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Assessment of Factors Affecting the Safety Performance in Construction Projects

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Abstract: ***This study analyzes the 152 responses of clients, contractors, and consultants within the construction industry in order to investigate safety performance factors within the construction industry. The data for the study were gathered through the use of a structured questionnaire, and statistical analysis, including ANOVA tests, was performed on it in order to evaluate the possibility of differences between the respondents in terms of their experience and designation. The findings highlight significant differences in perceptions among the various groups and suggest that areas of focus for improvement include safety training, availability of equipment, communication, and adherence to safety standards. The study emphasizes the significance of ongoing evaluation and improvement of safety measures and advocates for increased attention to the cultivation of a culture that places an emphasis on safety in construction projects. These findings provide valuable insights for improving overall safety performance and contribute to a better understanding of the dynamics of safety in the construction industry, which is a sector that is currently understudied.***

Keywords: Safety Performance Factors, Questionnaire Survey, ANOVA test, Construction Industry.

I. INTRODUCTION

The construction industry stands as a cornerstone of modern development, driving economic growth through the creation of infrastructure and built environments. Yet, within this dynamic sector lies inherent risks and challenges, prominently among them being the safety of individuals involved in construction projects (Bashirpour & Heravi, 2021). The construction industry is notorious for its high incidence of accidents and injuries, making safety performance a critical concern for all stakeholders. As such, understanding the factors influencing safety performance within construction projects is imperative for fostering a culture of safety, mitigating risks, and ensuring the well-being of workers (Agyekum et al., 2018; Wong & Soo, 2019).

Despite advancements in technology, regulations, and safety protocols, the construction industry continues to grapple with safety-related issues. Factors such as inadequate training, insufficient equipment, poor communication, and lax adherence to safety standards contribute to heightened risks and compromised safety outcomes (Cinu Mathew, 2020). Recognizing the multifaceted nature of these challenges, it becomes evident that a comprehensive understanding of the dynamics at play is necessary to enact meaningful improvements (Attarde, 2021; Sarkam et al., 2018; Tayeh et al., 2020).

This study endeavors to delve into the intricacies of safety performance within the construction industry by analyzing the perspectives of key stakeholders, including clients, contractors, and consultants. By gathering insights from individuals representing various roles and levels of experience within the industry, this research aims to elucidate the nuances of safety concerns and identify areas for enhancement (Amslak & Binti Aminudin, 2022). Through a structured questionnaire and rigorous statistical analysis, this study seeks to uncover disparities in perceptions among stakeholders, thereby providing valuable insights for targeted interventions and improvements.

In this context, the significance of this study extends beyond mere academic inquiry. By elucidating the factors influencing safety performance in construction projects, this research contributes to the broader discourse on occupational health and safety. Moreover, the findings of this study hold practical implications for industry practitioners, policymakers, and regulatory bodies tasked with safeguarding the well-being of workers and enhancing safety outcomes within the construction sector. By shedding light on critical issues and proposing actionable recommendations, this study aims to catalyze positive change and foster a safer working environment for all involved in construction projects.

II. LITERATURE REVIEW

The construction industry is renowned for its complexity and diversity, encompassing a wide array of projects, stakeholders, and challenges. Within this context, safety performance emerges as a paramount concern, given the inherent risks associated with construction activities.

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A review of existing literature reveals a rich tapestry of research aimed at understanding the factors influencing safety performance in construction projects.

One recurring theme in the literature is the importance of safety culture. Numerous studies emphasize the critical role of organizational culture in shaping attitudes, behaviors, and practices related to safety within construction firms. Rivera et al. (2021) highlights the link between a positive safety culture and improved safety performance, underscoring the need for proactive measures to cultivate a safety-conscious environment.

Another prominent area of inquiry pertains to safety training and education. Effective training programs have been shown to enhance workers' knowledge, skills, and awareness of safety protocols, thereby reducing the likelihood of accidents and injuries. Studies by Mohammadi et al. (2018) and Sawacha et al. (1999) emphasize the importance of comprehensive training initiatives tailored to the specific needs and risks present in construction projects.

Equipment availability and utilization also feature prominently in the literature on safety performance. Inadequate access to proper equipment and tools can pose significant hazards to workers and impede the efficient execution of construction tasks. Research by Peng & Zhang, (2022) and Nawi et al. (2016) underscores the importance of ensuring the timely provision and maintenance of equipment to safeguard workers' safety and productivity.

Communication plays a pivotal role in promoting safety within construction projects, serving as a conduit for disseminating information, clarifying expectations, and addressing concerns. Study by Usukhbayar & Choi, (2020) highlight the impact of effective communication channels and protocols in enhancing coordination among project stakeholders and facilitating timely responses to safety-related issues.

Adherence to safety standards and regulations is another key determinant of safety performance in construction projects. Compliance with established guidelines and protocols helps mitigate risks, ensure regulatory compliance, and promote a culture of accountability. Research by Abdul-Rashid et al. (2007) and Cetin & Kalaycı (2012) underscores the importance of aligning project practices with regulatory requirements to enhance safety outcomes.

While the literature offers valuable insights into various aspects of safety performance in construction projects, notable gaps and inconsistencies persist. Many studies focus on specific factors or stakeholder groups, overlooking the broader systemic issues that contribute to safety challenges within the industry. Additionally, there is a paucity of research examining the interplay between different factors and their cumulative impact on safety performance.

In light of these observations, this study seeks to address these gaps by adopting a holistic approach to examining safety performance factors within the construction industry. By integrating perspectives from clients, contractors, and consultants and employing rigorous statistical analysis techniques, this research aims to provide a comprehensive understanding of the dynamics influencing safety outcomes in construction projects. Through an in-depth exploration of key factors such as safety training, equipment availability, communication, and adherence to standards, this study endeavors to offer actionable recommendations for enhancing safety performance and fostering a culture of safety within the construction sector.

III. RESEARCH METHODOLOGY

The research methodology employed in this study is crucial for ensuring the validity, reliability, and comprehensiveness of the findings. This chapter outlines the specific procedures and techniques utilized to identify, select, process, and analyze information pertaining to safety performance factors in construction projects.

A. Identification of Questions for Questionnaire Development:

To achieve the objectives of the study, a structured questionnaire was designed based on insights derived from the literature review. The questionnaire consists of two main sections: demographic information and safety performance factors. The demographic section gathers information about respondents' roles, experience levels, and affiliations, while the safety performance factors section assesses respondents' perceptions regarding various aspects of safety within construction projects.

B. Data Collection and Sampling:

Data for the study were collected using a Google Form distributed to participants within the construction industry. The sample size was determined to be 152, ensuring adequate representation across different stakeholder groups. The questionnaire was designed to capture a diverse range of perspectives from clients, contractors, and consultants.

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C. Reliability Test of Questionnaire Responses:

To assess the reliability of the questionnaire responses, Cronbach's alpha was calculated. Cronbach's alpha is a statistical measure of internal consistency, providing insight into the extent to which the items in the questionnaire are related to each other. A Cronbach's alpha value above 0.7 is generally considered acceptable, indicating a reliable instrument for measuring respondents' perceptions.

D. Ranking of Factors based on Relative Agreement Index (RAI):

The relative agreement index (RAI) was computed to rank safety performance factors based on the collective agreement among respondents. The RAI considers the sum of responses for each factor relative to the maximum possible score, providing a measure of the overall consensus regarding the importance of each factor.

E. Hypothesis Testing:

Hypothesis testing was conducted to assess the significance of relationships between variables and test specific research hypotheses. One-way ANOVA tests were utilized to evaluate differences in perceptions among different stakeholder groups.

IV. RESULTS AND DISCUSSION

A. Reliability of Questionnaire Data

In Table 1, the reliability statistics for the questionnaire data are presented. The variable "Safety Performance Factors" yielded a Cronbach's Alpha coefficient of 0.923, indicating a high level of internal consistency. This variable comprises 34 items, demonstrating the reliability of the questionnaire in measuring respondents' perceptions of safety performance factors within the construction industry.

Table 1 Reliability Statistics

Variable	Cronbach's Alpha	N of Items
Safety Performance Factors	.923	34

B. Top 10 Safety Risk Factors

Table 2 presents the top 10 safety performance factors identified through the study, along with their Relative Agreement Index (RAI) scores and ranks. These factors represent the consensus among respondents regarding their significance in ensuring safety within construction projects.

Frequent safety training sessions emerged as the most crucial safety performance factor, with a high RAI score of 0.842, indicating strong agreement among respondents regarding its importance. This highlights the recognition of the pivotal role of ongoing training and education in promoting safety awareness and best practices among workers involved in construction projects.

Following closely behind is the provision of personal protective equipment, which garnered an RAI score of 0.825, indicating widespread acknowledgment of its importance in safeguarding workers from potential hazards on construction sites. This underscores the emphasis placed on ensuring the availability and proper utilization of protective gear to mitigate risks and enhance safety outcomes.

Safety concerns, safety procedures and rules, and safety signs occupied the next positions in the ranking, with identical RAI scores of 0.809. This indicates a shared understanding among respondents regarding the necessity of addressing safety concerns, adhering to established procedures, and employing clear signage to communicate hazards and safety protocols effectively within construction environments.

Construction risk management and addressing time constraints and workload handling also featured prominently among the top safety performance factors, underscoring the recognition of the need to proactively identify, assess, and mitigate risks, as well as manage project timelines and workloads in a manner that prioritizes safety.

Furthermore, the importance of well-maintained machineries, an organized layout of the work-site, and effective construction management were also acknowledged, reflecting the multifaceted nature of safety considerations within construction projects.

Overall, the findings from Table 2 provide valuable insights into the key safety performance factors perceived by stakeholders within the construction industry. By prioritizing these factors and implementing targeted interventions to address them, stakeholders can work towards fostering a culture of safety and enhancing overall safety outcomes in construction projects.

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Table 2 Top 10 Safety performance factors

Sr. No.	Safety Performance Factors	Relative Agreement Index (RAI)	Rank
1.	Frequent safety training sessions	0.842	1
2.	Personal protective equipment	0.825	2
3.	Safety concerns	0.809	3
4.	Safety procedures and rules.	0.809	4
5.	Safety signs	0.809	5
6.	Construction risk management	0.787	6
7.	Time constraints and workload handling	0.782	7
8.	Well-maintained machineries	0.771	8
9.	Layout of Work-Site	0.759	9
10.	Effective construction management	0.753	10

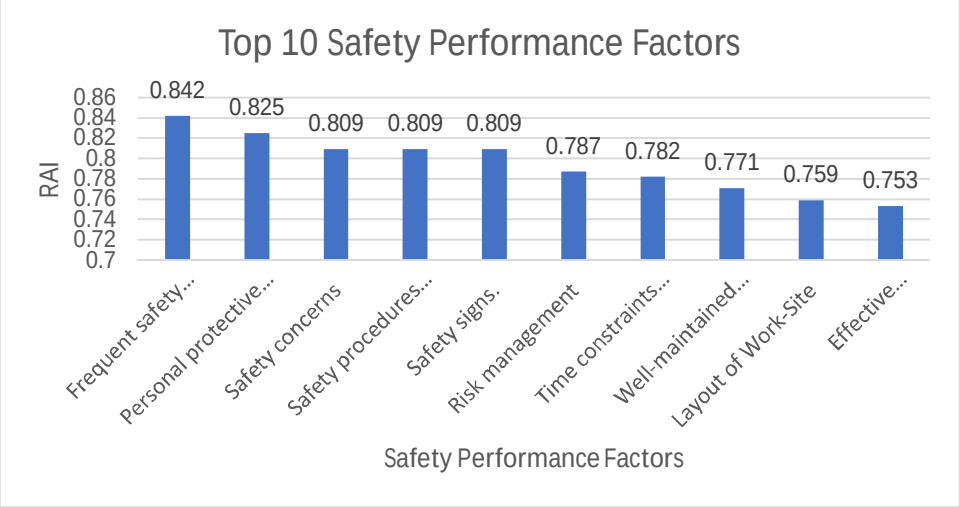


Figure 1 Top 10 Safety Performance Factors

C. Hypothesis Testing

The following Hypothesis needs to be tested for this research. One Way ANOVA test is applied for hypothesis testing.
Note: If P-value > 0.05 then Null Hypothesis Accepted (NHA), and if P-value < 0.05 then Null Hypothesis Rejected (NHR).
Hypothesis 1
H0: There is no significant difference in the responses of safety performance factor based on clients, contractors and consultants.
Ha: There is significant difference in the responses of safety performance factor based on clients, contractors and consultants.

Table 3 ANOVA (For Hypothesis 1)

	Sum of Squares	df	Mean Square	F	P-Value (NHA)
Between Groups	.141	2	.070	.213	.808
Within Groups	49.307	149	.331		
Total	49.448	151			

According to the findings in Table 3, the p-value is higher than the usual significance threshold of 0.05. Therefore, given the available information, it is not possible to reject the null hypothesis. This implies that there are no significant differences between clients, contractors, and consultants in their responses to safety performance variables.

Hypothesis 2
H0: There is no significant difference in the responses of safety performance factor based on experience of respondents.

Ha: There is significant difference in the responses of safety performance factor-based experience of respondents.

Table 4 ANOVA (For Hypothesis 2)

	Sum of Squares	df	Mean Square	F	P-Value (NHA)
Between Groups	.896	5	.179	.539	.747
Within Groups	48.552	146	.333		
Total	49.448	151			

The analysis of Hypothesis 2 in Table 4, which sought to ascertain whether there is a significant difference in responses to the safety performance factor based on respondents' experience, produced a p-value of 0.747 from the ANOVA. The fact that this p-value is higher than the usual significance cutoff of 0.05 suggests that there isn't enough data to reject the null hypothesis. In light of the findings, it appears that responses to the safety performance factor do not significantly differ across experience groups. In essence, the analysis contends that respondents' experience levels have little bearing on how they view safety performance factors.

Hypothesis 3

H0: There is no significant difference in the responses of safety performance factor based on designation of respondents.

Ha: There is significant difference in the responses of safety performance factor-based designation of respondents

Table 5 ANOVA (For Hypothesis 3)

	Sum of Squares	df	Mean Square	F	P-Value (NHA)
Between Groups	1.253	4	.313	.956	.434
Within Groups	48.195	147	.328		
Total	49.448	151			

In order to determine whether safety performance factor responses differ noticeably depending on the designation of respondents, Hypothesis 3's analysis yielded an ANOVA with a p-value of 0.434 (Table 5). This p-value is above the typical significance level of 0.05, indicating that there is only weak support for the null hypothesis. As a result, the findings imply that designation might not have a significant influence on responses to safety performance factors. The analysis suggests that respondents' designations may not significantly affect how they perceive safety performance factors, though there is a hint of a difference that is just barely significant enough to be considered statistically significant.

V. CONCLUSION

In conclusion, this study has provided valuable insights into the factors influencing safety performance within the construction industry. Through the analysis of 152 responses from clients, contractors, and consultants, key safety concerns and areas for improvement have been identified.

The findings highlight the importance of prioritizing safety training, provision of personal protective equipment, adherence to safety procedures, and effective communication among stakeholders. These factors emerged as crucial contributors to safety performance within construction projects, as evidenced by their high relative agreement index (RAI) scores.

Moreover, the hypothesis testing conducted using ANOVA revealed that there were no significant differences in responses to safety performance factors based on stakeholders' roles, experience levels, or designations. This suggests that stakeholders across various positions within the industry share similar perceptions regarding safety concerns and priorities.

The implications of this research extend beyond academic inquiry, offering practical recommendations for industry practitioners, policymakers, and regulatory bodies. By aligning practices with identified safety performance factors and fostering collaboration among stakeholders, significant progress can be made towards creating safer working environments and reducing the incidence of accidents and injuries in construction projects.

For future research, longitudinal studies, comparative analyses across regions or project types, qualitative research methods, and intervention studies are recommended. These avenues can further enhance our understanding of safety dynamics in the construction industry and contribute to the development of evidence-based strategies for promoting worker safety and well-being.

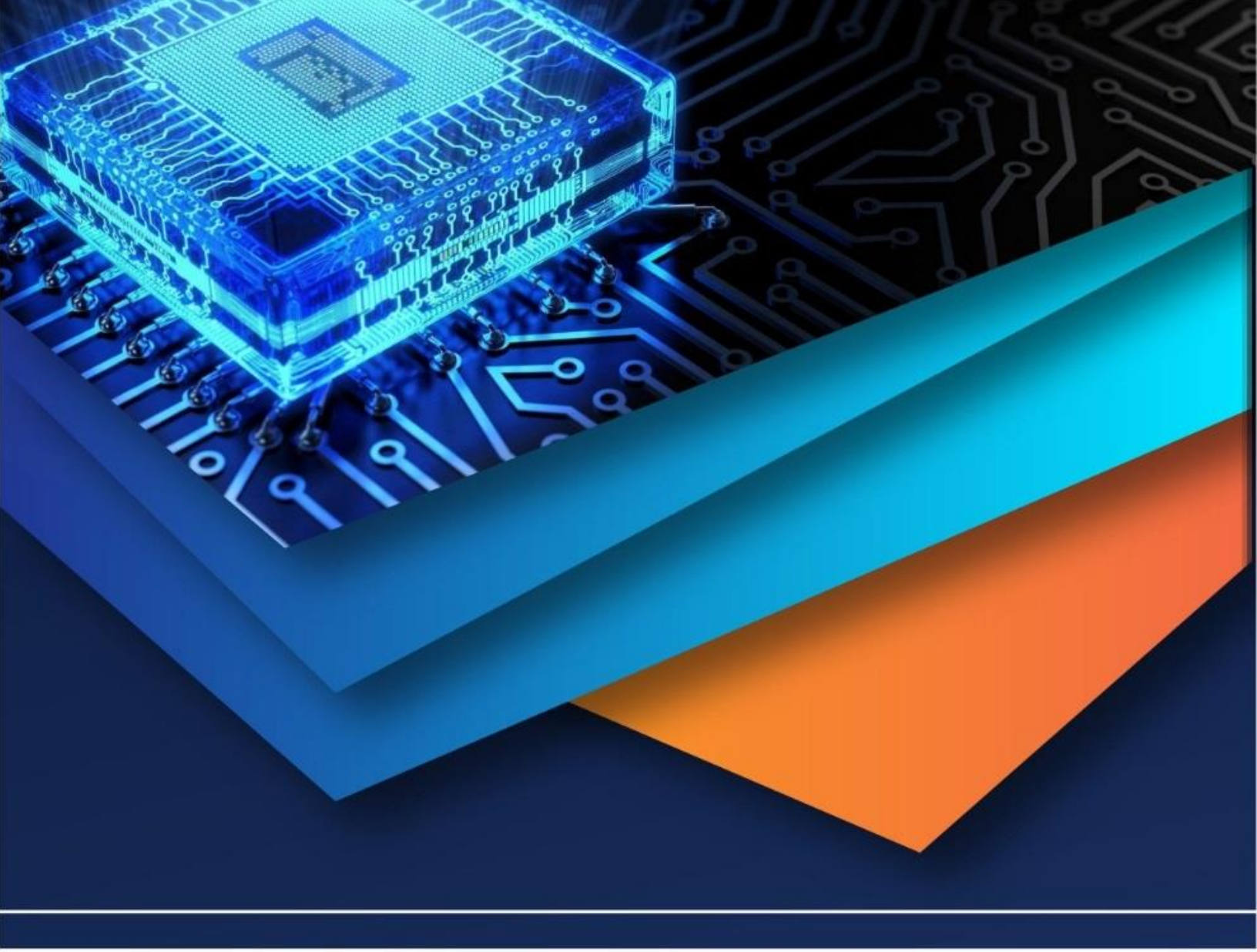
In essence, this study underscores the importance of continuous evaluation, improvement, and collaboration to enhance safety performance within the construction industry. By addressing identified safety concerns and implementing targeted interventions, stakeholders can work towards fostering a culture of safety and ensuring the well-being of all individuals involved in construction projects.

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