45001–certified safety management systems, promoting international best practices. Nonetheless, a comprehensive safety culture in construction remains a work in progress, signalling the need for frameworks that integrate human factors at all levels.

2.3 Migrant Workforce and Cultural Factors

The Saudi construction workforce is overwhelmingly migrant, primarily from South and Southeast Asia. In 2021, migrants accounted for roughly 76.4% of private-sector employment in Saudi Arabia [3]. This demographic reality has safety implications: international studies consistently show that migrant workers face higher occupational risk due to language barriers, cultural differences, limited training, and precarious employment conditions [3]. In Saudi Arabia specifically, Alruwaili et al. (2022) found that half of all construction industry injuries each year occurred among migrants [3]. Migrant laborers often lack formal education or HSE training, and communication gaps can impede hazard recognition and reporting. One analysis note that migrant workers "often do not have access to adequate training and protective equipment," making them especially vulnerable [3]. These challenges are compounded by long working hours and heavy tasks. Globally and regionally, similar patterns have been observed: surveys in the UAE, Qatar, and Malaysia report disproportionately high accident rates among foreign construction workers [3]. Thus, any safety framework in Saudi Arabia must address the unique needs of the migrant workforce, including multilingual training and culturally sensitive supervision.

2.4 Regional and Global Research on Construction Safety

Numerous international studies have documented the causes and trends of construction accidents, informing effective interventions. Common global findings include the predominance of falls, struck-by, and electrocutions in construction fatalities, and the strong influence of organizational factors (e.g. management commitment, workload, and safety climate) on incident rates

[3]. In the Middle East, research echoes these concerns: an Indian study in the Gulf highlighted poor safety training and heat stress as drivers of accidents, while a Kuwait review cited inadequate safety policies and cultural issues. One Saudi study specifically on falls-from-height identified "lack of training" as the top cause of fall accidents, followed by insufficient site inspections and poor communication between stakeholders [10]. These findings align with ours: unsafe acts and conditions were dominant causes in our dataset (Figure 3). Other Saudi investigations have reported similar

issues. For example, a large-scale time-series analysis of Saudi accident data (2011–2022) reported clear seasonal peaks and long-term trends that can inform proactive planning [2]. In sum, both global and Saudi-specific research highlight that construction safety lapses often stem from human-system interactions, reinforcing the value of integrating human factors theories into policy and management.

3. Methods

This study used a mixed method design to gain a holistic understanding of safety issues. In Saudi Arabia, the General Authority of Statistics (GAS, 2019) classifies registered companies into four categories based on workforce size: Type 1 (1–5 employees), Type 2 (6–49 employees), Type 3 (50–249 employees), and Type 4 (250+ employees (Figure 2). The qualitative component comprised 23 semi-structured interviews with construction professionals (project managers, engineers, foremen) from four major firms in western Saudi Arabia. Interviewees were selected using purposive sampling to ensure representation across managerial and operational roles, including project managers, engineers, and foremen from four major firms. Selection criteria included minimum five years of industry experience and involvement in safety-related decision-making. Interviews probed perceptions of accident causes, safety culture, and training, and were recorded, transcribed, and analyzed using thematic coding. The quantitative component included: (a) In this study, eight companies were selected to represent different size categories, as enterprise size has been shown to influence safety performance. Specifically, three companies belonged to Type 2 (6–49 employees), three companies to Type 3 (50–249 employees), and two companies to Type 4 (250+ employees). This stratified selection enabled comparative analysis of accident occurrence and safety practices across varying organizational scales (see (Figure 2). (b) A cross-sectional survey of 150 construction workers and managers. Survey items were derived from established safety climate instruments (e.g., Cooper's Safety Culture Model) and adapted to the Saudi context through expert review and pilot testing. Items covered management commitment, training adequacy, communication, and worker empowerment, rated on a 5-point Likert scale.

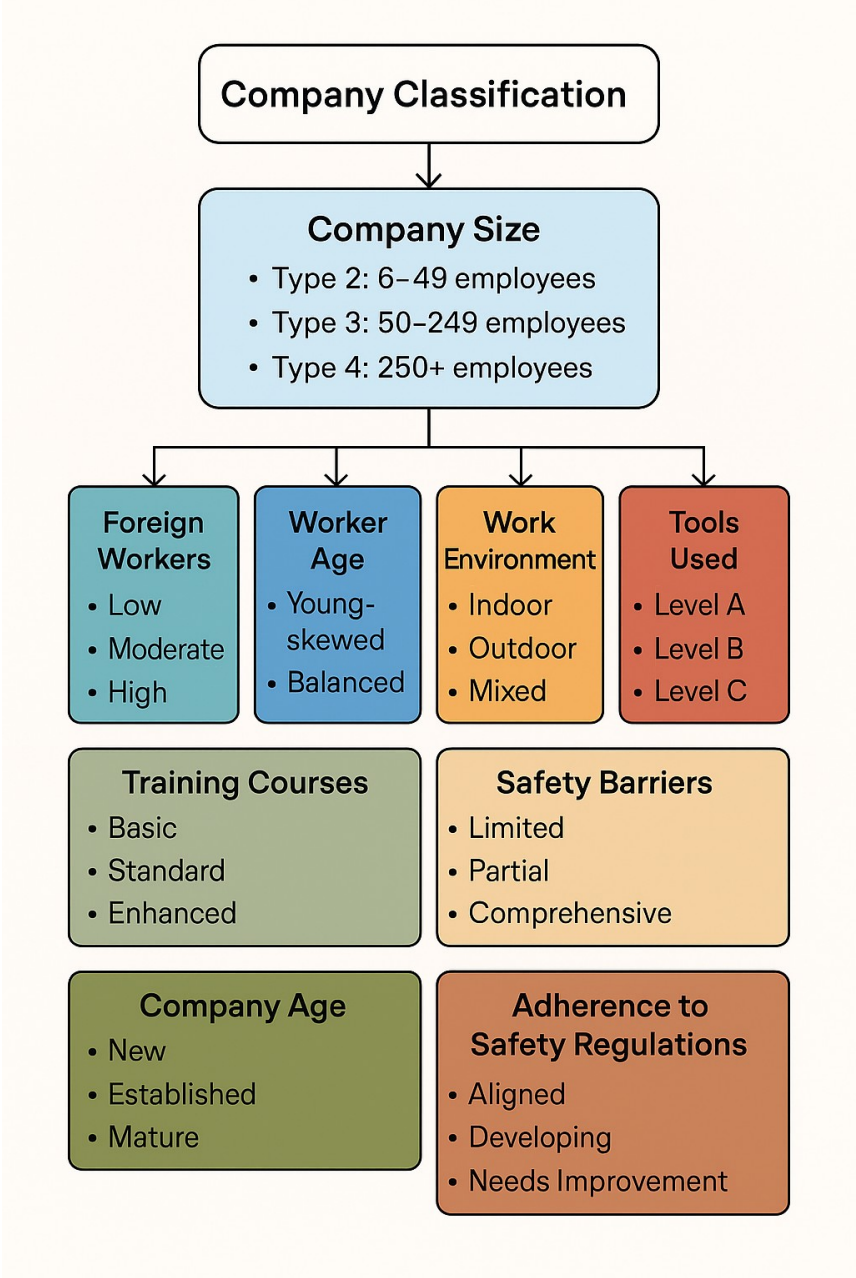

Figure 2: Companies classification chart

Quantitative data was analyzed using SPSS: descriptive statistics for incident attributes, and exploratory factor analysis on the survey responses to identify underlying dimensions of safety perception. Ethical approval was obtained; participation was voluntary, and data were kept confidential. These methods allowed triangulation of findings: archival trends provided objective incident data, while interviews and surveys captured subjective insights on safety culture and human factors.

4. Results

4.1 Accident Causes

Analysis of the 86 archived reports revealed recurring incident patterns. Figure 3 lists the top reported causes. “Carelessness” (worker error/intentional rule-breaking) was cited most frequently (n=54, 62.8% of cases), followed by “Lack of awareness” of hazards (n=36, 41.9%) and “Inadequate training” (n=34, 39.5%). Unsafe working conditions (e.g. equipment faults, poor housekeeping) appeared in 31 reports (36.0%). These factors often co-occurred (reports could cite multiple causes). The prominence of human-centered causes is consistent with prior studies: for instance, Mahmoud et al. (2023) similarly found that lack of training topped the list of fall-causing factors in Saudi construction [10]. Likewise, international research often identifies unsafe acts and insufficient training as major contributors to construction injuries.

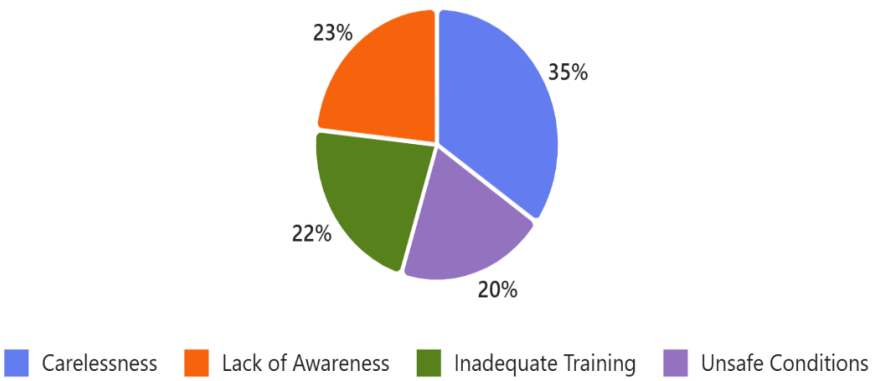

Figure 3: Reported causes of accidents (N=86)

4.2 Injured Body Parts

The accident reports also documented injury locations. Figure 4 summarizes the most frequently affected body parts. The hands/arms were the single most common injury site (33.7% of cases), followed by legs/feet (22.1%). Head and torso injuries were less common. This pattern indicates that many accidents involved manual tasks or falls involving upper limbs. While Saudi-specific comparisons are limited, it is generally observed that extremity injuries dominate non-fatal construction accidents globally. Together with causal data, the body-part distribution underscores the need for protective equipment and safe work practices for hands, as well as fall protection measures.

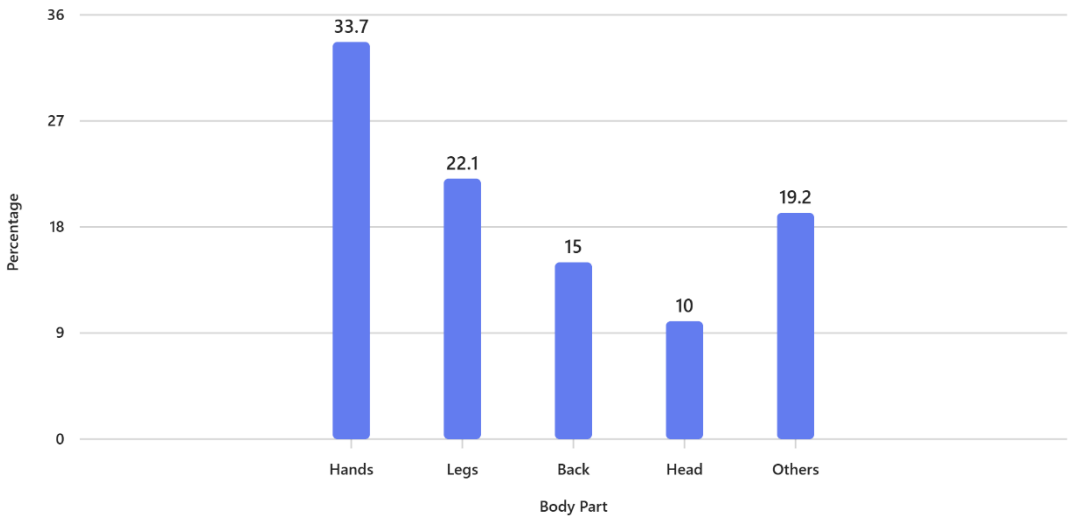

Figure 4: Injured body parts from recorded accidents (N=86)

4.3 Timing and Seasonal Trends

Accident timing showed a pronounced seasonal effect. Nearly half of all incidents occurred in the summer months (May–July), reflecting extreme heat stress and extended work hours during that period. This aligns with labor regulations: a 2014 decree prohibits outdoor work from 12–3pm in summer, pushing more activities into shoulder seasons. In fact, our interviewees and data suggest that spring (March–May) saw a relative uptick in accidents as projects accelerated to meet summer deadlines. A recent Saudi study similarly noted shifting patterns: legislative work bans during peak heat have reduced midday summer accidents, relocating many incidents to spring [3]. These findings imply that weather and scheduling are critical safety factors in this context.

4.4 Survey and Interview Insights

The worker survey (n=150) underwent exploration factor analysis, revealing six underlying dimensions of safety perception: (1) Management Commitment, (2) Training & Competence, (3) Communication & Supervision, (4) Risk Awareness, (5) Worker Empowerment, and (6) Organizational Procedures. For example, statements about visible leadership involvement and empowerment loaded on the Management Commitment factor, while language-appropriate training items loaded on Training & Competence. These factors highlight the multi-faceted nature of safety performance, combining both human and organizational elements.

Qualitative interview themes converged on known challenges:

- All participants noted the absence of a unified national safety authority. One manager remarked, "Each company does its own thing; there is no official oversight." This sentiment echoes calls in the literature for a central OSH body [14].
- Many commented that tight deadlines often override safety practices. A site supervisor explained that working overtime or skipping PPE checks can happen under schedule pressure.
- Several expatriate workers recounted difficulty understanding Arabic safety briefings or local rules. As one Bangladeshi foreman noted, "We work hard but sometimes we don't know exactly what is allowed." This confirms the quantitative finding that migrants lack access to adequate training [3].
- Repeatedly, interviewees stated that existing safety policies were "just on paper." Contractors with repeat violations faced few penalties, reinforcing an informal culture of leniency.
- Taken together, these results paint a clear picture: human factors such as inadequate training, communication breakdowns, and low managerial involvement are endemic issues. The findings align with broader evidence (e.g. the Saudi ARAMCO sector reports and global studies) that emphasize leadership commitment and worker engagement as crucial for safety.

5. Discussion

The integration of results suggests several implications for improving safety performance. Training and education remain critical areas of focus. Both this study and prior research identify inadequate training as a key contributor to accidents [10]. Tailored programs, particularly for low-skilled and migrant workers, may enhance hazard awareness and compliance. Delivering training in native languages and incorporating visual aids is consistent with international best practices and could improve comprehension among diverse labor groups [3]. On-site mentoring and workshops may complement formal instruction.

To operationalize this integrated perspective, the discussion can be structured around several interrelated dimensions that collectively influence safety performance, as outlined below:

- The predominance of unsafe acts in accident records indicates that safety performance is shaped not only by individual behavior but also by organizational leadership and workplace culture. International guidelines, such as those issued by OSHA and HSE, emphasize the importance of visible management commitment, proactive supervision, and the integration of safety indicators into performance evaluation systems. These practices may be particularly relevant for

organizations seeking to strengthen safety culture and align with national strategic objectives such as Vision 2030.

- Consistent and effective safety performance also depends on robust policy frameworks and regulatory oversight. The lack of a centralized enforcement mechanism can lead to inconsistencies in safety implementation across organizations. International labor standards, including ILO conventions, highlight the role of dedicated regulatory bodies in monitoring compliance and promoting continuous improvement. Establishing a national occupational safety and health authority, supported by mechanisms such as ISO 45001 certification and periodic audits, could enhance alignment with global benchmarks.
- Given the diverse demographic composition of the workforce, safety interventions must be tailored to address language, cultural, and educational differences. Multilingual safety instructions, pictorial signage, and peer-mentoring approaches are widely recommended in international best practices and can improve comprehension, engagement, and adherence to safety procedures among heterogeneous labor groups.
- In parallel with organizational and regulatory measures, technological innovations offer additional opportunities to improve safety outcomes. The global adoption of wearable sensors, real-time monitoring systems, and drone-based inspections demonstrates their potential to enhance hazard detection and support data-driven safety management. Integrating such technologies into construction safety practices may provide proactive risk mitigation and strengthen overall system resilience.

6. Strategic Framework

Drawing on these insights, Figure 5 presents a strategic framework integrating human factors into safety culture across four dimensions: Individual, Task, Organizational, and Regulatory (a synthesis of safety-by-design and safety-by-culture principles).

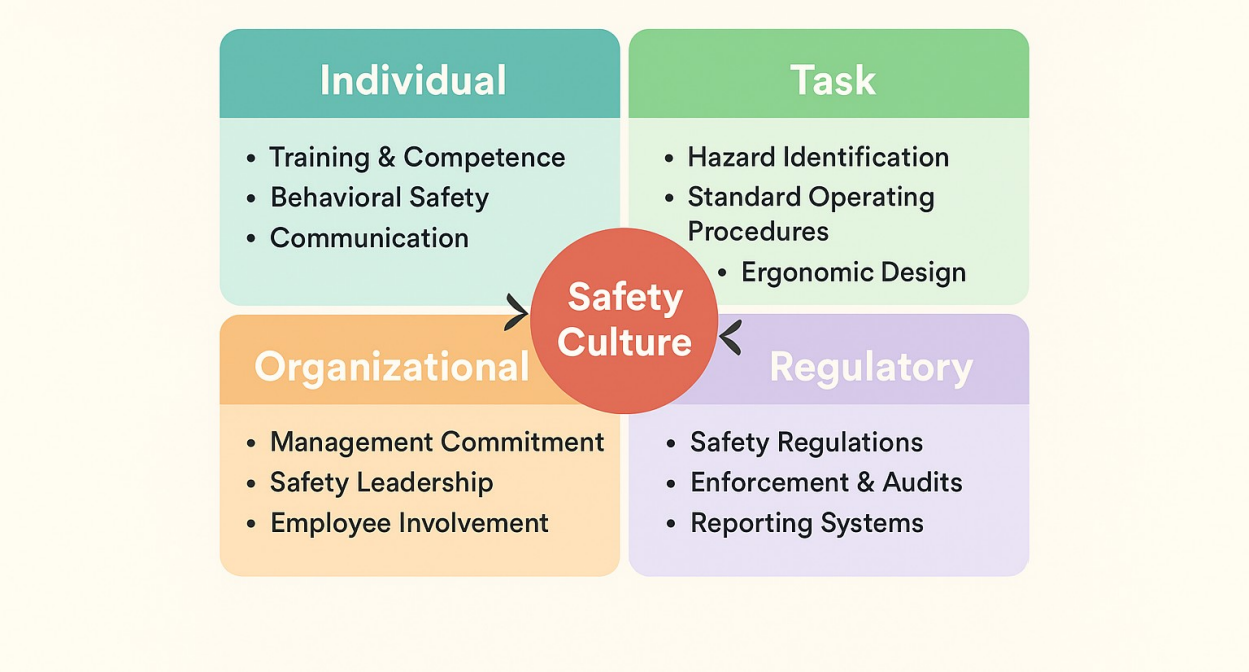

Figure 5: Framework integrating human factors into safety culture across

6.1. Individual Level

Focuses on the worker. Key elements include comprehensive safety induction and ongoing training (with multilingual content), behavior-based safety (e.g. peer observations), and easy-to-use tools (checklists, mobile apps). Emphasis is placed on language-accessible communication and visual aids, addressing the finding that many migrants struggle with standard training [3].

6.2. Task/Work Level

Involves job-specific controls. This encompasses ergonomic work design (to reduce strain and errors), clear standard operating procedures, and continuous hazard identification (job hazard analyses before tasks). Supervisors must provide real-time feedback and correction, since our interviews highlighted inadequate on-site supervision as a gap.

6.3. Organizational Level

Embodies management commitment and culture. The framework calls for visible leadership engagement (safety audits led by executives, reward systems for safe behavior) and integration of safety into organizational processes (e.g. including safety metrics in project KPIs and contracts). It also recommends fostering open communication, where workers can report risks without fear of penalty. These actions reflect both literature and interview themes: safety improvements require moving from symbolic compliance to genuine priority.

6.4. Regulatory/Institutional Level

Extends beyond individual companies to the national context. This includes establishing a formal Saudi Occupational Safety Authority with powers to enforce standards, conduct mandatory safety audits, and penalize violators. Regulations (e.g. working-hour limits in extreme heat) should be updated based on data. Alignment with global standards (ISO 45001) and ILO conventions is encouraged [4]. The framework also envisions national training initiatives (e.g. safety professional certification programs) and enhanced reporting systems to support data-driven policy.

While Saudi practices increasingly align with ISO 45001 and ILO conventions, gaps remain in enforcement and worker empowerment compared to mature systems like OSHA and HSE. For example, Saudi regulations mandate heat-related work bans, which mirror global best practices, but lack robust whistleblower protections common in EU frameworks.

This multi-level approach ensures that human factors are addressed from worker training up to societal infrastructure, creating a culture of safety that aligns with Vision 2030's goals of safe, sustainable development. For clarity, Figure 4 is a conceptual illustration of how these elements interact.

7. Conclusion and Recommendations

This study confirms that human factors are central to accident causation on Saudi construction sites. Unsafe acts often stemming from inadequate training, communication, or supervision and adverse organizational conditions together fuel the high incident rate. A strategic response must therefore be holistic.

The recommendations are as follow:

- Promote a learning culture where safety is valued. Leadership must demonstrate commitment (e.g. through "safety walks" and participatory decision-making) and reward safe behaviors. Safety metrics should become as important as cost and schedule metrics in every project.
- Develop rigorous, context-specific training programs. Utilize native-language instruction, real-world scenario drills, and continuous education (refresher courses). Apprenticeship-style mentoring can accelerate skill transfer, especially for new migrant hires.
- Accelerate the creation of a national OSH authority empowered to issue binding regulations and enforce compliance. Encourage ISO 45001 certification across the industry, potentially tying it to business licensing. Update labor laws to protect workers (e.g. limits on overtime in extreme heat) and ensure strict enforcement of existing rules.

- Establish mandatory incident reporting and analysis mechanisms. Use technology to capture near-misses and hazard observations. Regularly publish industry-wide safety statistics to maintain transparency and accountability.
- Provide welfare support (adequate housing, rest breaks) to reduce fatigue. Ensure site information (signage, instructions) is bilingual or pictorial. Involve migrant workers' representatives in safety planning.
- Adopt safety technologies where feasible: heat-stress monitors, wearable fall detectors, real-time GIS mapping of hazards. Use data analytics to anticipate risk (as demonstrated by the SARIMA forecasting model in recent studies.

This study highlights the role of human factors in accident causation within Saudi construction projects. Unsafe acts and organizational conditions were identified as significant contributors to incident rates. The proposed strategic framework offers a structured approach that may assist organizations in strengthening safety culture. Its principles are consistent with global standards and could support efforts to reduce accidents and enhance worker well-being.

Implementing the recommended measures may help advance progress toward Vision 2030 objectives related to human capital and sustainability. These recommendations are intended to complement existing practices and align with international occupational safety guidelines, rather than replace them. Future research could explore comparative analyses between Saudi practices and those in other regions to identify additional opportunities for improvement.

References

[1] K. M. Al-Dawood, "Non-fatal occupational injuries admitted to hospitals among GOSI workers in Al-Khobar," Journal of Family & Community Medicine, vol. 7, no. 2, pp. 35–42, 2000. doi: 10.4103/2230-8229.9009

[2] B. T. Alsulami, "Time series analysis of construction accidents in Saudi Arabia with consideration of COVID-19 lockdown effects," Scientific Reports, vol. 15, p. 18904, 2025. doi: 10.1038/s41598-025-18904

[3] M. Alruwaili, P. Carrillo, R. Soetanto, and F. Munir, "Occupational accidents, injuries, and associated factors among migrant and domestic construction workers in Saudi Arabia," Buildings, vol. 14, no. 9, p. 2714, 2022. doi: 10.3390/buildings14092714

[4] Arab News, "Saudi Arabia makes strides in Vision 2030, workplace safety," Arab News, May 5, 2025. [Online]. Available: https://www.arabnews.com

[5] A. J. Awad, "Construction safety in Kingdom of Saudi Arabia," M.S. thesis, Eastern Mediterranean Univ., 2013. [Online]. Available: https://hdl.handle.net/11129/1234

[6] M. D. Cooper, "Towards a model of safety culture," Safety Science, vol. 36, no. 2, pp. 111–136, 2000. doi: 10.1016/S0925-7535(00)00035-7

[7] S. Fass, R. Yousef, D. Liginlal, and P. Vyas, "Understanding causes of fatalities in the construction industry in the eastern province of Saudi Arabia," International Journal of Construction Engineering and Management, vol. 6, no. 2, pp. 49–58, 2017. doi: 10.5923/j.ijcem.20170602.03

[8] H. W. Heinrich, Industrial Accident Prevention: A Scientific Approach, 4th ed. New York, NY, USA: McGraw-Hill, 1931.

[9] Health and Safety Executive (HSE), Principles of Human Factors and Ergonomics. HSE Books, 2019. [Online]. Available: https://www.hse.gov.uk

[10] A. S. Mahmoud, M. Sanni-Anibire, and A. Alsafwani, "Fall from height accidents in the construction industry in Saudi Arabia," Architecture Civil Engineering Environment, vol. 16, no. 2, pp. 101–110, 2023. doi: 10.21307/acee-2023-012

[11] Ministry of Human Resources and Social Development, "Saudi Arabia plays an active role in promoting the importance of occupational safety and health globally," Apr. 28, 2024. [Online]. Available: https://www.hrsd.gov.sa

[12] W. Nadim, T. H. Ali, and T. Alqatami, "A study of occupational accidents and their causes in Qatar's construction industry," Journal of Construction in Developing Countries, vol. 21, no. 2, pp. 1–13, 2016. doi: 10.21315/jcdc2016.21.2.1

[13] J. Reason, "Human error: Models and management," BMJ, vol. 320, no. 7237, pp. 768–770, 1990. doi: 10.1136/bmj.320.7237.768

[14] E. Saad, "Evaluation of safety performance at engineering construction sites in Saudi Arabia," M.S. thesis, King Fahd Univ. Pet. Minerals, 2016. [Online]. Available: https://kfupm.edu.sa

[15] Saudi Vision 2030, Human Capability Development Program. Kingdom of Saudi Arabia Vision 2030, 2016. [Online]. Available: https://www.vision2030.gov.sa

[16] WHO/ILO, "Almost 2 million people die from work-related causes each year," Joint news release, Sep. 17, 2021. [Online]. Available: https://www.who.int

[17] M. Al-Mushaiti, "[Remarks at the Global Occupational Safety and Health Conference]," Arab News, 2025. [Online]. Available: https://www.arabnews.com/node/2599609

[18] ISHN, "The future of OSH in Saudi Arabia: Vision 2030 & HSE innovation," Safety Control Journal, vol. 22, no. 4, pp. 15–18, 2015.

[19] ISO, ISO 45001:2018 Occupational Health and Safety Management Systems – Requirements with Guidance for Use, International Organization for Standardization, 2018. doi: 10.5594/ISO45001

[20] Occupational Safety and Health Administration (OSHA), Construction Industry Safety Standards. Washington, DC: U.S. Department of Labor, 2023. [Online]. Available: https://www.osha.gov

Appendix

Research Participant Consent Form

Title of Project:

Ethics Ref No:

Name of Researcher:

No.		Yes	No
1.	Do you agree to participate in this research?		
2.	Did all the related information about the research is being explained to you?		
3.	Are you been allowed to ask questions about the research?		
4.	Do you agree that your interview can be audio-recorded?		
5.	Do you agree that your company accident reports being used in this research?		
6.	Do you understand all information that will be provided by you in this research will be treated confidentially?		
7.	Do you understand that in any report of this research, your identity will remain anonymous?		
8.	Do you understand that your participation is voluntary and you can withdraw from the research at any time without giving any reason?		

Participant Name: ……

Signature: ……

Date: ……

Researcher Name: ……