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# Human Factors in Construction Risk Management

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***ABSTRACT:***
*This research aims to explore the key human factors relevant to construction risk management and their effects on risk management outcomes. It primarily focuses on how communication, leadership style, experience and training, team dynamics, cognitive biases, stress and fatigue, and safety culture influence outcomes on the construction site. There has been much advancement of technology and implementation of safety measures; nevertheless, human behavior still plays an important role in contributing to accidents in the construction industry. The literature review and analysis of previous studies relevant to the research provided an insight into crucial human factors that affect risk perception and risk management. The research was quantitative and included an anonymous survey completed by 141 workers in the construction sector. The results suggest that good communication skills, supportive leadership, ongoing practices, good team dynamics, cognitive biases, stress and fatigue, and safety culture are all important to consider when implementing safety management systems. The research recommends that the practical strategies of key human factors be built into the current risk management systems, which can further improve safety and reduce construction site accidents. In addition, this study advocates for improved construction settings that enable a proactive response to risk management across the construction sector.*

***KEYWORDS:***
*Human Factors, Risk Management, Construction Safety, Safety Culture, Leadership Impact, Communication Effectiveness, Cognitive Biases, Stress, Fatigue, Experience, Training Practices, Team Dynamics*

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## I. INTRODUCTION

The construction industry has often been defined as one of the most dangerous and high-risk sectors in the world due to the high number of injuries and frequent accidents that still happen despite all the improvements that have been made in safety protocols and technology. The presence of continued uncertainties makes the environment highly complicated. Hence, more monitoring and coordination of the professionals belonging to different industries [1]. Tasks at construction sites are often undertaken at heights under various weather conditions and with the aid of heavy machinery. This exposes workers to serious risks. Some of the reasons why accidents and errors occur are tight schedules with often short notice, lack of resources and equipment, and continuous changes in the project [2]. In the past, the construction industry relied on traditional risk management strategies, which mainly focused on technical systems, compliance measures, and hazard identification tools. Today, researchers and industry professionals recognize that incidents on construction sites are not caused by system failures alone, but also by individual decisions and behaviour under pressure [3, 2]. Human factors are defined as the cognitive, social, physical, and psychological characteristics that influence how individuals perform their daily assigned tasks and are crucial in preventing safety risks in the construction industry [4]. Fatigue occurring from overtime and heavy work decreases concentration and can lead to inadequate risk assessment [5]. Poor communication between supervisors and workers can lead to misunderstandings of duties and hazard awareness, and short deadlines together with a culture of fast production can result in risk-taking behaviour and non-compliance with safety protocols [6].

Moreover, human factors at the organizational and systematic level are also part of the problem. Safety culture, leadership style, team dynamics, and overall management determine whether workers follow procedures, are willing to report possible hazards, and bring up unsafe conditions that might arise [7, 8]. Including human factors in construction risk management should be a practical requirement, rather than a theoretical issue. A human-centered approach provides a better understanding of why individuals make decisions the way they do and how design systems encourage safer behaviours [9].

Construction technology advancements and formal safety regulations have not reduced the high accident rates that still remain a global problem in the construction industry. Traditional risk management does not adequately address the importance of human factors and decision-making skills in safety outcomes. Rather, it mostly focuses on physical risks, engineering controls, and compliance procedures. Human factors are often viewed as extra risks rather than as essential elements of risk assessment and risk mitigation. This lack of attention limits the development of proactive safety strategies and the ability to recognize and evaluate risks associated with human behaviour and limitations [10, 11].

The aim of this study is to examine the role of human factors, especially communication effectiveness, leadership impact, cognitive biases, and stress and fatigue in construction risk management, and to test whether higher awareness and integration of these factors is positively associated with more effective risk management outcomes. The study further explores whether perceptions of these human factors differ across gender, years of experience, and professional role within the construction industry.

## II. BACKGROUND AND METHODS

Human performance affects safety outcomes through its strengths and weaknesses in complex high-risk settings, including the construction industry. Human factors represent a multidisciplinary field that explores how humans interact with set systems in place, such as tools, technologies, environments, and organizations, to enhance their safety, performance, and human well-being in general [4]. The successful implementation of construction risk management heavily depends on how effectively all individuals involved in the project communicate. It helps everyone who is involved understand the safety protocols better and follow them correctly. Due to the ever-changing working environment, which often contains unpredictable hazards, the construction industry needs to communicate information effectively and efficiently [12].

Leadership is a crucial factor that has an impact on how team members perform when it comes to motivation, behavior, and adherence to safety protocols on construction sites. Leadership itself creates a safety culture that opens better communication between team members and makes team members feel safe in the organization [13]. The transformational leadership style shows a positive correlation with improved safety performance since it encourages motivation, inspiration, and individualized attention. When leaders recognize the achievements of their team members, celebrate them, and foster shared safety goals, employees then tend to become more involved in the process [14]. Supportive leadership enhances the overall safety climate because the leaders who demonstrate that they care about workers' well-being and their safety make workers more likely to follow safety protocols [15]. On the other hand, an autocratic leadership style produces fearful environments that silence employees' input and feedback. When workers are fearful about getting into trouble for reporting unsafe conditions or near-misses, as well as being ignored by management, they will be less likely to report them in the future [16].

Construction personnel's experience level and training programs have a huge impact on their ability to recognize possible risks and how to properly handle them at construction sites. It is an essential element that determines workers' capacity to understand unknown and unpredictable situations quickly and then act adequately. Training programs targeted at all involved individuals on construction sites provide basic knowledge and a better understanding of safety protocols, which result in better compliance [17].

Team member relationships have a big impact on safety performance because they affect how decisions are really made, how well team members communicate with each other when doing their assigned tasks, and how aware they really are of potential risks happening on construction sites. Teams with stronger dynamics create a space for psychological safety, trust, and openness, which serves as the basis for the development of proactive safety cultures. When employees feel supported and respected by their supervisors and leaders, they are more likely to speak about noticed safety issues, give feedback, report and act adequately on possible risks which might arise [18].

Workers in the construction industry often experience systematic judgment deviations, which then affect their risk perception and response through cognitive biases. These cognitive biases can include overconfidence, confirmation bias, and collective thinking, and keep workers from saying what their real opinions are and can lead to possible poor decisions [19]. Stress and fatigue are important factors, but they are often overlooked and forgotten about. They often cause accidents on construction sites, and because of them, workers may end up in some type of accident. Construction workers usually feel both mentally and physically drained because they work for long hours under tough and demanding conditions to meet deadlines. Stress and fatigue make it difficult for workers to think clearly and make decisions that often result in more dangerous behaviors and accidents on construction sites [20].

Despite growing recognition of these factors, formal risk management models in construction still do not fully incorporate them, with most systems concentrating on technical hazards and regulatory requirements rather than attention span, decision-making, and communication skills among workers [10, 6].

### A. CONCEPTUAL MODEL AND HYPOTHESIS

The theoretical frameworks of systems ergonomics, human error theory, and the safety culture model are the three sources behind the conceptual model. Human factors are being used as independent variables to measure dependent variables in the model. This model has led to the formulation of the following hypothesis.

H: Higher awareness and integration of human factors are positively associated with more effective construction risk management outcomes.
The hypothesis was confirmed through correlation analysis, multiple regression, independent samples T-test, and one-way ANOVA.

B. RESEARCH DESIGN, SAMPLE AND INSTRUMENT
The study uses a descriptive cross-sectional survey design within the quantitative research paradigm. As this method allows for the study of a range of attitudes and behaviours, it will be adopted. It gathers organized data, which is analysed statistically to find patterns among the variables and potential predictors of those patterns. A self-administered online survey was used to collect data in this study. This technique enabled uniform collection of data from the scattered respondents. Also, it reduced interviewer bias since the respondents participated anonymously. The survey targeted construction professionals carrying out project management and implementation tasks like craftsmen, site supervisors, project managers, safety officers, and engineers.
A total of 141 valid responses were collected. The sample consisted of 99 male (70.2%) and 42 female (29.8%) respondents. In terms of experience, 9.9% had less than 2 years, 34.8% had 2-5 years, 30.5% had 6-10 years, and 24.8% had more than 10 years of experience in the construction industry. Respondents held a range of positions, mostly craftsmen (44.0%) and architects (22.0%), followed by project managers (9.9%) and various engineering and safety-related roles. Most respondents worked on residential projects (62.4%) in companies with 51-200 employees (54.6%), predominantly in Europe (53.9%) and Asia (44.7%).
The survey instrument consisted of 30 items, including demographic questions and Likert-scale items measuring four human factors constructs such as communication effectiveness, leadership impact, cognitive biases, and stress and fatigue, along with a multiple-choice item on perceived stress of work-related stress.

## III.RESULTS AND DISCUSSION

IBM SPSS Statistics has been used to analyse the data. The internal consistency of each construct was calculated using Cronbach's Alpha, as the items with low or negative corrected item-total correlations were removed iteratively. Exploratory factor analysis (principal component analysis with Varimax rotation) was used to examine the underlying factor structure of the instrument, both across the full item set and across the refined item set. Composite variables were then computed as the mean of the retained items for each construct. Pearson correlation and multiple linear regression tests were performed to test the hypothesis with Communication Effectiveness and Leadership Impact as predictors, whereas Cognitive Biases was a proxy outcome indicator of risk management effectiveness. Independent samples t-tests and one-way ANOVA (with Welch correction and Games-Howell post-hoc tests where the homogeneity of variance assumption was violated) were used to examine differences across gender, years of experience, and professional role.

**Table 1:** Reliability of the final four human factors constructs

| Construct | Retained Items | Cronbach's Alpha |
|---|---|---|
| Communication Effectiveness | Q9, Q10, Q12, Q13, Q14 | 0.826 |
| Leadership Impact | Q17, Q18, Q19 | 0.894 |
| Cognitive Biases | Q20, Q22 (r), Q24, Q25 | 0.777 |
| Stress and Fatigue | Q26 (r), Q28, Q29, Q30 | 0.809 |

Exploratory factor analysis (KMO = 0.883, Barlett's $\chi^2$ (210) = 1705.89, $p < 0.001$) on the full set confirmed that the items excluded during reliability analysis (Q11, Q15, Q16, Q21, Q23) loaded as statistically distinct components, independently corroborating the item-reduction decisions. A subsequent analysis of the retained items (KMO = 0.912) using the Kaiser criterion extracted three, rather than four, underlying components, explaining 67.1% of total variance, suggesting that communication effectiveness and leadership impact share a broader underlying dimension that can be described as a general perception of supportive safety climate, while cognitive biases and stress and fatigue form a related but distinguishable dimension. Despite this partial overlap, the four theoretically defined constructs were retained for further analysis given their strong grounding in the literature and their individually satisfactory reliability.

A. DESCRIPTIVE STATISTICS OF THE CONSTRUCTS
Composite scores (means of retained items) showed generally moderate to moderately positive perceptions across the sample: Communication Effectiveness (M =3.14, SD =0.76), Leadership Impact (M = 3.24, SD = 0.93), Cognitive Biases (M = 2.84, SD = 0.77), and Stress and Fatigue (M = 3.25, SD =0.52). Leadership Impact showed the greatest variability among respondents, while Stress and Fatigue showed the least.

B. TESTING OF HYPOTHESIS

Pearson correlations showed that Communication Effectiveness ($r = -0.643$, $p < 0.001$) and Leadership Impact ($r = -0.605$, $p < 0.001$) were both strongly negatively correlated with Cognitive Biases, indicating that more positive perceptions of communication and leadership are associated with lower susceptibility to cognitive biases. A high correlation was also observed between the two predictors themselves ($r = 0.855$, $p < 0.001$).

A multiple linear regression with Cognitive Biases as the dependent variable and Communication Effectiveness and Leadership Impact as predictors was statistically significant, $F(2, 138) = 50.958$, $p < 0.001$, explaining 42.5% of the variance in Cognitive Biases ($R^2 = 0.425$, Adjusted $R^2 = 0.416$). Communication Effectiveness was a significant independent predictor ($B = -0.473$, $\beta = -0.466$, $t = -3.745$, $p < 0.001$), while Leadership Impact did not reach significance in the combined model ($B = -0.173$, $\beta = -0.207$, $t = -1.668$, $p = 0.097$). This is attributable to moderate multicollinearity between the two predictors (VIF = 3.707 for both), reflecting the conceptual overlap identified in the factor analysis rather than an absence of effect for Leadership Impact, whose bivariate correlation with Cognitive Biases was strong.

Table 2: Multiple regression predicting Cognitive Biases ($R^2 = 0.425$)

| Predictor | B | B (Beta) | t | Sig. | VIF |
|---|---|---|---|---|---|
| Constant | 4.882 | - | 23.005 | < 0.001 | - |
| Communication Effectiveness | -0.473 | -0.446 | -3.745 | < 0.001 | 3.707 |
| Leadership Impact | -0.173 | -0.207 | -1.668 | 0.097 | 3.707 |

Normal P-P plot of standardized residuals and a residuals-versus-predicted-values scatterplot confirmed that the assumptions of normality and homoscedasticity were satisfied, supporting the validity of the regression model. Overall, these results provide moderate to strong empirical support for the hypothesis, showing that human factors, particularly effective communication, are significantly associated with more favourable risk-management-related outcomes.

C. DIFFERENCES ACROSS GENDER, EXPERIENCE, AND PROFESSIONAL ROLE

An independent samples t-test was run to determine any major difference between male and female respondents on any of the four constructs. There were no statistically significant differences on Communication Effectiveness, $t(139) = 0.608$, $p = 0.544$; Leadership Impact, $t(139) = 0.745$, $p = 0.457$; Cognitive Biases, $t(139) = -1.209$, $p = 0.229$; Stress and Fatigue, $t(139) = -0.222$, $p = 0.825$), with negligible effect sizes (Cohen's d between 0.04 and 0.22 across constructs), suggesting that perceptions of human factors are broadly similar across genders in this sample.

According to results gotten from one-way ANOVA analysis, differences across years of experience were statistically significant for all four constructs (Communication Effectiveness, $F(3,137) = 28.746$, $p < 0.001$; Leadership Impact, $F(3,137) = 16.461$, $p < 0.001$; Cognitive Biases $F(3,137) = 31.406$, $p < 0.001$; Stress and Fatigue, $F(3,137) = 16.649$, $p < 0.001$). A clear monotonic pattern emerged where Communication Effectiveness and Leadership Impact increased with experience (from $M = 2.27$ and $M = 2.33$ for respondents with less than 2 years, to $M = 3.79$ and $M = 3.90$ for those with more than 10 years), while Cognitive Biases and Stress and Fatigue decreased with experience (from $M = 3.71$ for both among the least experienced to $M = 2.21$ and $M = 2.84$ among the most experienced). Tukey HSD post-hoc tests confirmed that most pairwise differences between experience groups were statistically significant.

Table 3: Mean construct scores by years of experience

| Years of experience | Communication Effectiveness | Leadership Impact | Cognitive Biases | Stress and Fatigue |
|---|---|---|---|---|
| Less than 2 years | 2.27 | 2.33 | 3.71 | 3.71 |
| 2-5 years | 2.81 | 2.93 | 3.23 | 3.39 |
| 6-10 years | 3.28 | 3.37 | 2.60 | 3.26 |
| More than 10 years | 3.79 | 3.90 | 2.21 | 2.84 |

Positions were grouped into four categories for analysis due to small cell sizes in several individual roles: Field/Execution (craftsmen and site supervisors), Design (architects), Engineering/Technical, and Management/Safety (project managers, safety officers, HSE consultants). Welch's F and Games-Howell post-hoc tests were used since Levene's test indicated unequal variances for three of the four constructs. All four constructs differed significantly across position groups (Welch's F, $p \leq 0.002$ in all cases). The Management/Safety group consistently reported the most favourable profile, from highest Communication Effectiveness ($M = 3.66$) and Leadership Impact ($M = 3.92$) to lowest Cognitive Biases ($M = 2.19$) and Stress and Fatigue ($M = 2.73$), significantly different from the Field/Execution and Design groups on nearly all constructs, while Field/Execution and Design groups did not significantly differ from each other on any construct.

D. PERCEIVED SOURCES OF WORK-RELATED STRESS

The Communication Effectiveness construct is further supported by the importance of poor communication as a source of stress (58.2%). The multiple-response item of stress indicates that tight deadlines are noted by the great majority of respondents (92.2%), followed by lack of resources or equipment (63.8%), and conflict with team members (40.6%).

Table 4: Reported primary sources of work-related stress (multiple choice response)

| Sources of stress | N | Cronbach's Alpha |
|---|---|---|
| Tight deadlines | 130 | 92.2% |
| Lack of resources or equipment | 90 | 63.8% |
| Poor communication | 82 | 58.2% |
| Conflict with team members | 57 | 40.4% |

## IV.DISCUSSION

The results provide moderate to strong support for the study's hypothesis that greater integration of human factors is positively associated with more effective risk management outcomes, supporting prior findings that link communication quality directly to accident rates and hazard-recognition performance. Communication Effectiveness emerged as the most robust, independent predictor, consistent with the view that communication should be treated as a core component of construction safety management rather than a peripheral feature. Leadership Impact was strongly related to Cognitive Biases at the bivariate level, but its unique contribution was obscured in the combined model by its high correlation with Communication Effectiveness. This pattern also occurred in the factor analysis, where the two constructs partially merged into a broader safety-culture dimension. This is consistent with the safety leadership literature, which frames leadership largely as an enabler of open, safety-focused communication rather than an independent channel of influence. The strong, consistent effect of experience on all four constructs aligns with prior evidence that experienced workers are better at recognizing potential hazards and regulating their responses to time pressure and stress and supports the structured onboarding and mentoring for less experienced workers. The gap in perception between Management/Safety and Field/Execution roles mirrors findings elsewhere that organizational hierarchy shapes how safety-related information and support are experienced on-site, and points to a practical need for closer engagement between management and frontline workers. The prominence of tight deadlines as a stressor is consistent with research describing fast-paced production culture as a driver of risk-taking behaviour in the construction industry.

Several limitations should be noted as well. The cross-sectional design does not permit causal inference since the data are self-reported and may be subject to social desirability bias. Several professional subgroups were represented by a small number of respondents, requiring aggregation into broader categories. Future research should incorporate longitudinal designs and objective safety performance data, extend the sample to underrepresented regions, and further examine the overlap between communication and leadership constructs using qualitative methods.

## V.CONCLUSIONS

The study examined the role of human factors in construction risk management, using survey data from 141 construction professionals. Reliability and factor analyses confirmed a four-construct measurement model, while correlation, regression, t-test, and ANOVA results confirmed moderate to strong support for the hypothesis that greater awareness and integration of human factors is positively associated with more effective risk management outcomes.

Communication Effectiveness was the strongest independent predictor of favourable outcomes, while Leadership Impact, although strongly correlated with outcomes, was closely intertwined with communication rather than acting as a fully separate influence. Years of experience and professional role were significant differentiating factors where more experienced workers and those in management or safety roles consistently reported more favourable perceptions, while gender was not. Tight deadlines and lack of resources were identified as the dominant sources of work-related stress.

These findings support prioritizing structured communication practices, targeted onboarding and mentoring for less experienced workers, closer engagement between management and frontline workers, and more realistic project planning as practical strategies for the systematic integration of human factors into construction risk management systems.

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## References

[1] H. Lingard and S. Rowlinson, Occupational Health and Safety in Construction Project Management, London, UK: Routledge, 2005.
[2] R. M. Choundhry and D. Fang, "Why operatives engage in unsafe work behavior: Investigating factors on construction sites," *ScienceDirect,* vol. 46, no. 4, pp. 566-584, 2008.
[3] J. Reason, Human Error, Cambridge, UK: Cambridge University Press, 1991.
[4] J. R. Wilson, "Fundamentals of systems ergonomics/human factors," *Applied Ergonomics,* vol. 45, no. 1, pp. 5-13, 2014.
[5] J. Lee and Y.-K. Lee, "Can working hour reduction save workers?," *Labour Economics,* vol. 40, pp. 25-36, 2016.
[6] Z. Zhou, Y. M. Goh and Q. Li, "Overview and analysis of safety management studies in the construction industry," *Safety Science,* vol. 72, pp. 337-350, 2015.
[7] M. D. Cooper, "Towards a Model of Safety Culture," *Safety Science,* vol. 36, no. 2, pp. 111-136, 2000.
[8] B. Fernández-Muñiz, J. M. Montes-Peón and C. J. Vázquez-Ordás, "Safety culture: Analysis of the causal relationships between its key dimensions," *Journal of Safety Research,* vol. 38, no. 6, pp. 627-641, 2007.
[9] R. M. Choudhry, "Behavior-based safety on construction sites: A case study," *Accident Analysis & Prevention,* vol. 70, pp. 14-23, 2014.
[10] J. Reason, Managing the Risks of Organizational Accidents, First Edition ed., Aldershot, Hampshire, England: Ashgate Publishing, 1997, p. 272.
[11] T. Aksorn and B. H. W. Hadikusumo, "Critical success factors influencing safety program performance in Thai construction projects," *Safety Science,* vol. 46, no. 4, pp. 709-727, 2008.
[12] M. R. Hallowell and J. A. Gambatese, "Construction Safety Risk Mitigation," *Journal of Construction Engineering and Management,* vol. 135, no. 12, pp. 1316-1323, 2009.
[13] S. Clarke, "Safety leadership: A meta-analytic review of transformational and transactional leadership styles as antecedents of safety behaviours," *Journal of Occupational and Organizational Psychology,* vol. 86, no. 1, pp. 22-49, 2012.
[14] J. Barling , C. Loughlin and E. K. Kelloway, "Development and test of a model linking safety-specific transformational leadership and occupational safety," *Journal of Applied Psychology,* vol. 87, no. 3, pp. 488-496, 2002.
[15] D. Zohar, "Modifying supervisory practices to improve subunit safety: A leadership-based intervention model," *Journal of Applied Psychology,* vol. 87, no. 1, pp. 156-163, 2002.
[16] T. M. Probst, "Safety and insecurity: Exploring the moderating effect of organizational safety climate," *Journal of Occupational Health Psychology,* vol. 9, no. 1, pp. 3-10, 2004.
[17] X. Dong, P. Entzel, Y. Men, R. Chowdhury and S. Schneider, "Effects of safety and health training on work-related injury among construction laborers," *Journal of Occupational and Environmental Medicine,* vol. 46, no. 12, pp. 1222-1228, 2004.
[18] A. C. Edmondson, "Psychological Safety and Learning Behavior in Work Teams," *Administrative Science Quarterly,* vol. 44, no. 2, pp. 350-383, 1999.
[19] E. S. Geller, D. S. Roberts and M. R. Gilmore, Actively Caring for People's Safety: How to Cultivate a Brother's/Sister's Keeper Work Culture, Park Ridge, Illinois, USA: American Society of Safety Professionals, 2016, p. 192.
[20] S. E. Biggs, T. D. Banks, J. D. Davey and J. E. Freeman, "Safety leaders' perceptions of safety culture in a large Australasian construction organisation," *Safety Science,* vol. 52, no. 1, pp. 3-12, 2013.
[21] KU Libraries, "How to Select and Use Citation Management Tools: Citation tools in Microsoft Word," KU Libraries, 22 9 2022. [Online]. Available: https://guides.lib.ku.edu/c.php?g=95057&p=3908473. [Accessed 4 1 2012].
[22] J. W. Hinze, Construction Safety, Upper Saddle River, New Jersey: Prentice Hall, 1996.
[23] J. Reason, Human Error, Cambridge, UK: Cambridge University Press, 1991.
[24] J. W. Hinze, Construction Safety, Upper Saddle River, New Jersey: Prentice Hall, 1996.