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From Management Commitment to Safety Performance: An Integrated Analysis of Safety Culture, Training, Communication, Financial Constraints, and Behaviour-Based Safety in Construction

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Abstract
Safety performance describes the interplay of multiple layers within the organization, rather than from singular performance within the given compliance framework. This study creates a focused thesis-derived model that connects management commitment, safety training, safety communication, and financial restraints to safety culture. This model then connects safety culture to behavior-based safety and safety performance. The analysis uses the fixed synthetic dataset from the doctoral thesis (N=450; Chennai=250, Coimbatore=200) that includes several multi-item five-point Likert constructs and a prespecified Stata 18 analytic workflow. I accepted the overall KMO value at 0.889. Strong to good internal consistency was accepted across the principal scales (Cronbach's alpha 0.761–0.840). Robust multiple regression accounted for almost 38% of the variance in safety culture. Management commitment (B=0.289, p<0.001) and safety training (B=0.142, p=0.003) and safety communication (B=0.143, p=0.002) were positive constructs. Technology adoption (B=0.110, p=0.010) was positive. Financial constraints (B=-0.097, p=0.014) were negative. Safety culture was positively related to safety performance, and a bootstrap mediation analysis confirmed a significant, positive safety culture → behavior-based safety safety performance relationship that was moderated by safety culture, with a total estimated effect of 0.059 (95% CI 0.031–0.094). The positive results suggest a unified opinion that managerial decisions and communication create a protected resource environment that forms safe behaviors. Because the dataset is synthetic, the calculated numbers refer to a replicable analysis framework rather than a causal effect. Field validation is needed for external generalizability.

Keywords: Construction safety; Safety culture; Management commitment; Safety training; Safety communication; Behaviour-based safety; Safety performance; Financial constraints

1. Introduction

Construction projects are characterized by transient workforces, temporary structures, fragmented production, and the involvement of numerous contractors and subcontractors. These characteristics make construction safety management dependent not only on technical controls but also on effective organization, coordination, leadership, communication, learning, and risk control. Contemporary construction safety research therefore considers safety as an integrated organizational system in which safety culture is reflected through consistency in management decisions, reporting practices, and the ability to control risks under changing operational pressures (Duryan et al., 2020; Fang et al., 2020; Alkaissy et al., 2020). Management commitment is particularly important because workers assess whether adequate time, staffing, materials, equipment, training, and other safety resources are provided when projects face cost and schedule pressures. The Leadership–Culture–Behavior approach identifies leadership as an important driver of cultural and behavioural development (Fang et al., 2020), while resilient safety culture emphasizes the capacity of organizations to remain adaptable when project complexity and safety conditions change (Trinh & Feng, 2020, 2022).

Safety training and communication are important mechanisms through which organizational intentions are converted into worker competence, shared situational understanding, and appropriate safety behaviour. Duryan et al. (2020) emphasized knowledge transfer and the development of a learning culture within construction firms, while Naji et al. (2022) identified safety communication as an important factor linking safety culture and safety performance. However, training may become a procedural formality when it is evaluated only through attendance, and communication may remain ineffective when workers cannot raise concerns or receive meaningful feedback. Effective construction safety management therefore requires taskspecific training, reinforcement, verification of competence, supervisory involvement, and a culture that encourages workers to speak up. Financial constraints represent another important organizational pressure. Weak resources, ineffective governance, and insufficient safety awareness can obstruct implementation of formal safety programs (Buniya et al., 2021). Cost pressures may result in delayed training, inadequate replacement of personal protective equipment, insufficient maintenance, reduced staffing, and limited adoption of safety technologies. Thus, safety expenditure should be considered an essential component of organizational risk management rather than merely an overhead cost. Safety culture is also influenced by visible management decisions and supervisory control, with leadership expected to contribute positively and independently to safety culture (Fang et al., 2020).

Safety communication provides a bridge between formal safety procedures and everyday work practices. Toolbox meetings, hazard reporting, stop-work communication, supervisory feedback, safety discussions, and peer interaction can support the development of a stronger safety culture. Naji et al. (2022) reported that safety communication contributes to the relationship between safety culture and employee safety performance. Similarly, training becomes more effective when construction workers receive continuous learning opportunities because they frequently move between projects, tasks, and changing site hazards (Duryan et al., 2020). The relationship between safety culture and safety performance is largely behavioural, although it cannot be reduced to individual behaviour alone. A positive safety culture can encourage workers to report incidents, intervene when unsafe behaviour is observed, participate in safety activities, and communicate risks more effectively. Previous studies indicate that safety behaviour is influenced by psychological capital, work engagement, and group identification (Saleem et al., 2022; Chen et al., 2022). Accordingly, behaviour-based safety may function as an important mediating mechanism between safety culture and safety performance. At the same time, safety culture can influence performance through planning, supervision, engineering controls, resource allocation, and organizational decision-making. Therefore, construction safety performance should be understood as the outcome of interacting organizational, behavioral, and resource-related factors rather than as the result of a single safety intervention.

The objectives of the present study are to examine the influence of management commitment, safety training, safety communication, and financial constraints on safety culture; to assess the direct relationships of safety culture and behaviour-based safety with safety performance; to quantify the relationships among the principal safety-management constructs using the specified statistical framework; and to examine whether behaviour-based safety mediates the relationship between safety culture and safety performance.

2. Hypotheses

The hypotheses are: H1 management commitment positively predicts safety culture; H2 safety training positively predicts safety culture; H3 safety communication positively predicts safety culture; H4 financial constraints negatively predict safety culture; H5 safety culture positively predicts safety performance; H6 safety culture positively predicts behavior-based safety; H7 behavior-based safety positively predicts safety performance; and H8 behavior-based safety mediates the safety culture-safety performance relationship.

- H1: The greater the level of management commitment, the stronger the safety culture.
- H2: The level of safety training positively influences the safety culture.
- H3: Safety culture is positively influenced by the level of safety communication.
- H4: The presence of financial constraints negatively influences safety culture.
- H5: Safety culture positively influences safety performance.
- H6: Safety culture positively influences behavior-based safety.
- H7: Behavior-based safety positively influences safety performance.
- H8: Behavior-based safety mediates the safety culture-safety performance relationship.

3. Methodology

The design is cross-sectional and deductive with a post-positivist approach that accounts for measurement error. It permits restriction on causality. The author has proposed an empirical context composed of construction personnel in Chennai and Coimbatore. However, the actual dataset used here is synthetic. It consists of 450 observations generated with seed 20250818, among which 250 observations are allocated to Chennai and 200 observations are allocated to Coimbatore. Synthetic records have been created to illustrate questionnaire coding and construct scoring. They also demonstrate a complete statistical workflow; however, these records do not contain any construction workers' observations.

Seven principal constructs are used in this paper. These include management commitment (MC; 7 items), safety training (ST; 7 items), safety communication (SC; 6 items), financial constraints (FC; 6 items), safety culture (SCUL; 8 items), behaviour-based safety (BBS; 6 items), and safety performance (SP; 7 items). All items have a five-point Likert response structure. The constructs of technology adoption, PPE, safety participation and HIRA have been retained as controls in the principal safety-culture regression, since the thesis estimated the constructs simultaneously.

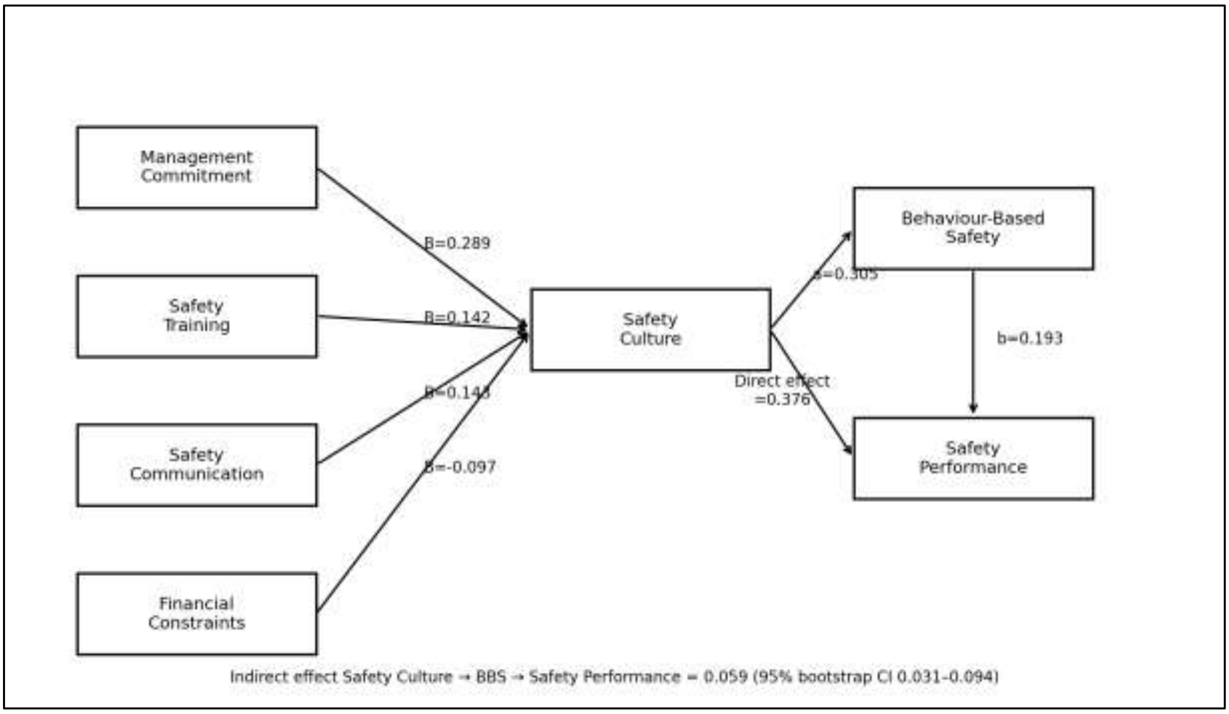

Figure 1: - Conceptual management culture behaviour performance model.

The analysis consists of a series of steps, including description, Cronbach's alpha, exploratory factor analysis, convergence validity, correlations, multiple regression, hierarchical regression, and bootstrap mediation. The overall KMO statistic was has been reported as 0.889, indicating factorability. Cronbach's alpha values for the constructs used in this article have been reported to be between 0.761 to 0.840. Composite reliability values were all greater than 0.70, although some AVE values were less than 0.50. These have been considered as measurement-development signs, rather than being hidden or adjusted with a remedial approach.

Safety culture is modelled as a continuous outcome with robust multiple linear regression. The mediation analysis will estimate path a (SCUL→BBS), path b (BBS→SP), and the direct SCUL→SP and a × b indirect effects with 1,000 bootstrap samples. In the interpretation, emphasis is placed on the magnitude of the relationship and the amount of uncertainty and model diagnostics, not just the p-values. Since the data is synthetic and cross-sectional, the coefficients are interpreted as the relationships as modeled, not causality nor the population.

Table 1: - Construct Structure and Measurement Quality

Construct	Code	Items	Cronbach α	Analytical role
Management commitment	MC	7	0.791	Predictor
Safety training	ST	7	0.840	Predictor
Safety communication	SC	6	0.781	Predictor
Financial constraints	FC	6	0.792	Barrier/predictor
Safety culture	SCUL	8	0.840	Outcome/antecedent
Behaviour-based safety	BBS	6	0.761	Mediator
Safety performance	SP	7	0.789	Outcome

4. Results

The sample was deliberately made synthetic in terms of occupational roles and project categories. The main constructs were grouped in the upper and mid-region of the five-point scale, facilitating the existence of meaningful covariation without generating perfectly measurable constructs. Reliability was deemed as acceptable to good: MC α=0.791, ST α=0.840, SC α=0.781, FC α=0.792, SCUL α=0.840, BBS α=0.761, and SP α=0.789.

Pearson correlations and the conceptual framework were directionally consistent. The Safety Culture construct was correlated with Management Commitment at approximately r=0.519 and with Safety Training at r=0.425. Safety Culture was also correlated with Safety Performance at r=0.451. Financial Constraints correlated negatively with Safety Culture at approximately r=-0.29 and with Safety Performance at approximately r=-0.31. The above-mentioned correlations indicated that the magnitudes of the negative correlations were smaller in comparison to what is needed to conclude that the constructs described above are duplicated.

The robust multiple regression explaining Safety Culture accounted for approximately 37.6% of the variance (Adjusted R^2=0.365) and was statistically significant at F=33.79, p<0.001. Among the Key variables, the largest positive coefficients were attributed to Management Commitment, (B=0.289, 95% CI 0.184–0.394, p<0.001) and Safety Training (B=0.142, 95% CI 0.050–0.235, p=0.003) and Safety Communication (B=0.143, 95% CI 0.054–0.232, p=0.002). Technology Adoption, a contextual control variable, was also positive (B=0.110, p=0.010). Financial Constraints were negative (B=-0.097, 95% CI -0.175 to -0.020, p=0.014). The other variables i.e. PPE, Participation, and HIRA, were not found to be independently important once the other variables were inserted.

Hierarchical regression of safety performance demonstrated that demographic and organizational controls accounted for a small variance (R^2=0.058) on their own. With the incorporation of substantive safety-management constructs, R^2 increased to 0.318 and the extended model reached R^2=0.331. In the final model, safety culture (B=0.194, p<0.001), management commitment (B=0.142, p=0.012), behavior-based safety (B=0.128, p=0.008) and PPE (B=0.118, p=0.008) were positive, and financial constraints were negative (B=-0.102, p=0.022). The occupational group coefficients remained insignificant, which further substantiated the assumption that constructs of safety-management were more significant than occupational-group labels.

The safety-culture construct and behavior-based safety (B=0.305) were the only significant predictors of safety performance, followed by a positive relationship (B=0.193) between behavior-based safety and safety performance. The indirect effect was 0.059 and had a 95% confidence interval of 0.031–0.094. The direct effect was positive and remained (B=0.376) while the total effect was (B=0.435). Because the indirect effect was significant and the direct effect remained, the relationship was interpreted as partially mediated.

Table 2: -Correlation Pattern

Relationship	Pearson r	Interpretation
Management commitment – Safety culture	0.519	Moderate positive
Safety training – Safety culture	0.425	Moderate positive
Safety communication – Safety culture	0.400	Moderate positive
Financial constraints – Safety culture	-0.290	Negative
Safety culture – Behaviour-based safety	0.310	Positive
Safety culture – Safety performance	0.451	Moderate positive
Financial constraints – Safety performance	-0.310	Negative

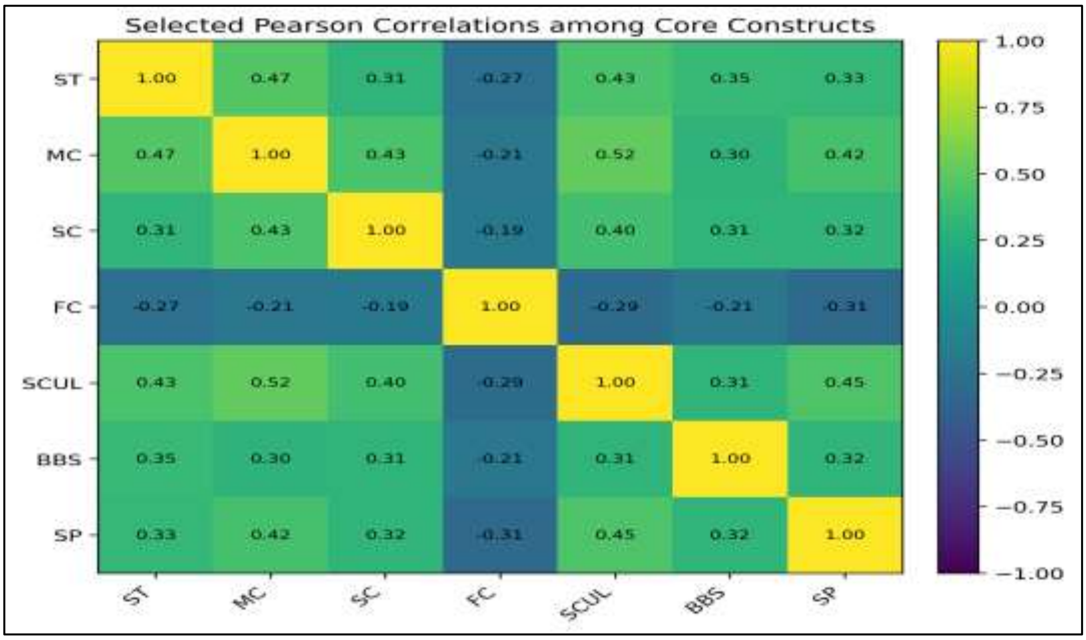

Figure 2: -Selected Pearson correlations among the focal constructs.

Table 3: -Robust Multiple Regression Predicting Safety Culture

Predictor	B	Robust SE	p	95% CI
Management commitment	0.289	0.054	<0.001	0.184 to 0.394
Safety training	0.142	0.047	0.003	0.050 to 0.235
Safety communication	0.143	0.045	0.002	0.054 to 0.232
Technology adoption	0.110	0.043	0.010	0.026 to 0.194
Financial constraints	-0.097	0.040	0.014	-0.175 to -0.020
PPE	0.056	0.038	0.136	-0.018 to 0.129
Safety participation	0.073	0.041	0.072	-0.007 to 0.153
HIRA	0.045	0.043	0.288	-0.038 to 0.129

Model summary: R^2=0.376; adjusted R^2=0.365; F=33.79; p<0.001. All reported VIF values in the thesis were below 2.

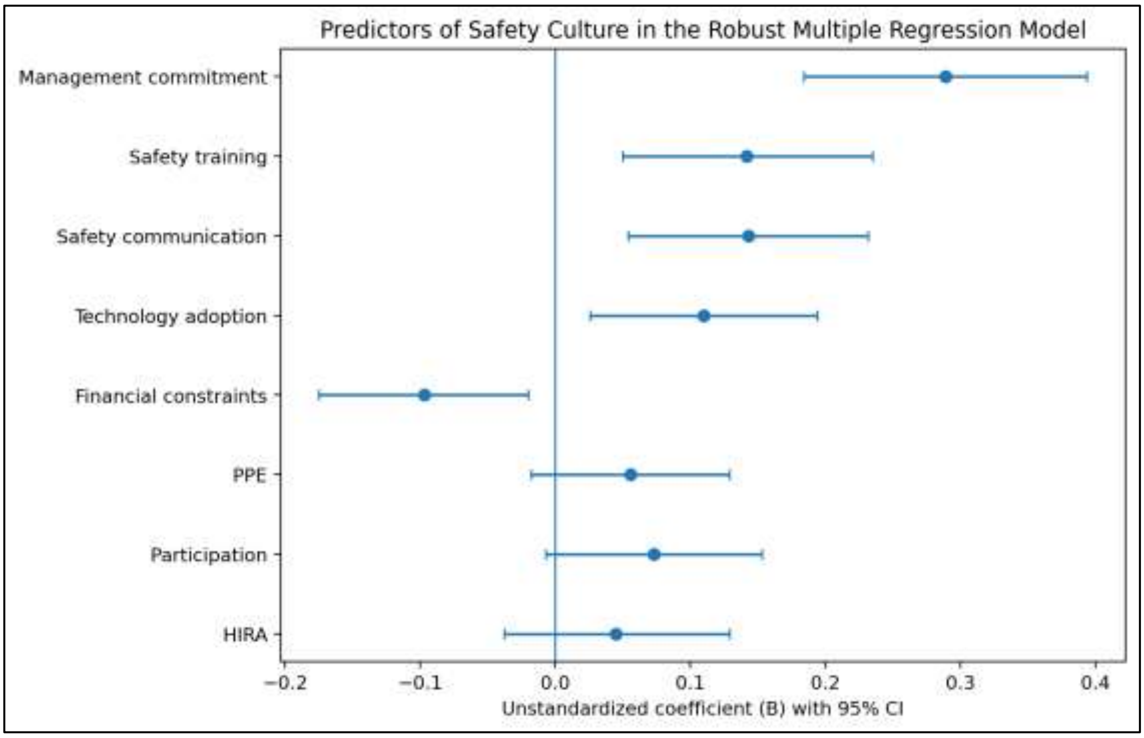

Figure 3: - Regression coefficients and 95% confidence intervals for predictors of safety culture.

Table 4: -Hierarchical Safety-Performance Model

Model	R^2	Adjusted R^2	Interpretation
M1	0.058	0.041	Organisational/demographic controls
M2	0.318	0.294	Adds substantive safety constructs
M3	0.331	0.303	Expanded substantive model

Selected M3 term	B	p
Safety culture	0.194	<0.001
Management commitment	0.142	0.012
Behaviour-based safety	0.128	0.008
PPE	0.118	0.008
HIRA	0.083	0.060
Financial constraints	-0.102	0.022

Table 5: -Mediation Analysis

Path/effect	Estimate	Bootstrap/interval
Safety culture → BBS (a)	0.305	—
BBS → Safety performance (b)	0.193	—
Direct effect	0.376	—
Indirect effect	0.059	95% CI 0.031–0.094
Total effect	0.435	—

The bootstrap interval for the indirect effect excluded zero while the direct effect remained positive; the thesis therefore interprets the pattern as partial mediation.

Table 6: -Hypothesis Summary

Hypothesis	Evidence	Decision
H1 MC → safety culture	B=0.289, p<0.001	Supported
H2 Training → safety culture	B=0.142, p=0.003	Supported
H3 Communication → safety culture	B=0.143, p=0.002	Supported
H4 Financial constraints → safety culture	B=-0.097, p=0.014	Supported
H5 Safety culture → performance	Positive; p<0.001 in performance model	Supported
H6 Safety culture → BBS	a=0.305	Supported
H7 BBS → performance	b=0.193	Supported
H8 Indirect culture → BBS → performance	0.059; 95% CI 0.031–0.094	Supported (partial mediation)

5. Discussion

The most significant finding is the central role of management commitment. A B coefficient of 0.289 does not imply that leadership is the sole determinant of culture, but does suggest that, after the other components (training, communication, technology, resources, and frontline controls) are considered, visible managerial priorities convey important information. This finding is also consistent with the LCB approach and resilient-safety perspectives (Fang et al., 2020; Trinh & Feng, 2020), in which leadership influences the context in the organization, and as a result the behaviors of employees, and does not simply concern the dictating of rules.

Training maintained an independent positive influence on safety culture. This is important in the context of construction, as the quality of training is more often measured by attendance, as opposed to the training being effectively absorbed. This result supports a more robust model: induction should be specific to the tasks and be repeated if controls or hazards change, as well as being reinforced by supervision and assessed by the presence of competence. Duryan et al. (2020) also emphasized the learning culture and the transfer of OHS knowledge across different parts of the organization.

Safety culture was also positively influenced by safety communication. The quality of communication, rather than the number of communications, must be evaluated. A suppression of communication and two-way communication are not equivalent. Naji et al. (2022) confirmed that communication connects culture to performance. This position supports safety communication as a priority, and a part of the mechanisms that link organizational priorities to daily practices.

Financial restrictions had a pronounced negative influence on safety culture and continued to do so in the safety-performance model. This is theoretically logical as constraints associated with resource allocation can impact training time, renewal of personal protective equipment (PPE), preventive maintenance, workforce allocation, and supply of required controls and technology. Safety expenditure should be viewed as a priority area rather than be treated as discretionary in cost pressure and safety-program implementation barriers, which are multi-dimension in nature, as demonstrated by Buniya et al. (2021).

The mediation effect is of particular interest and relevance to behaviour-based safety. The presence of a significant indirect effect establishes that safety culture has the potential to influence performance, particularly through the shaping of everyday behaviors, while the presence of a direct effect suggests that an exclusive behavioral explanation is not justified. This is consistent with a non-blaming culture, which suggests that unsafe behavior may be influenced by workload, supervision, competence, peer norms, equipment, design, and production incentives. Therefore, the purpose of behavioral observation and collection should be to identify the system antecedents and provide corrective action, as opposed to counting violations.

The final model demonstrates that, while it is tempting to interpret the occupational category as managerial, mid, or low, this should be avoided. Average safety-performance ratings did not differ sufficiently to warrant distinction based on role in the synthetic analysis. Therefore, formal hierarchy may not be the dominant design feature of safety-performance management. Future studies using real data are advised to test this hypothesis using multilevel models that distinguish worker-level, crew-level, and project-level safety-performance indicators.

6. Theoretical Implications

This paper endorses an integrated socio-technical approach to construction safety. In this regard, rather than treating safety culture as a standalone construct, this paper links leadership and resource allocation to safety culture. This paper also proposes that training and communication are the transmission mechanisms through which the organization's intent is transformed into the competence, collective understanding, and speaking up of employees. This paper retains behaviour as an important pathway, without reducing safety performance to individual choice. This structure aligns with the contemporary focus towards leading indicators of safety, learning systems, and resilience (Xu et al., 2023; Trinh & Feng, 2022).

7. Managerial and Policy Implications

In the construction industry, organizations need to make their safety-related commitments more visible through budget protection and timely closure of actions to address identified safety risks; provide supervisory level full authority regarding the decision to prioritize the control of risk over the pressure to meet production targets; and, finally, supporting visible decisions regarding the control of risk. A robust safety-related budget should cover priority safety controls, as well as the provision of adequate resources and regular replacement of personal protective equipment (PPE). Safety-related budgets should also resist cost cutting.

Behavioral safety should be implemented with the goal of increasing safety rather than blaming individuals for failing to comply. Training systems should verify competence, and ensure employees who have not been active for a significant period of time are assessed to ensure they remain competent. Leading safety indicators should focus on the closure of reported hazards, training and competence, learning from near misses, the quality of permits, and regular safety inspections. These suggest the intent of ISO 45001, along with the Occupational Safety, Health and Working Conditions Code, 2020.

8. Conclusion

Following the analysis derived from the thesis, the discrete constructs of leadership, competence, technology, resources and communication demonstrate that safety culture within construction is an organizational outcome. Of all the factors considered, management commitment was the strongest and most important. Positive contributions were also observed for safety training and safety communication, with financial constraints observed to have a negative impact. Safety culture is related to both direct and indirect safety performance via behavior-based safety. The overall model confirms the notion that to a greater extent than previously recognized, safety culture is shaped by all the components of the system, both visible and invisible, including management commitment, safety training, and safety communication. The overall model, however, should be viewed from an analytical perspective as opposed to an epidemiological perspective. This is primarily due to the artificial nature of the dataset. The next phase of research should be undertaken in a more comprehensive field setting to validate the model.

9. Limitations and Future Research

The main factor limiting this study was the synthetic nature of the dataset. The reported N=450, city allocation, and numerical estimates are demonstrations at the methodological level and cannot be used to find the real prevalence, the performance of companies, or causal effects in Chennai or Coimbatore. The cross-sectional nature of the data also prevents the making of any causal inferences, and all constructs have been represented through self-report Likert-type responses. Some AVE values were below 0.50, signaling the need for review of the items during field validation.

The syringe data has to be replaced with primary ethical data as the first step. The measurement invariance for the different job groups and for the different cities has to be studied. Since the data for different levels of the organization is nested, such as employees in teams and teams in projects, the data has to be modeled at the different levels. Longitudinal studies have to analyze whether changes in management focus and commitment on competence and involvement have an impact on changes in safety and behavior at work. Diversifying the data sources, such as digital data logs of incidents and behavior at work, and incorporating other methods such as objective leading indicators, could help in minimizing common method bias.

References

1. Duryan, M., Smyth, H., Roberts, A., Rowlinson, S., & Sherratt, F. (2020). Knowledge transfer for occupational health and safety: Cultivating health and safety learning culture in construction firms. Accident Analysis & Prevention, 139, 105496. https://doi.org/10.1016/j.aap.2020.105496
2. Trinh, M. T., & Feng, Y. (2020). Impact of project complexity on construction safety performance: Moderating role of resilient safety culture. Journal of Construction Engineering and Management, 146(2), 04019103. https://doi.org/10.1061/(ASCE)CO.1943-7862.0001758

3. Fang, D., Huang, Y., Guo, H., & Lim, H. W. (2020). LCB approach for construction safety. Safety Science, 128, 104761. https://doi.org/10.1016/j.ssci.2020.104761
4. Alkaissy, M., Arashpour, M., Ashuri, B., Bai, Y., & Hosseini, R. (2020). Safety management in construction: 20 years of risk modeling. Safety Science, 129, 104805. https://doi.org/10.1016/j.ssci.2020.104805
5. Buniya, M. K., Othman, I., Sunindijo, R. Y., Kineber, A. F., Mussi, E., & Ahmad, H. (2021). Barriers to safety program implementation in the construction industry. Ain Shams Engineering Journal, 12(1), 65–72. https://doi.org/10.1016/j.asej.2020.08.002
6. Buniya, M. K., Othman, I., Durdyev, S., Sunindijo, R. Y., Ismail, S., & Kineber, A. F. (2021). Safety program elements in the construction industry: The case of Iraq. International Journal of Environmental Research and Public Health, 18(2), 411. https://doi.org/10.3390/ijerph18020411
7. Buniya, M. K., Othman, I., Sunindijo, R. Y., Kashwani, G., & Durdyev, S. (2021). Critical success factors of safety program implementation in construction projects in Iraq. International Journal of Environmental Research and Public Health, 18(16), 8469. https://doi.org/10.3390/ijerph18168469
8. Naji, G. M. A., Isha, A. S. N., Mohyaldinn, M. E., Leka, S., Saleem, M. S., Syed Abd Rahman, S. M. N., & Alzoraiki, M. (2021). Impact of safety culture on safety performance; mediating role of psychosocial hazard: An integrated modelling approach. International Journal of Environmental Research and Public Health, 18(16), 8568. https://doi.org/10.3390/ijerph18168568
9. He, C., McCabe, B., Jia, G., & Sun, J. (2021). Effect of leader-member exchange on construction worker safety behavior: Safety climate and psychological capital as the mediators. Safety Science, 142, 105401. https://doi.org/10.1016/j.ssci.2021.105401
10. Naji, G. M. A., Isha, A. S. N., Alazzani, A., Saleem, M. S., & Alzoraiki, M. (2022). Assessing the mediating role of safety communication between safety culture and employees safety performance. Frontiers in Public Health, 10, 840281. https://doi.org/10.3389/fpubh.2022.840281
11. Saleem, M. S., Isha, A. S. N., Yusop, Y. M., Awan, M. I., & Naji, G. M. A. (2022). The role of psychological capital and work engagement in enhancing construction workers' safety behavior. Frontiers in Public Health, 10, 810145. https://doi.org/10.3389/fpubh.2022.810145
12. Chen, H., Gong, W., Li, H., & Shi, S. (2022). Co-workers' guanxi and construction workers' safety behavior: The mediating role of group identification. Frontiers in Public Health, 10, 964514. https://doi.org/10.3389/fpubh.2022.964514
13. Han, Y., et al. (2022). Grounded theory and social psychology approach to investigating the formation of construction workers' unsafe behaviour. Computational Intelligence and Neuroscience, 2022, 3581563. https://doi.org/10.1155/2022/3581563
14. Deng, S., Peng, R., & Pan, Y. (2022). A cognitive failure model of construction workers' unsafe behavior. Advances in Civil Engineering, 2022, 2576600. https://doi.org/10.1155/2022/2576600
15. Trinh, M. T., & Feng, Y. (2022). A maturity model for resilient safety culture development in construction. Buildings, 12(6), 733. https://doi.org/10.3390/buildings12060733
16. Xu, J., Cheung, C., Manu, P., Ejohwomu, O., & Too, J. (2023). Implementing safety leading indicators in construction: Toward a proactive approach to safety management. Safety Science, 157, 105929. https://doi.org/10.1016/j.ssci.2022.105929
17. Berglund, L., et al. (2023). Safety culture development in the construction industry: The case of a safety park in Sweden. Heliyon, 9, e18679. https://doi.org/10.1016/j.heliyon.2023.e18679
18. Liu, X., Xue, Z., Ding, Z. and Chen, S., 2023. Current status and future directions of construction safety climate: visual analysis based on wos database. *Sustainability*, *15*(5), p.3911. https://doi.org/10.3390/su15053911
19. Al-Otaibi, A. and Kineber, A.F., 2023. Identifying and assessing health and safety program implementation barriers in the construction industry: a case of Saudi Arabia. *Applied sciences*, *13*(4), p.2630. https://doi.org/10.3390/app13042630
20. Adzivor, E., Emuze, F., Ahiabu, M. and Kusedzi, M., 2024. Scaling up a positive safety culture among construction small and medium-sized enterprises in Ghana. *International journal of environmental research and public health*, *21*(7), p.817. https://doi.org/10.3390/ijerph21070817
21. Sankar, S.S., Anandh, K.S. and Prasanna, K., 2024. Safety leadership: a catalyst for positive safety climate on construction sites. *Buildings*, *14*(6), p.1806. https://doi.org/10.3390/buildings14061806
22. Senthamizh Sankar, S. and Anandh, K.S., 2024. Building safer workplaces: Unveiling the impact of safety leadership styles in the construction industry. *Administrative Sciences*, *14*(9), p.212. https://doi.org/10.3390/admsci14090212
23. Alqahtani, F.M., Abas, M., Alkahtani, M., Hayat, M. and Farrukh, A., 2024. Enhancing sustainable safety practices in construction: Insights from cultural and socio-economic analysis. *Sustainability*, *16*(12), p.5103. https://doi.org/10.3390/su16125103
24. Zhao W and Li S (2024) How does psychosocial safety climate affect safety behavior in the construction industry? A cross-level analysis. Front. Public Health 12:1473449. doi: 10.3389/fpubh.2024.1473449 https://doi.org/10.3389/fpubh.2024.1473449

25. Man, S.S., Xie, Y., Chen, Y., Chan, A.H.S. and Liu, L., 2025. Role of safety supervision, coworker support and safety training in shaping the safety behaviour of construction workers. *Safety Science*, *192*, p.106998. https://doi.org/10.1016/j.ssci.2025.106998
26. Wang, Y., Liu, C., & Zhao, W. (2025). Effects of safety training and accident experience on construction workers' safety behavior. https://doi.org/10.1177/10519815251368901
27. Guo, N., Liu, Y., Yu, S., Xia, B. and Cong, W., 2025. Examining the role of psychological symptoms and safety climate in shaping safety behaviors among construction workers. *Behavioral Sciences*, *15*(1), p.66. https://doi.org/10.3390/bs15010066
28. Vural, S., Dalyan, O., Öztürk, Ö.F. and Pişkin, M., 2025. Sustainable OSH training for safety culture in construction industry: The case of Izmir Province. *Disiplinlerarası Eğitim Araştırmaları Dergisi*, *9*(21), pp.367-381. https://doi.org/10.57135/jier.1675024
29. International Organization for Standardization (2018) *ISO 45001:2018 Occupational health and safety management systems—Requirements with guidance for use*. Geneva: International Organization for Standardization.
30. Government of India (2020) *The Occupational Safety, Health and Working Conditions Code, 2020*. New Delhi: Government of India.
31. International Organization for Standardization (2018) *ISO 45001:2018 Occupational health and safety management systems—Requirements with guidance for use*. Geneva: International Organization for Standardization.