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SAFETY CLIMATE IN HIGH-RISE CONSTRUCTION

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Abstract
This study examines safety climate perceptions in construction using two models: Safety Climate Model (SMC) and the Nordic Safety Climate Questionnaire (NOSACQ-50). Data from 20 projects of various sizes (ranging from 11 to 50 floors) and company years of experience (1->25) were analysed using the 5-point Likert scale and ANOVA tests. SMC and NOSACQ-50 contained 10 and 7 questions, respectively. Responses were gathered from safety officers and supervisors. Results revealed insights into safety culture and the impact of management practices on safety perceptions in high-rise construction. The study found that safety climate perceptions were relatively low, with a score of 3.865 for the SCM and 3.600 for NOSACQ-50. The findings emphasize the need for stronger safety practices at higher organizational levels, particularly in management, control, and leadership. Alpha Cronbach's values were 0.935 and 0.943 for SMC and NOSACQ-50, respectively, indicating internal adherence of the models to safety practices. A moderate positive correlation of 0.470 between the two models suggests that both measures overlap, but distinct aspects of safety perceptions exist. The study underscores that project size and company years of experience do not significantly affect safety perceptions, but effective safety communication, management commitment, and employee engagement are crucial. These findings contribute to the body of knowledge by highlighting the value of using complementary assessment models to uncover nuanced dimensions of safety climate, offering a more comprehensive basis for targeted and highly effective improvements in construction safety management.

Keywords: communication, high-rise construction, nosacq-50, safety climate model.

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1. Introduction

The construction industry, particularly in the context of high-rise building projects, faces inherent challenges related to worker safety and risk management. The escalating complexity and scale of these projects have intensified safety concerns, contributing to significant rates of both fatal and non-fatal occupational accidents. Despite advancements in safety protocols and regulatory frameworks, safety incidents continue to occur, often resulting in devastating losses. These incidents are exacerbated by factors such as prolonged construction periods, frequent changes in workplace conditions, and the unique risks associated with working at height. In this context, the importance of understanding the safety climate in high-rise construction projects becomes increasingly evident [1].

Safety climate, as defined by [2], refers to workers' shared perceptions of an organization's safety practices, policies, and procedures. This perception significantly influences workers' behaviour, safety outcomes, and the overall effectiveness of safety management systems. Recent studies indicate that safety climate is a critical determinant in reducing accident rates. A study by Shahin et al. [3] identified key safety factors in large construction enterprises, emphasizing the relationship between safety climate and accident rates. Their study suggests that organizational safety practices, along with management's commitment to safety, are pivotal in shaping a favourable safety climate. Kima et al. [4] highlighted the

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significant role of organizational safety culture and proactive monitoring in reducing incidents. Additionally, the building sector, especially in high-rise construction, has attracted significant scholarly attention regarding risk management in health and safety. Victory et al. [5] conducted a bibliometric study to assess the existing body of research in this area, revealing the evolution of safety and health risk management strategies. Their findings highlight the interdisciplinary nature of the field, emphasizing the need for comprehensive safety practices that address both the human and technical aspects of construction operations.

Research by Ansari et al. [6] highlights critical safety risks in high-rise construction, including falls from heights and the working with manual tools and equipment. They emphasize that safety training and monitoring are the most significant criteria for mitigating these risks and improving safety performance. Similarly, [7] identifies safety rule violations, such as the lack of fire protection and improper practices, as key contributors to heightened safety risks in high-rise projects. Their findings underscore the importance of addressing human factors through comprehensive safety measures, including training and monitoring. These observations align with the earlier work of [8], who proposed a two-factor model of safety climate, emphasizing the critical role of management's commitment to safety alongside workers' involvement in fostering a safer construction environment.

Despite progress in understanding safety in high-rise construction, challenges remain. Ni [9] identified weak accident prevention awareness among workers as a critical issue, emphasizing the need for enhanced safety education and re-education. The study also highlighted the importance of case studies to deepen understanding of safety management practices. Building on these insights, this paper explores key safety issues, evaluates the role of safety climate, and offers recommendations to improve safety outcomes in high-rise construction projects. Building on these insights from the literature review, this paper examines key safety issues, evaluates the influence of safety climate, and provides recommendations to improve safety outcomes in high-rise construction projects.

2. Method

This study aims to identify optimal strategies for improving safety and reducing failures in high-rise construction projects by utilizing two key models: the Safety Climate Model (SCM) [2], and the NOSACQ-50 (Nordic Safety Climate Questionnaire) [10]. The SCM focuses on workplace safety perceptions and is a known predictor of occupational injuries, while the NOSACQ-50 incorporates various factors like managerial commitment and safety priorities. By using these models, the study seeks to understand the safety climate in the high-rise construction sector, addressing the core question of how to enhance safety and prevent failures in such projects. The SCM consists of 10 questions, and the NOSACQ-50 consists of 7 questions assessing safety perceptions. Cronbach's Alpha is used to assess the internal consistency of the two questionnaires. A Likert scale was used from 1 (very low) to 5 (very high). The questionnaires were distributed to 32 construction companies, and responses were collected from 20 companies through safety coordinators and officers using electronic channels such as email. The dataset focuses on Israel's construction sector, with a specific emphasis on high-rise projects, and includes information from these 20 diverse companies. These companies were carefully chosen to represent various operational scales, geographical regions, and different years of experience. Safety officers and coordinators from completed projects filled out the questionnaires, ensuring anonymity to encourage honest responses. The statements in the questionnaires were tailored to individual projects, offering a detailed understanding of safety perceptions and practices at the project level. The company's years of experience and number of floors of the chosen 20 projects are presented in Table 1 and Table 2, respectively.

To assess the internal consistency of both models (SCM and NOSACQ-50), Cronbach's Alpha was used, ensuring the reliability of the questionnaires. Pearson correlation analysis was conducted to examine the relationship between the two models, while ANOVA tests were applied to determine whether project number of floors and company years of experience significantly influence safety perceptions. This analytical phase was essential in identifying correlations between various safety factors and their potential impact on preventing accidents and safety failures in high-rise construction projects. Furthermore, the reliability and validity of the questionnaires were rigorously evaluated to ensure the robustness and credibility of the findings. These methodological steps were integral to gaining a comprehensive understanding of the safety climate and its implications for improving safety measures in high-rise construction projects.

Table 1. Distribution of company years of experience among the 20 projects.

Years of experience	Frequency	Percentage (%)
1-5	3	15
6-10	3	15
11-15	3	15
16-20	4	20
21-25	3	15
>25	4	20

Table 2. Number of floors distribution among the 20 projects.

Number of floors	Frequency	Percentage
11-20	7	50
21-30	5	20
31-40	5	25
41-50	3	5

3. Results

The models used in this research showed a high rate of internal consistency. SCM had an Alpha Cronbach value of 0.935, indicating excellent internal consistency and strong correlation between the questions, which effectively measure the safety climate as per Zohar's model. NOSACQ-50 had an Alpha Cronbach value of 0.943, demonstrating even stronger internal consistency despite having fewer questions. This suggests the NOSACQ-50 based questionnaire is also highly reliable, with strong coherence among its variables.

Table 3 presents the results of the questionnaires. SCM had a mean score of 3.865 (out of 5 in the Likert scale). This is slightly higher than NOSACQ-50, indicating a more positive perception of safety climate. NOSACQ-50 showed greater variability, with a higher standard deviation and a broader response range, suggesting more diverse opinions. The Pearson correlation analysis revealed a moderate positive correlation (R^2=0.470, P-value = 0.036) between responses to the two models, indicating that as scores rise in one model, they tend to do so in the other as well, reflecting some similarity in the constructs measured. This result is statistically significant. While the moderate correlation points to shared features between the models, the lack of a stronger correlation indicates that each model captures unique dimensions of safety perceptions. This underscores the potential advantage of using both questionnaires to gain a more comprehensive understanding of the safety climate.

Table 3. Questionnaires results.

Questionnaire	Mean	S.D.	Min	Max
SCM	3.865	0.625	2.70	4.80
NOSACQ	3.600	0.835	2.29	4.71

Table 4 presents the differences in organizational safety climate according to project size (number of floors). For the SCM, the F-value is 0.239 with a p-value of 0.868, indicating that the differences between groups were not statistically significant. The size effect is 0.043, suggesting a very weak relationship between project size and the questionnaire responses, with minimal variance explained by the model. For the NOSACQ-50, the F-value is 1.460 with a p-value of 0.263, also showing no statistically significant differences between groups. The size effect is 0.215, indicating a weak to moderate relationship, though the results remain non-significant. Overall, the analysis suggests that project size does not have a significant impact on the organizational safety climate based on the questionnaire responses in either model.

Table 4. Differences in organizational safety climate according to project size (N=20).

Value	SCM	NOSACQ-50
Sum of Squares between groups	0.318	2.848
Mean Square between groups	0.106	0.949
F	0.239	1.460
Sig.	0.868	0.263
Size effect	0.043	0.215

Table 5 presents the differences in organizational safety climate according to company years of experience. In the SCM, the F-value is 1.173 with a p-value of 0.370, indicating that the differences between groups were not statistically significant. The size effect is 0.295, suggesting a moderate relationship between the company's years of experience and the questionnaire responses, but the small values imply that the model did not capture all the variance. In NOSACQ-50, the F-value is 0.555 with a p-value of 0.732, and no statistically significant differences were found. The Eta value is 0.166, smaller than in SCM, indicating a weaker relationship. Overall, the analysis suggests that the company's years of experience does not have a significant impact on the questionnaire responses in both models.

Table 5. Differences in organizational safety climate based on company seniority (N=20).

Value	SCM	NOSACQ-50
Sum of Squares between groups	2.192	2.193
Mean Square between groups	0.438	0.439
F	1.173	0.555
Sig.	0.370	0.732
Size Effect	0.295	0.166

4. Conclusions

This research explores safety climate perceptions in high-rise construction projects using two models: the SCM and NOSACQ-50. Data from 20 projects of varying sizes (11 to 50 floors) and company years of experience levels were analyzed using 5-point Likert scale responses from safety officers and supervisors. SCM and NOSACQ-50 demonstrated strong internal consistency (Cronbach's alpha of 0.935 and 0.943, respectively), and a moderate positive correlation ($R^2 = 0.470$) highlighted overlapping yet distinct aspects of safety perceptions. Mean scores revealed relatively low safety perceptions, with SCM scoring 3.865 and NOSACQ-50 scoring 3.600. Results emphasized the importance of management commitment, safety communication, and employee engagement, while noting deficiencies in shared safety responsibility and the impact of work pace on safety. ANOVA tests showed that project size and company years of experience did not significantly influence safety perceptions. This study focused on project size and company tenure, while factors such as organizational culture and external pressures, potentially influential on safety perceptions, remain for future exploration. The findings underline the need for stronger safety practices, particularly in management and leadership, to enhance the safety climate in high-rise construction projects. A limitation of this study is its relatively small sample size and the focus on safety officers and supervisors, which presents an opportunity for future research to broaden the participant base and further validate the findings across diverse organizational settings.

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