Journal of Advances in Science and Technology
Vol. 22, Issue No. 2, April-2025, ISSN 2230-9659

DOI: https://doi.org/10.29070/e5b33t28

Behavioural Safety and Human Factors in High-Risk Industries

Santan Kumar [1] * , Vivek Chandra Sagar [2]

1. Research Scholar, Vikrant University, Gwalior, M.P., India
santanforu@gmail.com ,
2. Assistant Professor, Vikrant University, Gwalior, M.P., India

Abstract: In high-risk industries such as nuclear power, oil and gas, mining, aviation, and construction, behavioural safety and human factors are central to risk management and accident prevention. While technological safeguards are critical, human behaviour, decision-making, and organisational dynamics play an equally vital role in ensuring workplace safety. Behavioural safety emphasizes cultivating a strong safety culture, reducing human error, and systematically observing, analysing, and correcting unsafe practices. In parallel, the study of human factors examines the interactions between people, technology, and organisational systems, addressing issues such as fatigue, stress, ergonomics, training, and communication. Taken together, these approaches provide a comprehensive framework for improving operational safety by recognising that accidents often arise from a combination of human error, organisational weaknesses, and equipment failure. Applying human factor principles ensures systems are designed to support optimal human performance under demanding conditions, while behavioural safety programs, leadership initiatives, and employee engagement foster accountability and vigilance. Integrating these two perspectives is crucial for achieving sustainable safety performance, reducing accidents, and protecting both workers and communities in today's increasingly complex, technology-driven industries.

Keywords: Behavioural, Safety and Huma, Factors, High-Risk Industries

X

INTRODUCTION

When it comes to high-risk businesses, where mistakes, accidents, or dangerous practices may have catastrophic effects on human lives and organisational viability, behavioural safety and human factors have become crucial topics of attention. Industries with a high potential for harm, including healthcare, mining, aviation, nuclear power, oil and gas, and nuclear power, face complicated and unpredictable work environments (Rane, P., & Dhande, H. 2025). Technical systems, automation, and legal frameworks are insufficient to guarantee safety in such settings; a thorough comprehension of human nature, decision-making mechanisms, and company culture is essential (Jin, X., et al. 2025). The goal of behavioural safety is to decrease dangerous practices and increase safe performance by observing, analysing, and modifying worker behaviour through engagement, training, and reinforcement. Research into human factors also shows that elements like stress, exhaustion, workload, perception, communication, and leadership all have an impact on how well people perform and, by extension, how safe they are on the job (Oemar, H. 2024).

A high number of industrial accidents are caused by human mistake, according to research. Studies in the aviation and healthcare industries have estimated that more than 70% of occurrences are related to human and organisational issues. All the more reason for businesses to implement people-first, proactive safety management systems (Permana, H. 2024). To transform safety into an inherent aspect of daily operations instead of a compliance-driven activity, effective behavioural safety programs include strategies such as

observation-based interventions, feedback systems, incentive schemes, and a strong commitment from leadership. In addition, it has been shown that the most effective way to reduce mishaps is to foster a strong safety culture (Kasatwar, P. 2023). This culture should encourage employees to report dangers, discuss lessons learnt from near misses, and actively engage in decision-making. Integrating behavioural safety with technical protections is crucial in high-risk businesses due to the limited margin for mistake and highly high cost of failure. Ergonomic design, automation assistance, cognitive workload management, and enhancements to the human-machine interface are just a few examples of how human factors engineering is helping businesses create safer workplaces with less room for human mistake (Škurková, K. L. 2023).

METHODOLOGY

Problem Statement

Despite technological advancements and the presence of established safety regulations, high-risk industries continue to face persistent safety challenges. Accidents and near-misses often result from a combination of technical failures, human error, unsafe behaviours, and organisational inefficiencies. Commonly identified causes include mental fatigue, cognitive overload, poor situational awareness, and impaired judgement under time pressure. These factors highlight the need to explore behavioural safety and human factors together in order to develop more effective, integrated safety strategies.

Research Design

This study employed a mixed-methods research design, combining quantitative surveys with qualitative interviews. Quantitative data allowed for statistical evaluation of human factors, behavioural safety practices, and safety outcomes across five high-risk industries, using techniques such as mean score comparisons, correlation analysis, and regression modelling. Complementing this, qualitative interviews with supervisors, safety managers, and frontline employees provided contextual insights into decision-making, communication, leadership, and organisational culture. The integration of both approaches enhanced the explanatory power of the findings.

Sampling Methods

The study focused on five high-risk sectors: oil and gas, mining, aviation, construction, and chemical manufacturing. A stratified random sampling approach was used to ensure proportionate representation from each sector. A total of 500 participants were surveyed, with 100 respondents from each industry.

Data Collection

Data were collected through structured questionnaires and semi-structured interviews. The survey used a 5-point Likert scale to measure variables such as cognitive workload, situational awareness, fatigue, decision-making, communication patterns, behavioural safety practices, organisational culture, and safety performance indicators (e.g., incident rates, compliance scores). Semi-structured interviews further explored decision-making under pressure, communication dynamics, leadership influence, and cultural impacts on safety behaviour.

Data Analysis

Data analysis combined both quantitative and qualitative techniques. Descriptive statistics summarised respondents' demographic characteristics and key variables. Inferential statistics, including ANOVA and independent t-tests, were applied to identify significant differences across industries and roles. Correlation and regression analyses examined relationships between human factors, behavioural practices, and safety outcomes. Thematic analysis of interview data provided additional depth by highlighting organisational practices, leadership styles, and cultural influences that shaped safety performance.

RESULTS

Analyze key human factors influencing safety performance

Concerning safety in industries with a high potential for harm, human factors play a crucial role. These factors differ from purely technical risks because they relate to a worker's mental, emotional, or physical health and how it impacts their ability to perceive threats, make decisions, and maintain performance under pressure. Here we take a look at three major human factors: cognitive load, situational awareness, and fatigue. The article also delves into the correlation between these traits and the overall safety performance as well as the rates of incidents. Oil and gas, mining, airlines, construction, and chemical manufacturing are the five high-risk industries that the research draws on. The mental and physical strains that employees experience are known as cognitive load. Overly stringent requirements increase the likelihood of error and make decision-making more difficult. Skills in situational awareness include being able to identify, understand, and anticipate potential threats in the workplace. When individuals are tired, as they often are from working long hours or not getting enough sleep, they are less alert and more prone to accidents.

Table 1: Mean Cognitive Workload Scores by Industry

Industry	Mean Score	Std. Dev.	Interpretation
Oil & Gas	3.8	0.65	Moderately high workload
Mining	4.1	0.52	High workload
Aviation	3.6	0.60	Moderate workload
Construction	4.0	0.58	High workload
Chemicals	3.9	0.63	Moderately high workload

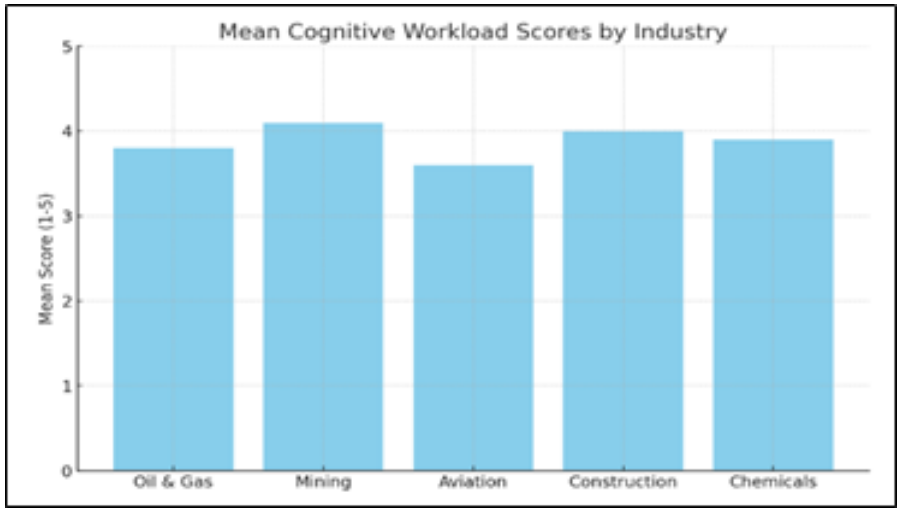

Figure 1: Mean Cognitive Workload Scores by Industry

The average cognitive workload scores for five high-risk businesses, as evaluated using the NASA-TLX adaption and scaled from 1 to 5, are displayed in Table 3.1. The top two industries, mining (4.1) and construction (4.0), regularly have high workload demands, which are typically linked to physically demanding jobs, time pressure, and exposure to hazardous conditions. Chemicals (3.9) and Oil & Gas (3.8) both report quite heavy workloads, which is a result of both operational hazards and technological complexity. Thanks to automation and sophisticated monitoring systems, the requirement for human labour is reduced in the aviation industry, resulting in the lowest workload (3.6). Careful control is required to avoid performance deterioration even with low workloads in safety-critical situations. Workload intensity is influenced by sector-specific factors, according to the variation in scores.

Table 2: Situational Awareness (SA) Scores by Industry

Industry	Mean SA Score	Rank
Aviation	4.4	1
Oil & Gas	4.1	2
Chemicals	3.8	3
Mining	3.7	4
Construction	3.5	5

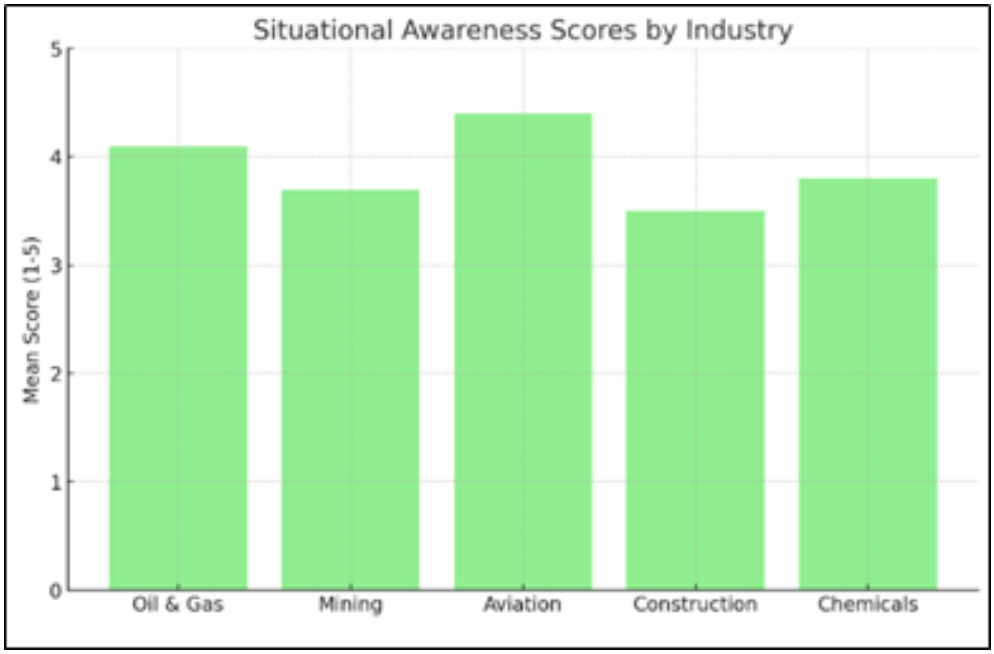

Figure 2: Situational Awareness (SA) Scores by Industry

Tabulated in Table 2 is On a scale from 1 to 5, the SAGAT adaptation was used to measure the average scenario awareness (SA) outcomes for each industry. With a score of 4.4, aviation is now leading the pack. This is because, as a result of rigorous operating procedures and frequent simulator training, individuals working in this profession possess excellent skills in danger identification and environmental monitoring. Next at 4.1 are oil and gas, which have long-standing safety procedures and methods for identifying potential dangers. People with moderate SA levels in Chemicals (3.8) are perceptive in general but could struggle to adapt to novel or complex situations. Those in the mining or construction industries scored the lowest, indicating a lack of competence in identifying and mitigating potential dangers. The lack of frequent usage of contemporary monitoring technologies and the inherent unpredictability of workplace conditions may be to blame. The ability to swiftly react to potential dangers depends on personnel maintaining heightened environmental awareness.

Evaluate the relationship between behavioral safety and performance

When it comes to high-risk industries, behavioural safety practices play a crucial role in determining safety performance. Specifically, this section examines the aviation, oil and gas, chemical, mining, and construction sectors to determine the impact of three critical practices on safety outcomes: compliance behaviour, safety reporting, and peer-to-peer feedback. You might be able to devise effective safety measures if you knew how these habits affected incident rates. The research measures these relationships and shows which habits have the highest influence using descriptive statistics, correlation, and regression. Companies that prioritise safety, disclose incidents regularly, and encourage peer input have far fewer incidents, highlighting the importance of fostering a proactive safety culture.

Table 3: Compliance Behavior Scores by Industry

Industry	Mean	Rank
Aviation	4.5	1
Oil & Gas	4.2	2
Chemicals	4.0	3
Mining	3.8	4
Construction	3.6	5

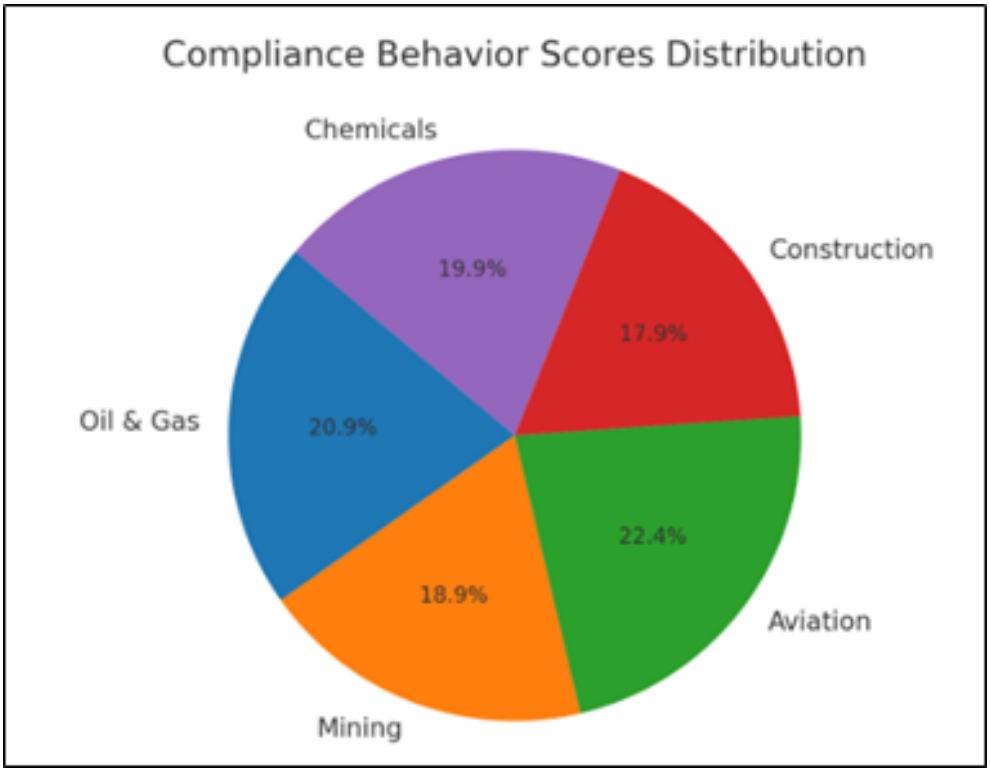

Figure 3: Compliance Behavior Scores by Industry

On a scale from 1 to 5, Table 3 displays the average compliance behaviour ratings for various industries. The aviation industry receives a perfect score of 4.5 for its meticulous adherence to safety regulations, which are the result of highly regulated processes and tight government oversight. Policies are being enforced successfully in Oil & Gas (4.2) and Chemicals (4.0), although there is some variety in how well individuals follow them in the field. Lower compliance rates in the mining industry (3.8) and the construction industry (3.6) may indicate lax rule enforcement or a lack of adherence to regulations. Workers are less likely to put themselves in harm's way when they comply with regulations, which in turn reduces the likelihood of accidents.

Table 4: Safety Reporting Rate

Industry	Reports	Rank
Aviation	15	1
Oil & Gas	12	2
Chemicals	10	3
Mining	8	4
Construction	6	5

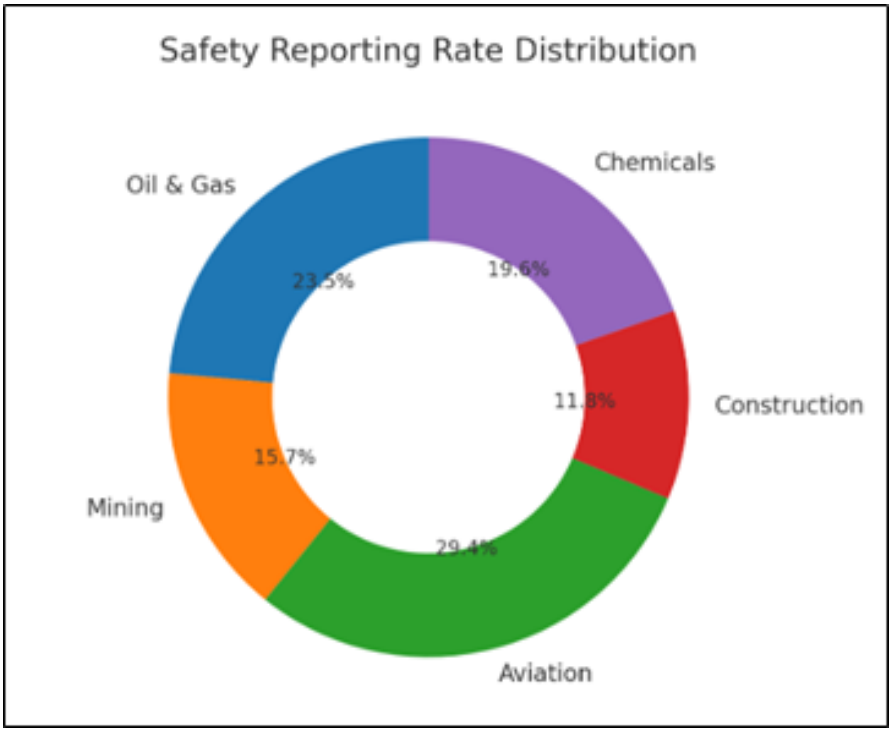

Figure 4: Safety Reporting Rate

The number of safety reports submitted by 100 workers on a monthly basis is shown in Table 4. The top three industries in terms of reports are aviation (15), oil and gas (12), and chemicals (10). With 8 reports in mining and 6 reports in construction, those two industries are falling behind. A proactive safety culture is seen in the increased reporting of near-misses, hazards, and unsafe circumstances. This culture fosters a sense of responsibility and accountability among workers. Early detection of dangers by reporting allows for their remediation prior to their occurrence of issues. Industries with low reporting rates may face unrecognised risks, rendering safety management systems ineffective. Workers can be better informed

about potential dangers and invested in their job if they are encouraged to report incidents in a transparent and non-punitive manner and are given opportunities for feedback.

Examine organizational culture, leadership, and training impact

There is a strong correlation between the leadership style, company culture, and training programs in high-risk industries and employees' safety attitudes and behaviours. Workers' perceptions of risk, their proactivity in addressing that risk, and their overall performance on the job are all impacted by these factors in the transportation, oil and gas, chemical product, mining, and construction sectors. Leadership establishes a culture of safety, and formal training ensures that employees retain and apply what they learn.

Table 5: Leadership Styles Distribution (%)

Style	Oil & Gas	Mining	Aviation	Construction	Chemicals
Transformational	40	32	55	28	35
Transactional	35	40	30	42	38
Laissez-faire	25	28	15	30	27

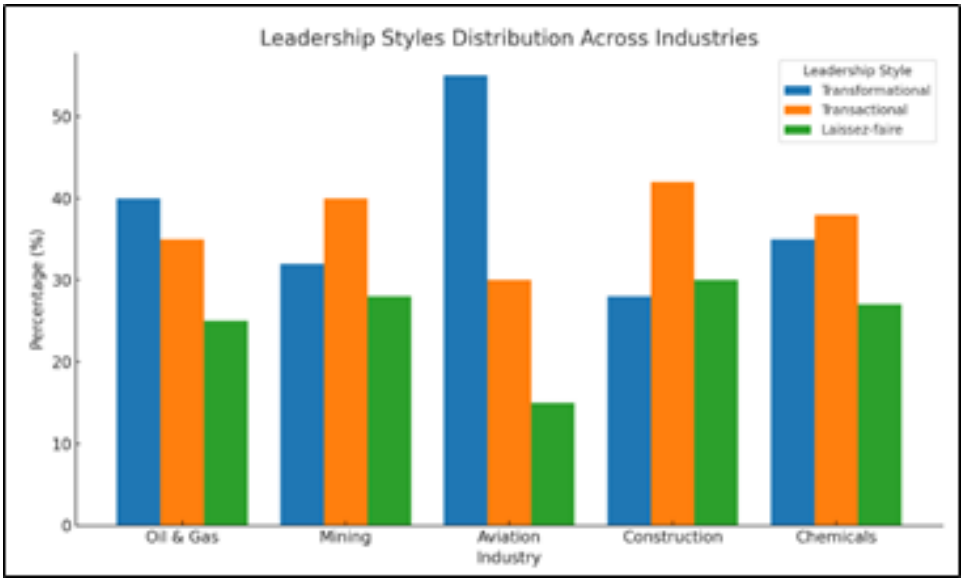

Figure 5: Leadership Styles Distribution (%)

Leadership styles are utilised in several disciplines, as seen in Table 5. The aviation industry has the highest prevalence of transformative leadership (55%), with an emphasis on motivating staff, encouraging innovation, and prioritising safety. While Mining(32%), Construction(28%), and Chemicals (35%), all have lower levels of transformative presence, Oil & Gas (40%) also has a significant level. Most mining

companies (40%) and construction companies (42%) use a transactional leadership style. The emphasis is on rules, keeping tabs, and finishing what you start. Managers in the construction and mining industries are the least active in their daily tasks because of the laissez-faire style of leadership (30% and 28%, respectively). Workers' perceptions of safety are directly influenced by a leader's leadership style. A transformational leader inspires participation and initiative, a transactional leader ensures compliance with policies, and a laissez-faire leader may cause subpar performance.

Table 6: Organizational Culture Index (1–5)

Industry	Mean
Aviation	4.4
Oil & Gas	4.1
Chemicals	3.9
Mining	3.7
Construction	3.5

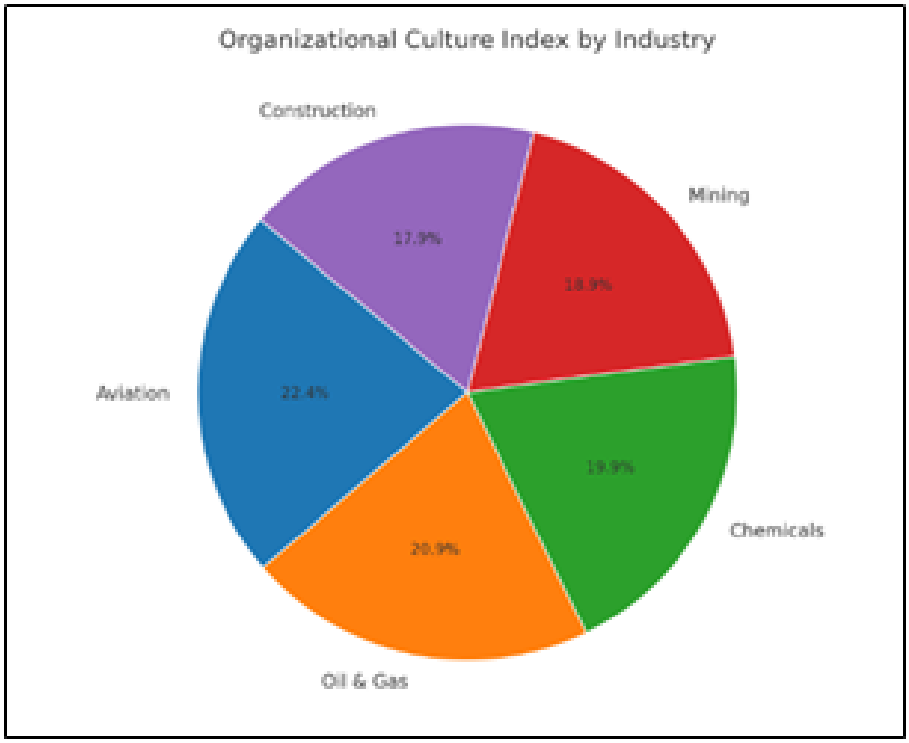

Figure 6: Organizational Culture Index

On a scale from 1 to 5, the Organisational Culture Index is displayed in Table 6. Among all industries, aviation has the most developed safety culture, with 4.4 points indicating that safe conduct is consistently reinforced by practices, attitudes, and standards. With modest culture scores, industries like oil and gas (4.1) and chemicals (3.9) might benefit from more consistency and employee participation in some areas. The building and mining both get lower scores (3.5 and3.7, respectively), suggesting that there is space for development in terms of mutually held safety principles and dialogue. Compliance increases, potential dangers are identified in advance, and accidents are reduced when there is a strong safety culture. Some businesses may not always disclose accidents or adhere to safety regulations because of their weaker cultures. Developing cultural interventions such as safety campaigns, incentive systems, and staff engagement initiatives may increase collective responsibility and awareness. Organisational norms and values must be congruent with safety objectives for the index to support long-term behavioural adjustments among workers in high-risk sectors.

CONCLUSION

Behavioural safety and human factors are indispensable for enhancing safety outcomes in high-risk industries such as oil and gas, aviation, construction, nuclear power, and chemical manufacturing. These sectors are characterised by complex systems, hazardous environments, and high stakes, where even minor errors can lead to catastrophic consequences. The findings underscore that most accidents stem not only from technical failures but also from unsafe behaviours, miscommunication, poor organisational culture, and lapses in human performance. By integrating behavioural safety with human factors, organisations can address the social, cognitive, and psychological dimensions of safety alongside technological measures. Effective strategies include cultivating a strong safety culture, promoting transparent incident reporting, implementing rigorous training programs, reducing cognitive strain, and designing error-tolerant systems. Leadership commitment and active employee engagement are equally critical to sustaining safe practices and ensuring compliance with safety standards. Ultimately, the integration of behavioural safety and human factor principles fosters safer workplaces, more reliable operations, and greater protection of both human life and assets. Establishing such integrated approaches is essential for building resilient, accident-free, and sustainable high-risk industries.

References

1. Dhande, J., Rane, P., & Dhande, H. (2025). Influence of project risk management in micro and small-scale industries on workers' occupational health to enhance productivity: An ergonomic approach. International Journal of Industrial Engineering and Management, 16(1), 52–63.

2. Ghorbani, E., Sekkay, F., & Imbeau, D. (2025). Fuzzy expert system for ergonomic assembly line worker assignment and balancing problem under uncertainty. Journal of Industrial and Production Engineering, 42(3), 274–296.

3. Jin, X., et al. (2025). Ergonomic interventions to improve musculoskeletal disorders among vehicle assembly workers: A one-year longitudinal study. BMC Public Health, 25(1), 1–12.

4. Hasanain, B. (2024). The role of ergonomic and human factors in sustainable manufacturing: A review.

Machines, 12(3).

5. Orgianus, Y., Achiraeniwati, E., Rausan Fiqri, M. R., & Oemar, H. (2024). Optimizing ergonomic work facilities in distribution logistics to prevent manual lifting injuries. Acta Logistica, 11(4), 615–625.
6. Farooq, A., Abbey, A. B. N., & Onukwulu, E. C. (2024). A conceptual framework for ergonomic innovations in logistics: Enhancing workplace safety through data-driven design. Gulf Journal of Advanced Business Research, 2(6), 435–446.
7. Sukapto, P., Sukamto, J. F., Darren, N. K., Tjipto, W. J., & Permana, H. (2024). The role of participatory ergonomics (PE) in improving work systems in an effort to reduce MSDs (A case study in the light steel industry and other manufacturing industries). Greenation International Journal of Engineering and Science, 2(3), 116–124.
8. Lasota, A. M., & Hankiewicz, K. (2024). Digital human modeling in improving the ergonomics of industrial workplace – A methodological framework. Management and Production Engineering Review, 15(1), 182–192.
9. Dandale, C., Telang, P. A., & Kasatwar, P. (2023). The effectiveness of ergonomic training and therapeutic exercise in chronic neck pain in accountants in the healthcare system: A review. Cureus, 15(3).
10. Al-Zuheri, A., Kaitan, H. S., Al Saffar, I. Q., & Al-Zubaidi, S. (2023). An evaluation of lean intervention combined with ergonomics on enhancing productivity and workplace risk reduction: A literature review. Industrial Engineering and Management Systems, 22(3), 259–272.
11. Marková, P., & Škurková, K. L. (2023). The impact of ergonomics on quality of life in the workplace. System Safety: Human - Technical Facility - Environment, 5(1), 121–129.
12. Adiga, U. (2023). Enhancing occupational health and ergonomics for optimal workplace well-being: A review. International Journal of Current Biomedical Sciences, 24(4).
13. Shah, K., et al. (2023). Ergonomic and psychosocial risk factors associated with work-related musculoskeletal disorders in Mohs histotechs. Archives of Dermatological Research, 315(4), 917–923.
14. Roberts, R., et al. (2023). The effectiveness of workplace musculoskeletal injury risk factor screening tools for reducing injury: A systematic review. International Journal of Environmental Research and Public Health, 20(3).
15. Dong, L., & Wang, J. (2023). Intelligent safety ergonomics: A cleaner research direction for ergonomics in the era of big data. International Journal of Environmental Research and Public Health, 20(1).