CHAPTER 73

Identification of Success Factors and Analysis of Barriers in the Implementation of Safety Management System (SMS) in the Construction Industry

Akshay Ashokkumar Kayapak[1], Tejas Prashant Borawake[1], Soham Kishor Raut[1], Shreyash Sanjay Talokar[1] and Babalu Rajput[2]

ABSTRACT

Despite being a key driver of economic growth, the construction industry remains one of the most dangerous, accounting for 16.4% of all occupational deaths worldwide. In India, where most construction workers are untrained and work in hazardous environments, implementing efficient Safety Management Systems (SMS) is essential to lowering risks and enhancing worker safety. However, there are several obstacles to SMS adoption, such as cultural barriers, high implementation costs, and inadequate safety awareness. These challenges result in fewer accidents, monetary loss, and lower employee morale. This study aims to analyze the obstacles to SMS deployment in the Indian construction sector and to pinpoint essential success factors. A thorough literature review and a structured questionnaire survey were components of the methodical research technique. 384 professionals received the survey; 112 valid responses were examined for stakeholder alignment using Spearman's coefficient and the Relative Importance Index (RII). High safety investment costs, constrained project timelines, a lack of safety expertise, and a preference for output over safety are some of the main obstacles found. The critical success elements were introducing early warning systems, enhanced safety culture, appropriate authority distribution, and safety education and training. Stakeholder viewpoints differ significantly despite the broad consensus regarding many obstacles and success criteria. The findings highlight the need for stronger regulatory frameworks, enhanced stakeholder collaboration, and targeted training programs. Addressing these barriers and leveraging success factors can help improve safety performance, reduce accidents, and align the Indian construction industry with global safety standards.

Keywords: Safety management systems (SMS); Barriers; Construction industry; Critical success factors; Safety awareness.

1.0 Introduction

After agriculture, the construction sector is India's second-largest economic sector.

[1]*School of Construction, NICMAR University, Pune, Maharashtra, India*
[2]*Corresponding author; School of Construction, NICMAR University, Pune, Maharashtra, India (E-mail: babalurajput@nicmar.ac.in)*

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

It includes building and civil work projects, contributing significantly to infrastructure and economic growth. The Indian government has spent ₹23 lakh crore on infrastructure in the last three years, with capital spending doubling as a percentage of GDP. However, there is a considerable risk of accidents in the construction sector.

Although they represent approximately 7.5% of the global labor force, construction workers in India are responsible for 16.4% of workplace fatalities worldwide. Most unskilled workers work under tough conditions, leading to a high accident rate—nearly three times higher than other industries.

The need for safety in construction is crucial. The Silkyara-Barkot tunnel collapse in 2023 highlighted the lack of proper safety management. Safety Management Systems (SMS) were introduced in the 1980s in Europe and later adopted in India to improve workplace safety. The National Safety Council was established in 1966, and March 4 is celebrated as National Safety Day.

Despite improvements, implementing safety measures faces challenges. Effective safety management requires policies, training, and proper risk control. A well-structured SMS can reduce accidents, improve worker morale, and minimize financial losses, making construction sites safer.

2.0 Literature Review

Because construction is a high-risk sector, safety is a major concern. Risky tasks, including working at heights, operating large gear, and coming into contact with toxic materials, are all part of construction sites, leading to many workplace accidents and injuries. The construction industry contributes substantially to the economy but remains one of the most accident-prone sectors worldwide.

To mitigate these risks, a well-implemented Safety Management System (SMS) can help reduce workplace hazards, accidents, and financial losses. SMS is a structured framework that integrates policies, procedures, and practices to manage workplace safety effectively. It includes hazard identification, risk assessment, employee training, incident reporting, and compliance with regulatory standards. A successful SMS ensures safety measures are in place, actively followed, and improved. However, despite the recognized benefits of SMS, several barriers hinder its successful adoption. These barriers range from financial constraints and resistance to change to inadequate enforcement of safety regulations and a lack of awareness among construction workers.

Therefore, examining the key success factors and challenges in implementing SMS in the construction industry is essential. A thorough examination of research articles from respectable publications found twenty success factors and twenty hurdles, offering important new perspectives on the challenges of SMS adoption in the Indian construction industry. Tables 1 and 2 depict the barriers mentioned above and the success factors.

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

3.0 Research Methodology

The study followed a structured methodology, including questionnaire formulation, respondent profiling, sample selection, survey execution, data collection, and analysis. Based on a literature review, a questionnaire was created and validated by piloting it with ten safety experts with five or more years of experience.

Table 1: Barriers in the Implementation of SMS

Sr. No.	Barriers	References
1	Workers Under the Influence of Drugs or Alcohol	(Maliha *et al.*, 2021; Pereira *et al.*, 2018)
2	Poor equipment and lack of various machine and equipment	(Maliha *et al.*, 2021; Pereira *et al.*, 2018; Rivera *et al.*, 2021)
3	Safety Investment and operational cost	(Rivera *et al.*, 2021)
4	Lack of Safety Standards	(Al-Otaibi & Kineber, 2023; Buniya *et al.*, 2021)
5	Lack of safety knowledge to implement proper safety measures as required	(Maliha *et al.*, 2021)
6	Operational Cost	(Okonkwo *et al.*, 2023)
7	Lack of analysis of accidents and injuries	(Kineber *et al.*, 2023)
8	Prioritising production over safety and health	(Kineber *et al.*, 2023)
9	Lack of proficiency	Jeong *et al.*,2021.
10	Organizational Complexity	(Gao *et al.*, 2018)
11	Language barriers among project participants	(Gao *et al.*, 2018)
12	Tough projects (e.g. tight budget, complex design, tight schedule and long construction period.	(Gao *et al.*, 2018)
13	Putting safety as a lower priority due to cultural differences in organizations	(Yiu *et al.*, 2019)
14	Inactive participation for the SMS implementation by the project team member	(Yiu *et al.*, 2019)
15	Lack of motivation by project team or sub-contractors	(Yiu *et al.*, 2019)
16	The disparity between the number of workers and qualified trainers in the industry	(van der Ham & Opdenakker, 2023)
17	Use of low-engagement training approaches (e.g., trainer centric with limited discussion)	(Kashmiri *et al.*, 2020)
18	Poor planning and safety risks	(Azil & Jabar, 2022)
19	General workers taking shortcuts or ignoring safety rules and regulations	(Azil & Jabar, 2022)
20	Attitude and Behaviour	(Mohammadi *et al.*, 2018)

Source: Compiled by authors

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

Based on their feedback, necessary modifications were made. Three sections make up the final questionnaire: (1) background information about the respondents, (2) implementation difficulties for SMS, and (3) success factors. On a 5-point Likert scale, respondents scored success factors and impediments from 1-strongly disagree to 5-strongly agree. The target group included professionals like architects, engineers, project managers, safety officers, contractors, laborers, etc. 384 surveys were disseminated via social media and email using convenience sampling. The response rate was calculated, and data was analyzed using the Relative Importance Index (RII) to rank barriers and success factors. The degree of agreement between the various professionals regarding the corresponding ranks was assessed using Spearman's rank correlation.

Table 2: Success Factors in the Implementation of SMS

Sr. No.	Success Factors	References
1	Emergency Planning	(Pereira *et al.*, 2018)
2	Management team's priority with safety over schedule and cost	(Pereira *et al.*, 2018)
3	Safety Budget	(Pereira *et al.*, 2018)
4	Appropriate plant and equipment for carrying the work safely	(Yiu *et al.*, 2019)
5	Personal attitude	(Buniya *et al.*, 2021)
6	Intensive Collaboration with all Stakeholders	(van der Ham & Opdenakker, 2023)
7	Idea and Promotion of Safety Culture	(Guo *et al.*, 2023)
8	Safety Education and Training	(Guo *et al.*, 2023; Ajslev & Nimb, 2022)
9	Adequate Time to complete the Assigned Job Task Safely	(Gao *et al.*, 2018)
10	Contribution of some external experts in supervision works	(Maliha *et al.*, 2021)
11	Allocation Of Authority and Responsibility	(Othman *et al.*, 2020)
12	Early Warning System	(Phinias, 2023)
13	Increase compliance with H&S legislations	(Phinias, 2023)
14	Organization commitment	(Xu *et al.*, 2023)
15	Client, designer and contractor engagement	(Xu *et al.*, 2023)
16	Safety Legislation	(Rashid *et al.*, 2023)
17	Daily safety meetings	(Engler Bridi *et al.*, 2021).
18	Safety inspections carried out by external evaluators	(Engler Bridi *et al.*, 2021).
19	Improved safety culture	(Yiu *et al.*, 2019)
20	Improvement in accident investigations and analyses	(Yiu *et al.*, 2019)

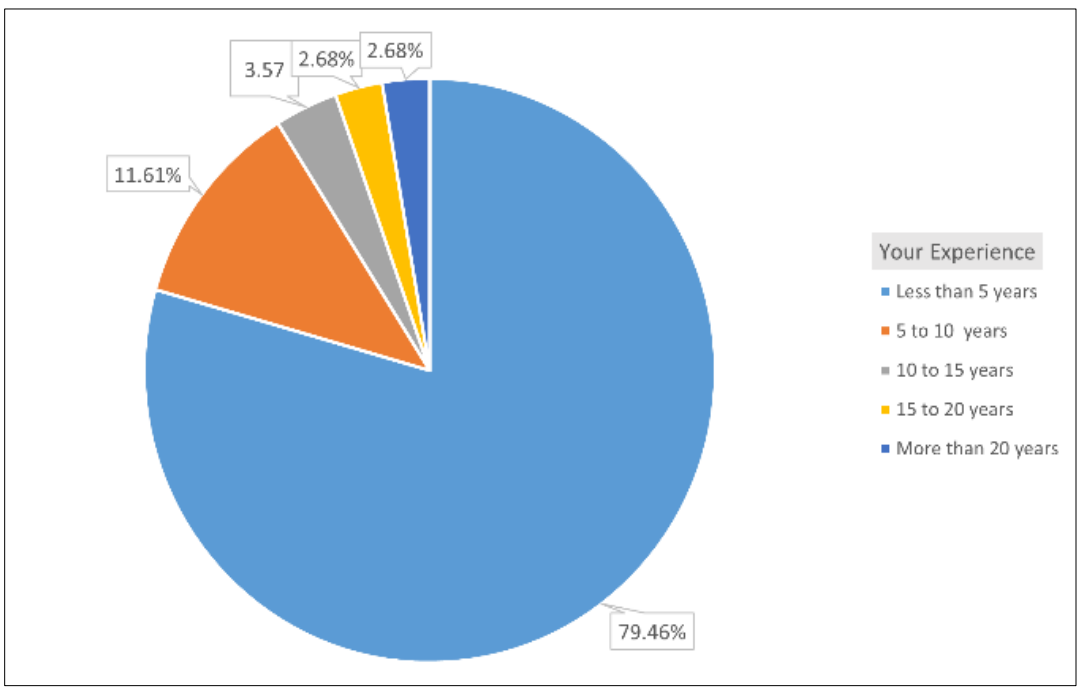
Source: Compiled by authors

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

4.0 Results and Discussions

A structured questionnaire survey was conducted to gain insights into the barriers and success factors associated with implementing Safety Management Systems (SMS) in the construction industry. The survey targeted professionals across various organizational roles and work backgrounds, with 384 Surveys. After careful screening and validation, 112 of the 123 received responses were legitimate. This resulted in a response rate of approximately 29.2%, which ensures statistical significance for reliable analysis. The respondents' profiles are shown in Figures 1 to 4. They were categorized based on work experience, qualifications, organizational role, and primary work experience sector.

Figure 1: Experience of the Respondents

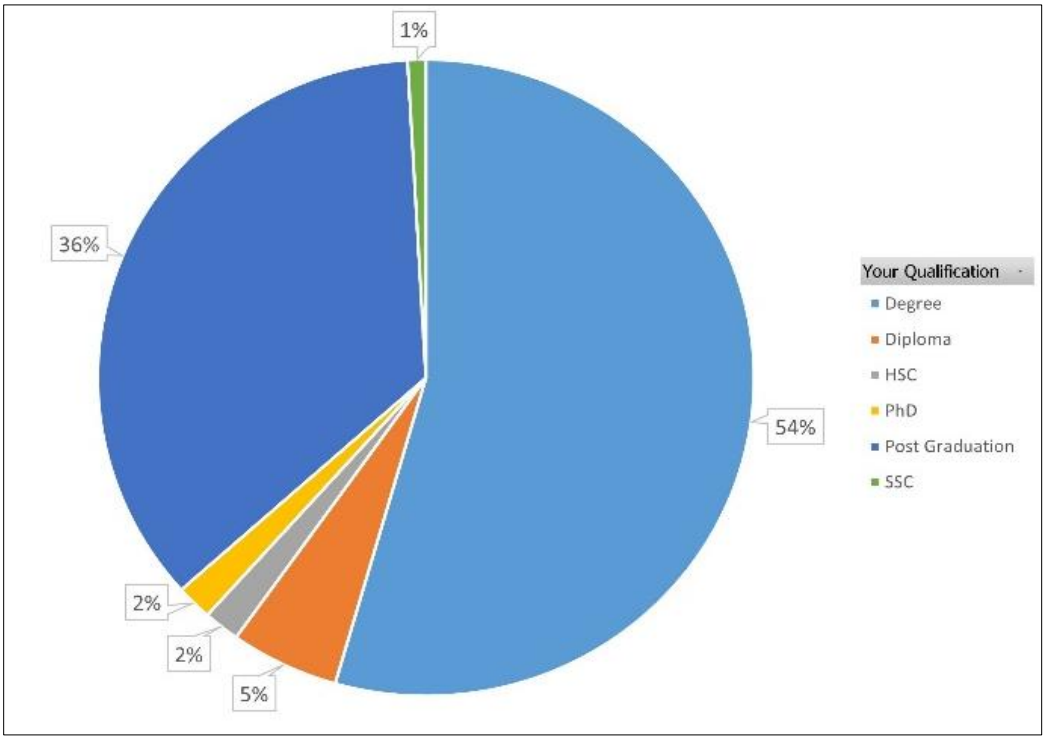


Source: Compiled by authors

As illustrated in Figure 1, the majority, i.e., 89 out of 112 (79.46%) of respondents had up to five years of experience in the construction sector, while 20.54% had more than five years of experience. This distribution reflects the perspectives of both early-career and experienced professionals regarding SMS implementation.

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

Figure 2: Qualification of the Respondents



Source: Compiled by authors

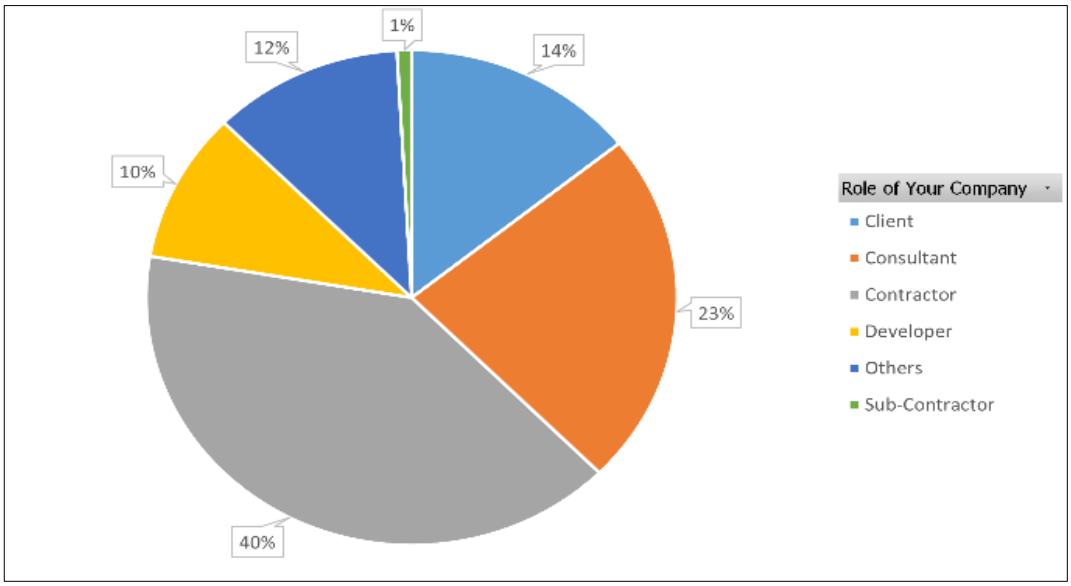
Figure 2 presents the distribution of respondents based on their qualifications. Approximately 54.46% of the participants held an undergraduate degree, while 35.71% possessed a postgraduate qualification. The respondents' educational background indicates high expertise and understanding of construction safety practices.

Figure 3 displays the respondent stakeholder groups. Among the respondents, 40.17% were employed by contractors, 23.21% by consultants, 14.28% by client companies, and 9.82% by developers. This diverse representation ensures a balanced perspective on SMS implementation challenges and success factors.

As depicted in Figure 4, 63.39% of respondents worked in the building sector, while 12.50% were involved in roads and bridges. The remaining respondents were distributed across other infrastructure projects. This distribution highlights the prominence of building sector professionals in the study. RII values and final rank for different barriers and success factors are shown in Table 3 & Table 4.

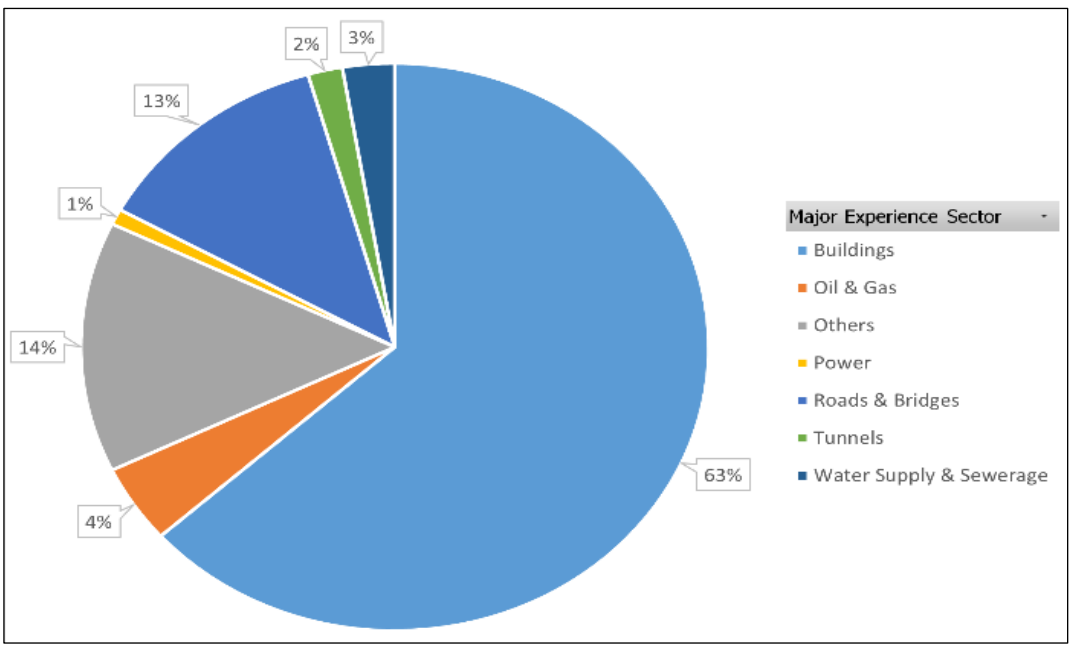
DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

Figure 3: Role of Company of the Respondents



Source: Compiled by authors

Figure 4: Major Experience Sector of the Respondents



Source: Compiled by authors

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

Table 3: RII Score & Ranking for Barriers

	Barriers in the implementation of SMS	Overall	
Code	**Name**	**RII Score**	**Rank**
B3	Safety Investment and operational cost	0.763	1
B12	Tough projects (e.g. tight budget, complex design, tight schedule and long construction period.)	0.718	2
B20	Attitude and Behaviour	0.716	3
B8	Prioritising production over safety and health	0.702	4
B6	Operational Cost	0.693	5
B5	Lack of safety knowledge to implement proper safety measures as required	0.691	6
B16	The disparity between the number of workers and qualified trainers in the industry	0.689	7
B19	General workers taking shortcuts or ignoring safety rules and regulations	0.679	8
B11	Language barriers among project participants	0.666	9
B7	Lack of analysis of accidents and injuries	0.655	10
B4	Lack of Safety Standards	0.654	11
B18	Poor planning and safety risks	0.646	12
B9	Lack of proficiency	0.643	13
B10	Organizational Complexity	0.643	13
B14	Inactive participation for the SMS implementation by the project team member	0.643	13
B15	Lack of motivation by project team or sub-contractors	0.636	16
B17	Use of low-engagement training approaches (e.g., trainer centric with limited discussion)	0.634	17
B13	Putting safety as a lower priority due to cultural differences in organizations	0.625	18
B2	Poor equipment and lack of various machine and equipment	0.607	19
B1	Workers Under the Influence of Drugs or Alcohol	0.580	20

Source: Compiled by authors

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

Table 4: RII Score & Ranking for Barriers

	Success Factors in the implementation of SMS	Overall	
Code	**Name**	**RII Score**	**Rank**
S8	Safety Education and Training	0.823	1
S11	Allocation Of Authority And Responsibility	0.800	2
S12	Early Warning System	0.800	2
S19	Improved safety culture	0.800	2
S15	Client, designer and contractor engagement	0.796	5
S20	Improvement in accident investigations and analyses	0.796	5
S14	Organization commitment	0.795	7
S7	Idea and Promotion Of Safety Culture	0.791	8
S18	Safety inspections carried out by external evaluators	0.789	9
S4	Appropriate plant and equipment for carrying the work safely	0.782	10
S16	Safety Legislation	0.779	11
S9	Adequate Time to complete the Assigned Job Task Safely	0.773	12
S3	Safety Budget	0.771	13
S10	Contribution of some external experts in supervision works	0.770	14
S1	Emergency Planning	0.763	15
S5	Personal attitude	0.757	16
S13	Increase compliance with H&S legislations	0.757	16
S17	Daily safety meetings	0.754	18
S2	Management team's priority with safety over schedule and cost	0.752	19
S6	Intensive Collaboration with all Stakeholders	0.752	19

Source: Compiled by authors

The degree of agreement or disagreement with the ranks derived from the responses of different parties was measured using Spearman's rank correlation coefficient. The Spearman correlation analysis indicated varying levels of agreement among stakeholders regarding prioritizing these factors. Contractors and other groups showed the highest agreement (0.64) in ranking barriers, whereas contractors and subcontractors had the lowest agreement (0.22).

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

Similarly, the highest agreement on success factors was between clients and contractors (0.63), while developers and subcontractors showed a negative correlation (-0.52). The findings highlight the need for improved safety investments, better project planning, and stronger stakeholder collaboration to enhance SMS implementation in construction projects.

5.0 Conclusion and Recommendations

Despite being a vital component of economic growth, the construction business is nevertheless one of the riskiest because of its high level of danger. This study highlights the crucial role of Safety Management Systems (SMS) in minimizing workplace hazards, reducing accidents, and ensuring worker safety. Despite growing awareness and regulatory measures, effective SMS implementation still faces considerable challenges. Through research and analysis, this study identifies key success factors and barriers hindering SMS adoption in the construction sector.

The study findings indicate that financial constraints, organizational complexities, and weak safety culture are the primary barriers to SMS implementation. Conversely, safety education, management commitment, and proactive risk assessment are critical success factors in enhancing safety performance. A strong safety culture protects workers, improves project efficiency, and reduces long-term costs. Collaboration among stakeholders, i.e., clients, contractors, and regulatory agencies, is crucial to guaranteeing SMS uptake.

Using a structured questionnaire survey, the study examined the success factors and obstacles affecting the construction industry's implementation of Safety Management Systems (SMS). Out of 384 distributed surveys, 112 valid responses were received, ensuring a Statistically significant sample. The survey included respondents from various roles, including contractors (40.17%), consultants (23.21%), clients (14.28%), and developers (9.82%), with most having up to five years of experience.

Furthermore, the adoption of advanced technology can significantly enhance safety practices. Artificial intelligence, IoT-based monitoring systems, and wearable safety devices can help predict and prevent potential hazards, thereby reducing risks on construction sites. Another vital aspect is fostering stakeholder collaboration, where active participation from all levels, including workers, supervisors, clients, contractors, and regulatory authorities, is encouraged to create a strong safety culture within the industry.

Future research should focus on developing innovative safety solutions, addressing financial and behavioral challenges, and exploring comparative studies across different regions or countries. These kinds of studies can offer insightful information on best practices that can be modified to improve construction safety performance in India. By implementing specific safety-related measures and cultivating a safety culture, the construction industry may improve worker well-being, increase productivity, and lessen workplace accidents' overall financial and social effects.

DOI: 10.17492/JPI/NICMAR/2507073 ISBN: 978-93-49790-54-4

References

Al Otaibi, A. I., & Kineber, A. F. (2023). Identifying and assessing health and safety program implementation barriers in the construction industry: A case of Saudi Arabia. *Applied Sciences (Switzerland), 13*(4), Article 2630. https://doi.org/10.3390/app13042630

Azil, N. A. S., & Jabar, I. L. (2022). A review on issues confronted by safety team in managing safety practices at Malaysian construction industry. *IOP Conference Series: Earth and Environmental Science, 1067*(1), 012059. https://doi.org/10.1088/1755-1315/1067/1/012059

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

Engler Bridi, M., Torres Formoso, C., & Abreu Saurin, T. (2021). A systems thinking-based method for assessing safety management best practices in construction. *Safety Science, 141*, 105345. https://doi.org/10.1016/j.ssci.2021.105345

Gao, R., Chan, A. P. C., Lyu, S., Zahoor, H., & Utama, W. P. (2018). Investigating the difficulties of implementing safety practices in international construction projects. *Safety Science, 108*, 39–47. https://doi.org/10.1016/j.ssci.2018.04.018

Guo, H., Gao, X., Lin, Q., & Gao, B. (2023). Assessing the degradation of safety management performance in large construction projects: An investigation and decision model based on complex network modeling. *Sustainability (Switzerland), 15*(16), Article 12283. https://doi.org/10.3390/su151612283

Kashmiri, D., Taherpour, F., Namian, M., & Ghiasvand, E. (2020). An analysis of safety climate and behavior in construction: A case from the Construction Research Congress 2020. *Construction Research Congress, 007*(1994), 809–818.

Kineber, A. F., Antwi-Afari, M. F., Elghaish, F., Zamil, A. M. A., Alhusban, M., & Qaralleh, T. J. O. (2023). Benefits of implementing occupational health and safety management systems for the sustainable construction industry: A systematic literature review. *Sustainability (Switzerland), 15*(17), Article 12697. https://doi.org/10.3390/su1517 12697

Maliha, M. N., Abu Aisheh, Y. I., Tayeh, B. A., & Almalki, A. (2021). Safety barriers identification, classification, and ways to improve safety performance in the architecture, engineering, and construction (AEC) industry: Review study. *Sustainability (Switzerland), 13*(6), Article 3316. https://doi.org/10.3390/su13063316

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*

Mohammadi, A., Tavakolan, M., & Khosravi, Y. (2018). Factors influencing safety performance on construction projects: A review. *Safety Science, 109*, 382–397. https://doi.org/10.1016/j.ssci.2018.06.017

Okonkwo, C., Okpala, I., Awolusi, I., & Nnaji, C. (2023). Overcoming barriers to smart safety management system implementation in the construction industry. *Results in Engineering, 20*, 101503. https://doi.org/10.1016/j.rineng.2023.101503

Othman, I., Kamil, M., Sunindijo, R. Y., Alnsour, M., & Kineber, A. F. (2020). Critical success factors influencing construction safety program implementation in developing countries. *Journal of Physics: Conference Series, 1529*(4), 042079. https://doi.org/10.1088/1742-6596/1529/4/042079

Pereira, E., Ahn, S., Han, S., & Abourizk, S. (2018). Identification and association of high-priority safety management system factors and accident precursors for proactive safety assessment and control. *Journal of Management in Engineering, 34*(1), 1–12. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000562

Phinias, R. N. (2023). Benefits and challenges relating to the implementation of health and safety leading indicators in the construction industry: A systematic review. *Safety Science, 163*, 106131. https://doi.org/10.1016/j.ssci.2023.106131

Rashid, S. A. U., Hadikusumo, B. H. W., & Chowdhury, M. R. I. (2023). What are the factors influencing construction safety? A review. *Journal of Civil Engineering and Construction, 12*(4), 211–222. https://doi.org/10.32732/jcec.2023.12.4.211

Rivera, F. M. L., Mora-Serrano, J., & Oñate, E. (2021). Factors influencing safety on construction projects (FSCPS): Types and categories. *International Journal of Environmental Research and Public Health, 18*(20), 10884. https://doi.org/10.3390/ ijerph182010884

Van der Ham, M., & Opdenakker, R. (2023). Overcoming process-related barriers in modular high-rise building projects. *International Journal of Construction Management, 23*(10), 1779–1789. https://doi.org/10.1080/15623599.2021.2007593

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

Yiu, N. S. N., Chan, D. W. M., Shan, M., & Sze, N. N. (2019). Implementation of safety management system in managing construction projects: Benefits and obstacles. *Safety Science, 117*, 23–32. https://doi.org/10.1016/j.ssci.2019.03.027

DOI: 10.17492/JPI/NICMAR/2507073 *ISBN: 978-93-49790-54-4*