

Perceived effectiveness of near-miss reporting on proactive safety performance in construction: A mixed-methods study from India

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ABSTRACT

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Introduction: Construction industry is one of the most dangerous industries involving 5.5 million work-related accidents and nearly 60,000 fatalities every year across the world. Near-Miss Reporting Systems (NMRS) is one of the proactive safety management options to identify hazards prior to any major accidents contributing to injury prevention. While NMRSs are increasingly adopted in construction, there remains a gap in understanding how their effectiveness is perceived by frontline workers. This research evaluated the perceived effectiveness of the NMRS among construction employees and tested its relationship with other safety management practices and outcomes.

Methods: A quantitative, cross-sectional, and correlational research design was used, gathering data from 475 construction workers in 18 Indian units and five-year accident and near-miss reporting trends. Descriptive analysis, Pearson correlation, and linear regression were applied to evaluate worker perceptions of NMRS effectiveness, safety interventions, and safety performance, as well as the relationship between accident and near-miss reporting trends.

Results: The analysis demonstrated NMRS's effectiveness in boosting safety awareness, preventing accidents [84.5% affirmation], and increasing job satisfaction [84.6% affirmation]. This effectiveness was strongly linked to robust safety management practices, including an open safety culture [$r=0.56$], regular safety audits [$r=0.22$], and employee engagement [$r=0.16$]. Critically, higher near-miss reporting frequencies correlated negatively with accident rates, signifying a proactive role of NMRS in reduction in incidents.

Conclusion: NMRS effectiveness is closely tied to safety culture and management practices. Integrating NMRS into broader safety frameworks enhances construction site safety outcomes.

Keywords: Accident Prevention, Construction Safety, Near-Miss Reporting, Risk Management, Safety Culture

Introduction

The construction sector is always ranked among the most dangerous in the world, with a high number of injuries, accidents, and deaths being recorded. It is estimated by the International Labour Organization (ILO) that more than 5.5 million accidents and close to 60,000 fatal construction cases occur worldwide per year.¹

These dismal numbers compel the necessity of having effective and proactive safety measures. Conventional, reactive methods of safety mainly look into past incidents, and in most instances, they are inadequate in predicting future incidents. Conversely, Near Miss Reporting Systems (NMRS) have been effective

internationally in not only preventing injuries but also playing key roles in carrying out critical proactive risk management. According to the Occupational Safety and Health Administration (OSHA,2020), a near miss refers to an unintended occurrence that did not cause harm, illness, or damages, yet could have caused those. They are very important leading indicators of safety performance, and they provide priceless insights into unsafe conditions and risky behaviours that would otherwise contribute to a serious accident.^{2,3,4} The NMRS play a central role in enhancing and actively ensuring safety in construction environments by establishing improvement-proactive and risk-based prioritization systems,^{5,6} thus promoting resilience. This idea is developed and embodied in the concept of the so-called 'The accident triangle', which states that every serious injury has a prehistory of thousands of minor incidents and countless near misses.⁷ Herein lies the extreme significance of the gathering of such early signals.^{8,9} The research findings also confirm the negative interrelation between near-miss reporting and injury incidences, which further indicates the proactive nature of NMRS as a safety performance-enhancing tool.¹⁰ Near-miss reporting at the institutional level significantly enhances the overall safety culture of an organization by encouraging preventive action and fostering a culture of transparency within it.¹¹ In a similar way, research determined that the integration of effective reporting systems and a high level of management commitment are crucial to positive safety results, which further confirms the role of NMRS in safety culture and performance.^{12,13,14}

Although the theoretical benefits and predictive capabilities of near-miss systems exist, human, cultural, behavioral, and structural obstacles to their implementation are common in the construction industry. The primary barrier is a worker's perception of usefulness and risk on reporting.^{15,16} The general barriers include the fear of blame, uncertainty about what to do next, and a lack of awareness about the significance of reporting.^{15,16} Studies emphasize that psychological safety, trust, and proper training are key factors in nurturing an open reporting culture.^{17,18,19} Although studies suggest that NMRS can be used to detect and correct the processes that create accidents,^{15,20} not all organizations have incorporated NMRS into their thinking and safety practices.^{18,21,22} The effectiveness of any Near-miss system is not only based on its technical structure but also on how

the workforce accepts it.²² The perceptions of the workers are critical in shaping the levels of participation, reporting frequency and the general trust in the system. The reason is that when workers feel safety programs are in place, effective and promoted by management, they would tend towards implementing safe behaviour and even reporting near misses.²³ Managerial commitment and methodical feedback are essential to realize the best use of the near-miss data and a prevention-oriented approach to safety management.^{24,25,26} Safety training and visual aids to boost awareness and reporting, safety committees for follow-up, and incentives that foster a genuine safety culture.²⁷ Proactive safety culture, which is associated with active communication on lessons learned due to near misses, plays a big role in the prevention of accidents and the enhancement of better safety results.^{13,14,26} Quality supervision, toolbox talks, and audits build trust. Crucially, systematic analysis of reports helps prioritize risks and improve safety.

Nevertheless, there is a significant lack in the scholarly literature, with many studies focusing on incident records or the technical efficiency of such systems, but not on how employees at the ground level perceive and value them.^{9,10,14,16,25,28} This forms a significant research gap. The other gaps include a lack of research examining the correlation between perceived NMRS effectiveness and other active industrial safety management practices, as well as their correlation with measures of safety performance. Although near-miss and accident data are typically accessible, little research has combined these with tools that examine the effectiveness of the system based on perception to provide a multidimensional view of the system's effectiveness. Even as Hasanspahic et al. demonstrate the significance of analyzing near-miss reports during risk prioritization, corrective actions, and safety enhancement comments in the building industry,²¹ little is known about how data is collected through workers' perceptions. This study is based on the assumption that worker perception is not only vital in the assessment of safety outcomes, but also vitally important in the creation of an organizational culture that encourages proactive accident and injury prevention through harmonizing efforts. Although they are increasingly being adopted, the performance of NMRS in construction has never been exhaustively studied.^{10,15,25,29,30} The current study will: determine how the system of near-miss reporting is perceived as enhancing

safety performance, employee awareness, and satisfaction on construction sites; investigate the relationship between the perceived effectiveness of the system of near-misses and the level of other formal systems and strategies of industrial safety management; and relate the trends of near-misses and accidents data of selected units of the construction over the period of five years to provide a context to perception-based findings.

Methods

The research study used a cross-sectional, quantitative, and correlational research design. It mainly aimed to identify how effective NMRS were perceived to be in enhancing safety performance on construction sites. It also examined the statistical correlations between the perceived effectiveness of NMRS and the prevalence of different organizational industrial safety management practices in the eighteen units of the construction. To give contextual depth, the study also analysed five years of past near-miss and accident data of three large construction units.

Population, Sampling and Study Setting

The research was conducted at eighteen construction sites in northern India. They were selected because these sites have already adopted the practice of implementing and regularly using industrial safety management practices, including NMRS, to improve safety performance. The target audience consisted of construction workers, supervisors, engineers, and managers who were directly involved in site operations and industrial safety management practices. The selection of participants was based on their willingness to participate in the study, with a convenience sampling strategy adopted to cover the various job levels within the units. A total of

475 valid responses were received out of the 500 questionnaires administered resulting in an amazing response level of 95 percent.

Data Collection and Designing of Instrument

The main instrument of data collection was a structured questionnaire. It was designed based on the author's previous experience, the results of related research, and compliance with international safety management standards (e.g., ISO 45001). Three principal sections constituted the questionnaire:

Demographics: Collected data about the age, education, monthly income, marital status, job role, experience and gender of the participants.

Perceived Effectiveness of Near-Miss Reporting: Applied Likert-scale questions to gauge the variables of accident prevention, safety awareness, sense of safety and job satisfaction.

Presence and Perceived Effectiveness of Industrial Safety Management Practices: The effectiveness of several practices to manage safety (interventions), such as safety training programs, safety committees, safety professionals, safety posters visible, rewards of near misses, pep-talks/toolbox talks, supervision, safety auditing, and participation of employees and the open safety culture, was assessed by the participants.

All items of perception were measured using a five-point Likert scale, ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). To provide proper insight into what the survey instrument covers, a sample of questions, along with the accompanying Likert scale, is presented in Table 1 below. These questions would be used to capture respondents' perceptions of different safety practices and the effectiveness of Near-Miss Reporting Systems (NMRS) as a whole.

Table 1: Sample Survey Questions on Safety Management Practices and NMRS Effectiveness

S. No.	Question / Statement	Likert Scale
Part 1: Perceived Effectiveness of Industrial Safety Management Practices		
1	Safety Training is effective in preventing accidents in our organization.	1 (Highly Ineffective) to 5 (Highly Effective)
2	Pep-Talks and Tool Box Talks are very effective in enhancing safety awareness.	1 (Highly Ineffective) to 5 (Highly Effective)
3	Work Supervision is effective in ensuring safety compliance at our workplace.	1 (Highly Ineffective) to 5 (Highly Effective)
4	Work culture in our organisation encourages reporting of safety issues, accidents and NMAs.	1 (Highly Ineffective) to 5 (Highly Effective)
5	Near Miss Reporting System aids in prevention of accidents in our units.	1 (Highly Ineffective) to 5 (Highly Effective)

6	Safety Audits are effective in enhancement of safety performance in our organisation.	1 (Highly Ineffective) to 5 (Highly Effective)
Part 2: Overall Impact of Near Miss Reporting System		
1	There is an overall improvement in safety awareness and safety compliance in our organization.	1 (Strongly Disagree) to 5 (Strongly Agree)
2	I feel very safe in carrying out work in my organization.	1 (Strongly Disagree) to 5 (Strongly Agree)
3	In my opinion, Near Miss Reporting helped in accident prevention and improved overall safety performance in our organisation.	1 (Strongly Disagree) to 5 (Strongly Agree)

Validity, Reliability, and Data Collecting Procedure

Pilot-testing was conducted with 25 people to determine the clarity and reliability of a questionnaire. The construct validity was strictly checked by professionals who are well versed in construction work and safety management. Its internal consistency and reliability were at an excellent level, recording a Cronbach alpha on the perception-related constructs of 0.83.²⁴

The data collection process was divided into two sections. The primary data were collected through a paper survey, a mode of survey adopted due to the limitations of the number of respondents and the location. There was willing participation and all the respondents gave informed consent. None of the personal identifiers were recorded to ensure high levels of strict confidentiality. This data-gathering exercise took three months during the peak stages of the project. In the case of secondary data, historical records of near-misses and accidents over five years were captured through the safety departments of three large participating construction units. The datasets were anonymized and grouped by year and severity to identify temporal patterns.²¹

Data Analysis

The responses to the questionnaires were tabulated and coded with MS Excel. Demographic characteristics, overall perception scores, and reported status of industry safety management practices were described using descriptive statistics (frequencies, percentages, means, and standard deviations). Internal consistency and reliability of all multi-item constructs were determined using Cronbach's alpha. Pearson correlation coefficients were calculated to measure the relationships between perceived effectiveness of an NMRS and the other safety management practices in industry and measures of safety performance. Thereafter, the multiple linear regressions were used to assess the predictive associations between NMRS effectiveness and other industrial safety

management practices. Further, trend analysis was done descriptively based on plotting and analysis of five-year records of the accidents and near-miss incidents in three chosen construction units. The purpose of this assessment was to identify temporal trends, differences between occurrences, and put perception-based results into perspective, with possible links to safety interventions.^{14,21}

Ethical Considerations

All the ethical guidelines were followed such as ensuring that the participants were informed, participation was voluntary, and the studies and all the participants remained anonymous and their data confidential. No personal identifiers have been recorded or synchronized, and information has been managed securely.

Results

This section presents the results of the perception survey conducted among employees working in eighteen construction units, as well as the analysis of accident and near-miss data from three selected participating units. The findings are classified into four subsections: respondent demographics, descriptive statistics of perceptions towards the NMRS, correlation analysis of the effectiveness of the NMRS with other selected industrial safety management practices and safety performance indicators, and trends in the number of accidents and near-misses over consecutive five-year intervals.

Respondent Demographics

The questionnaire yielded 475 valid responses from the eighteen participating construction units. The sample comprised a diverse representation of job roles: 29.3% workers, 27.8% site supervisors, 31.2% engineers, and 11.8% management personnel. A majority of the participants (64.5%) reported having over five years of experience in the construction industry.

Perceptions about the Effectiveness of NMRS

A descriptive analysis of the Likert-scale data indicated a generally positive perception among respondents toward the NMRS. The average score for the perceived level of NMRS effectiveness (on a 5-point scale) was 4.15 (SD = 0.76), suggesting a strong overall agreement among respondents regarding the positive impact of NMRS on safety management.

Perceptions about the Impact of NMRS on Safety Performance Indicators

The study also measured the perceived effectiveness of NMRS on specific safety performance indicators, including accident prevention, safety awareness, feeling of safety, and overall job satisfaction. The findings are as follows:

- 84.5% of respondents affirmed that the NMRS is beneficial in the future prevention of accidents.
- 81.8% believed that it contributed to their personal sense of safety.
- 82.9% stated that it helped raise overall safety awareness and compliance.

- 83.8% opined that it made their units more secure in their performance.
- 84.6% of respondents expressed increased job satisfaction due to a prevailing proactive safety culture in their units.

Correlation Analysis

Pearson correlation analysis was conducted to examine the relationships between the perceived effectiveness of NMRS and various safety performance indicators, as well as its associations with other industrial safety management practices. The strength of the correlation was interpreted using conventional guidelines: $|r| \geq 0.5$ suggests a strong correlation, $0.3 \leq |r| < 0.5$ indicates a moderate correlation, and $|r| < 0.3$ suggests a weak correlation. The results, as detailed in Figure 1 and Figure 2, provide a quantitative measure of the strength and direction of these relationships, with statistical significance determined at the $p < 0.05$ level.

Correlation between NMRS and Safety Performance Indicators

Pearson correlation analysis indicated a statistically significant positive impact of the NMRS on various safety performance indicators, as shown in Figure 1.

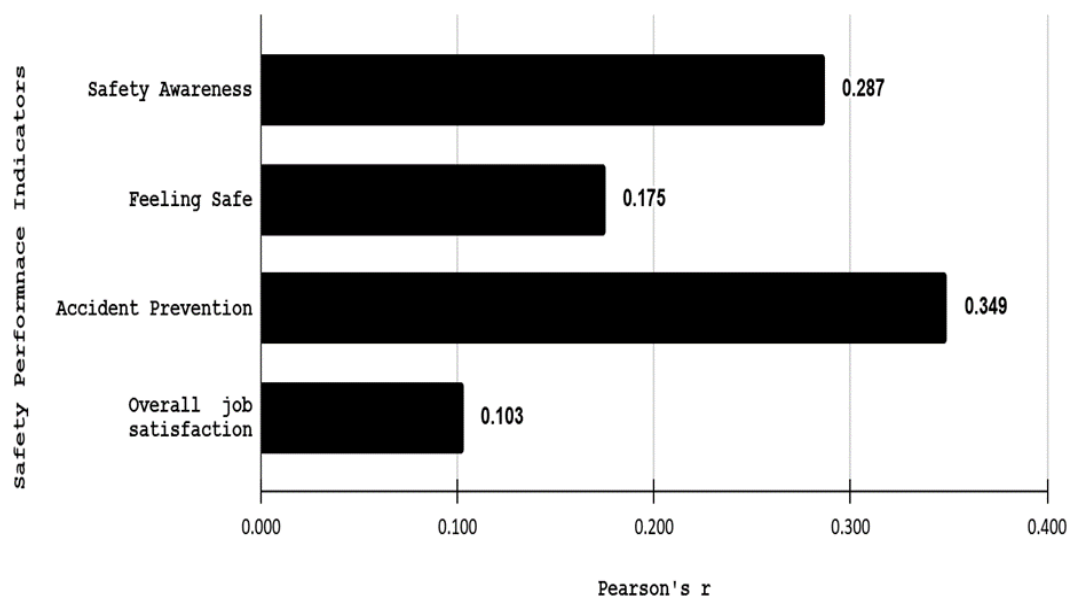


Figure 1: Correlation Between NMRS and Safety Performance Indicators

As depicted in Figure 1, the NMRS demonstrated a moderate positive correlation with accident prevention ($r = 0.349$), followed by safety awareness, feeling of safety, and overall job

satisfaction. These results suggest that near-miss systems are an effective means of improving safety performance on construction sites.

Correlation between Near-Miss System Effectiveness and Other Industrial Safety Management Practices

Pearson correlation analysis also revealed statistically significant and positive associations

between the perceived effectiveness of the NMRS and several other industrial safety management practices in the construction industry, as presented in Figure 2.

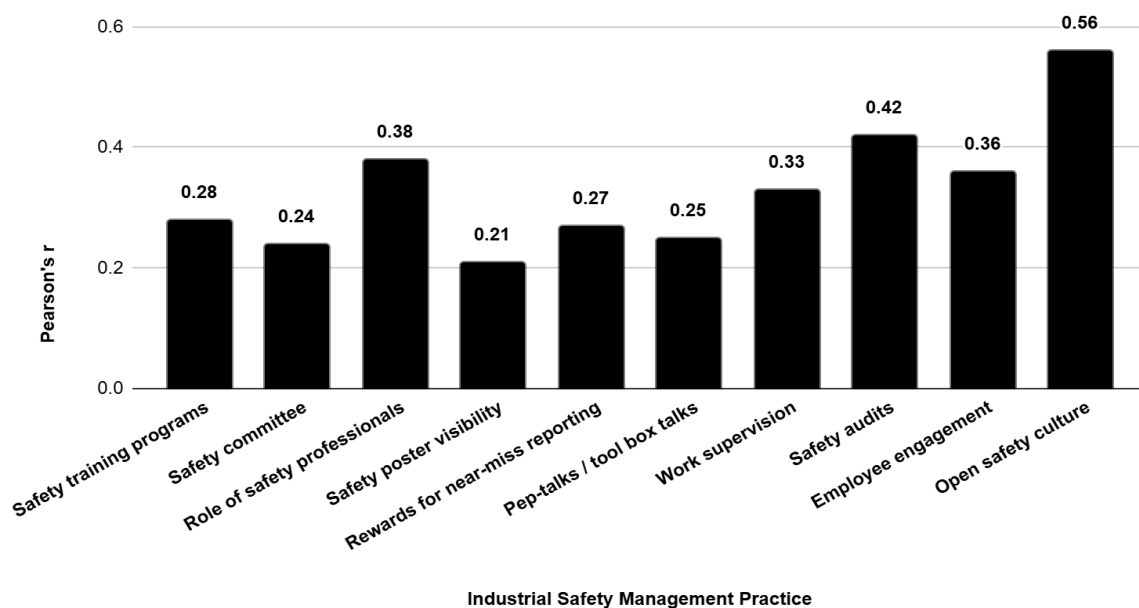


Figure 2: Correlation Between Near-Miss System Effectiveness and Other Safety Management Practices

A high correlation was observed between an open safety culture and near-miss effectiveness ($r = 0.56$), followed by safety audits, the role of safety professionals, and employee involvement in safety matters, as illustrated in Figure 2. These findings further indicate that the effectiveness of NMRS is directly linked to broader employee engagement and a comprehensive review of industrial safety management practices.^{24,31}

Regression Analysis between NMRS Effectiveness and Other Industrial Safety Management Practices

To explore the correlation between NMRS effectiveness and key predictors in more detail, given that there is insight that allows for establishing which predictors are the main determinants of NMRS efficacy, a multiple linear regression analysis was conducted using Jamovi, version 2.5.5.0. The visualization of the results is presented through a pair of charts created using

Google Sheets. Figure 3(a) visually presents a Cobweb (Radar Chart) of the magnitude of relationships between NMRS effectiveness and a number of industrial safety management practices and Figure 3(b), visually presents a Coefficient Plot of the statistical significance and direction of each of these predictors, in greater detail.

Cobweb (radar) chart, as shown in Figure 3(a), visualizes the perceived effectiveness of various industrial safety management practices on NMRS effectiveness at construction sites. The figure evidently shows that Reporting Culture and Safety Audit depicts the highest scores represented in the longest points on the radar. This implies that, according to the perception of the employees in the surveyed construction units, these two factors are viewed as the most effective and influential Industrial Safety Management Practices in supporting a successful NMRS at construction sites.

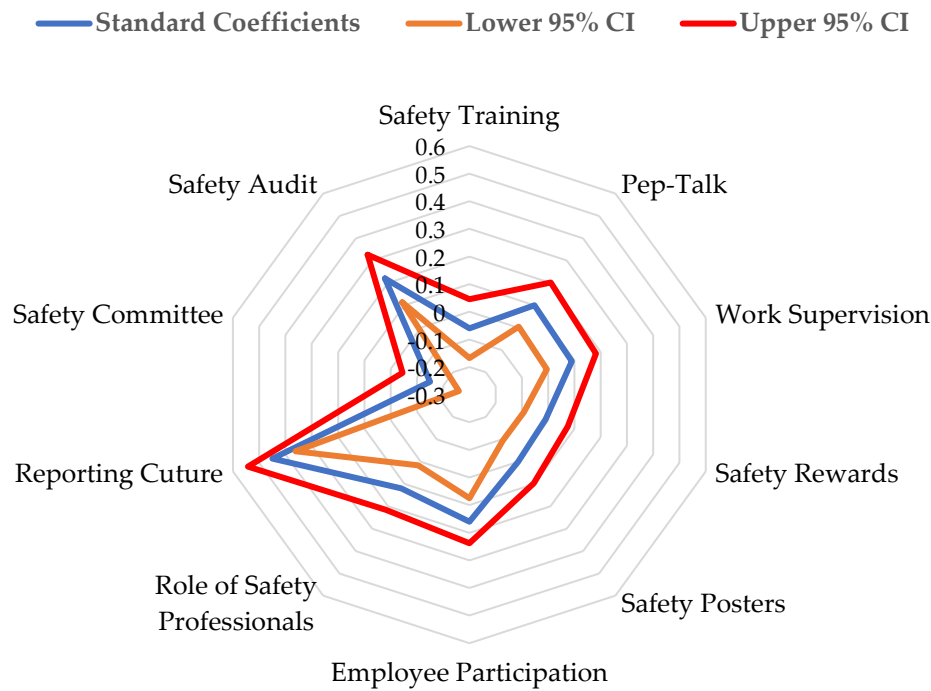


Figure 3 (a): Cobweb (Radar) Chart- Regression Analysis Between NMRS Effectiveness and Other Industrial Safety Management Practices



Figure 3 (b): Coefficient Plot - Regression Analysis Between NMRS Effectiveness and Other Industrial Safety Management Practices

These relationships are shown in greater statistical detail in **Figure 3(b)**, a **Coefficient Plot** of the results of the multiple linear regression. This analysis identified important predictors influencing the effectiveness of NMRS at construction sites. In line with the visual pattern as demonstrated in Figure 3(a), a coefficient plot as

depicted in Figure 3 (b) visualized that amongst all the variables, **reporting culture** exhibited the strongest positive association with NMRS effectiveness ($\beta = 0.45$, $p < 0.001$), indicating that fostering an open and proactive reporting environment significantly enhances NMRS functionality.

Additionally, regression analysis, as shown in Figure 3 (b), also revealed that Safety audits ($\beta = 0.22$, $p < 0.001$) and employee participation ($\beta = 0.16$, $p < 0.001$) also demonstrated substantial positive impacts, highlighting the importance of formal safety evaluations and inclusive engagement in safety processes.³¹ Moderate yet significant contributions were made by the involvement of safety professionals ($\beta = 0.12$, $p < 0.01$), pep talks ($\beta = 0.10$, $p < 0.01$), and work supervision ($\beta = 0.09$, $p < 0.05$), suggesting that continuous motivation, expert input, and supervisory oversight further reinforce NMRS. These findings underscore the multifactorial

nature of NMRS success and the need for a holistic safety management approach.²¹

Trends in Near-Miss and Accident Data (2019–2023)

An analysis of unit-level data from 2019 to 2023 reveals a sustained upward trend in near-miss reporting, consistently accompanied by a gradual decline in recorded workplace accidents (Table 2). The total number of reported near-misses across the three units increased significantly from 96 in 2019 to 189 in 2023, while the total number of accidents decreased from 3 to 1 over the same five-year period.

Table 2: Trends in Near-Miss and Accident Reports (2019–2023)

Year	Unit-A (NMA/Accident)	Unit-B (NMA/Accident)	Unit-C (NMA/Accident)
2019	36 /1	32/1	28/1
2020	59/0	40/0	30/2
2021	75/0	47/1	38/1
2022	79/0	57/0	45/1
2023	85/0	48/1	56/0

Unit-wise Observations:

Unit A demonstrated the most significant improvement, with near-miss reports rising sharply from 36 in 2019 to 85 in 2023.

Simultaneously, reported accidents declined from 1 to 0, indicating effective hazard identification and potential mitigation of risks, as shown in Figure 4.

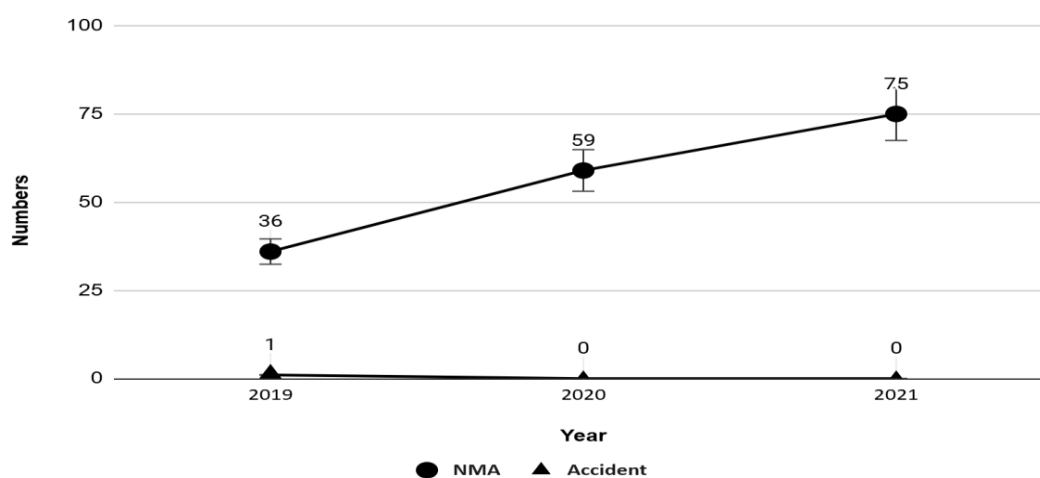


Figure 4: Year-wise Data of Near Misses and Accidents for Unit-A

Unit B had a comparatively stable trend in the number of near misses reported, with a slight increase from 32 in 2019 to 48 in 2023. As shown in

Figure 5, the number of accidents varied, indicating less consistent effectiveness of safety interventions.

Unit C also made positive progress, with the number of near-miss reports increasing steadily from 28 to 56 in 2023. Concurrently, the number of

accidents dropped to 0 in 2023 after reaching 1 in 2019, with slight surges in 2020 and 2022, as reflected in Figure 6.

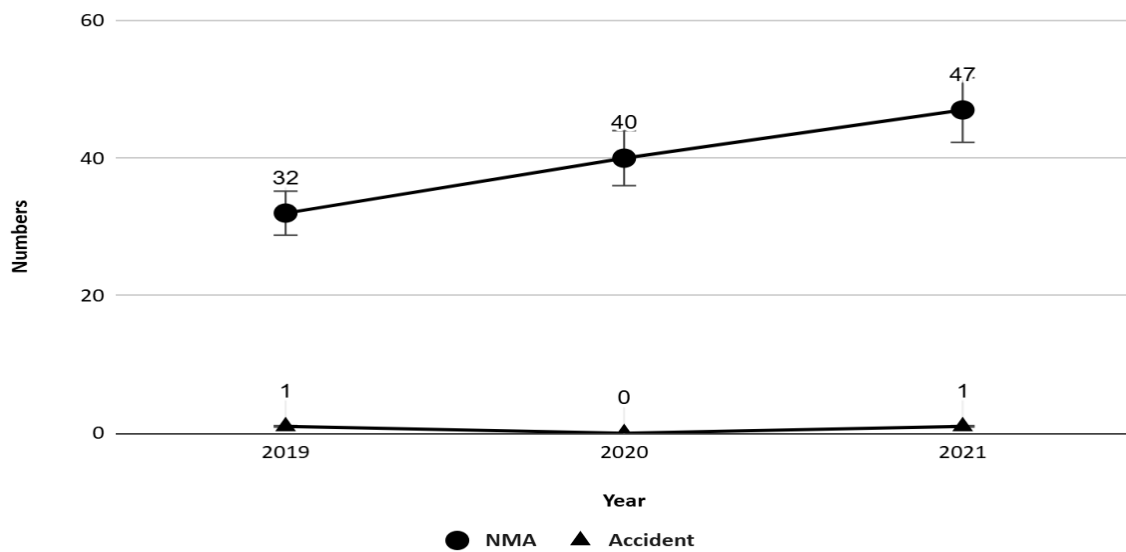


Figure 5: Year-wise Data of Near Misses and Accidents for Unit-B

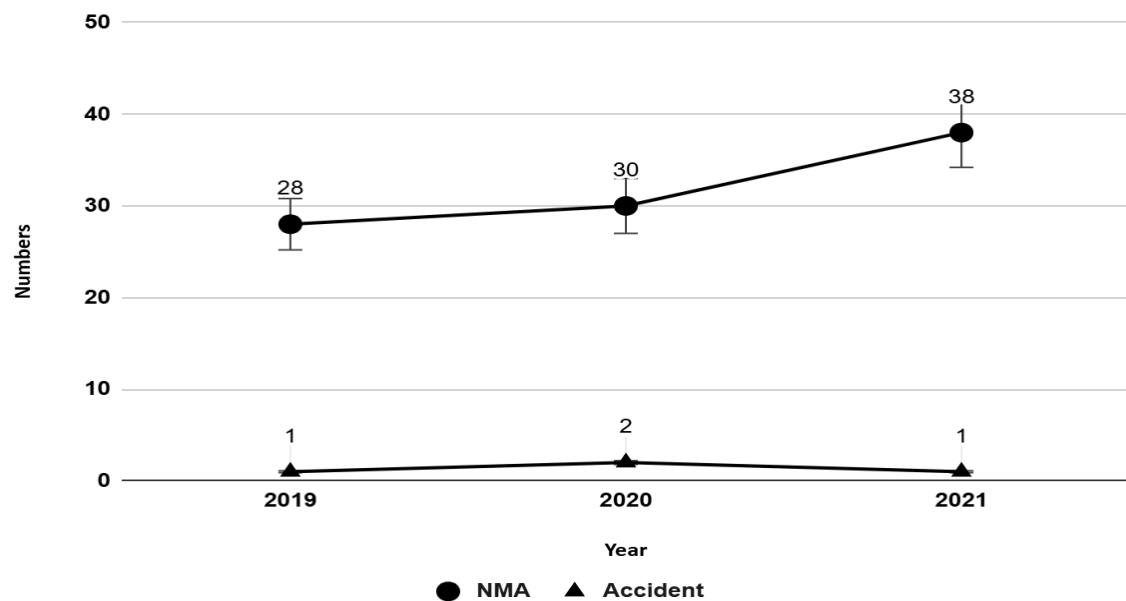


Figure 6: Year-wise Data of Near Misses and Accidents for Unit-C

These patterns align with literature on safety management, which emphasizes that proactive reporting of near-misses is a valuable practice. Such reporting systems, when paired with comprehensive investigation and corrective procedures, can help organizations identify early

Discussion

This paper examined the perceptions of employees of construction towards Near Miss Reporting Systems (NMRS) and their combination with other

warning signs and prevent more severe accidents.^{8,21} Prompting more near-miss reports can reduce injuries, thus identifying near-miss reports as an indicator of proactive safety improvement.^{10,32}

safety management and performance measures to offer an insightful understanding into proactive industrial safety. The research results indicate a

high level of positive perception among employees regarding the effectiveness of NMRS as a safety management tool.³¹ There was a very strong correlation between the scales of perceived NMRS effectiveness and many important safety outcomes such as accident prevention, personal safety awareness, sense of safety, and overall job satisfaction. In addition, NMRS effectiveness exhibited strong correlations with the development of an open safety culture, safety audits, participation by safety professionals, and employee involvement in safety issues.³¹ The reporting culture, safety audits and the participation of employees were also revealed as key drivers of the effectiveness of NMRS through regression analysis. Most importantly, a prospective and historical analysis of five years of selected unit data reflected an inverse relationship between the frequency of near-miss reporting and accident rates, confirming the validity of such perception-based results in practice.³³

The high mean perception score of 4.15, with NMRS effectiveness provided by the study, demonstrates that construction workers perceive the systems as beneficial learning stages and means of intervention. This finding is consistent with available literature, which places near-miss reporting as a dominant leading indicator in monitoring safety performance and a precursor to proactive safety and injury prevention.^{3,4,10,15,20,34} The most significant relationship was between NMRS and accident prevention ($r=0.349$), making it evident that NMRS is a precursor of hazards and preventive measures that inherently lower the number of accidents, as demonstrated by studies that highly effective near-miss management decreases accidents.³⁵ The strong correlation with safety awareness ($r=0.287$) also speaks in favour of NMRS, its importance in modelling a safety-oriented culture and compliance.^{6,15} Although NMRS was found to be positively correlated with a high sense of safety among workers ($r=0.175$), it had a lower impact in association with job satisfaction ($r=0.103$), which implies that even though NMRS instigates strong safety frameworks with its direct effects, its indirect effects on satisfaction should be addressed on a larger scale in terms of organizational strategy.^{2,20,36}

Significant positive relationships between the perceived NMRS effectiveness and other safety management practices, especially open safety culture ($r=0.56$), safety audit ($r=0.42$), the role and place of safety professional ($r=0.38$) and the employee participation on safety matters ($r=0.36$) underline the imperative role of the cultural and procedural parameters.³¹ Its close connection to

open safety culture highlights transparency and proactiveness as the key aspects of effective NMRS,³⁵ which requires non-punitive policies and, possibly, incentive schemes, as well as corresponding training and expandable models of technological implementation.^{16,17,19} The recognition of the major role of safety auditing and professionals corresponds with the supporters of premeditated examinations and professional involvement.^{29,37} On the other hand, correlations with more generalized practices, such as safety rewards ($r=0.268$) or posters ($r=0.212$), indicate their weaker direct effect on the studied parameter in contrast to the embedded cultural-procedural factors, which is consistent with the understanding that accountability and motivation present a more effective intrinsic scaling.^{27,36} These findings confirm the theory of safety climate raised by Zohar,²³ in which their organization culture moulds the employee attitude. The level of worker engagement positively influences quality and quantity of near-miss reports,^{9,30} and it is worth noting that open and non-punitive culture adds additional value.^{15,16} The nature of the organizational policies affects reporting trends in the context of complex construction settings; therefore, specific safety measures are necessary to adjust to the system dynamics.^{26,38} In addition, high correlations with safety training, pep talks/toolbox talks, safety committees, work supervision, rewards/incentives, and visual aids make it clear that NMRS success is embedded within a multidimensional safety management environment.²⁷ Investigating near miss reports can be used to set priorities and align feedback mechanisms to improve safety,³⁴ whereas dissemination of lessons learned can create a proactive safety culture, enhancing accident prevention and performance.²⁶

Practical Implications

This research provides important practical implications for the construction stakeholders. NMRS should be an integral part of a comprehensive safety management system and not treated in isolation.³⁸ It is important to develop an open reporting culture that is fair and based on transparent rewards and non-punitive feedback to enhance the frequency of reporting and build trust.^{16,25} Near-miss identification and reporting should be expressly taught during training, particularly during training of new and contract workers.¹⁹ Active engagement of employees and strong safety leadership from supervisors and professionals must be continually used to encourage reporting as a form of vigilance and

overall good.^{11,31,39} Finally, a culture of positive reinforcement and decisive action regarding near-miss reports will allow achieving an important transformation of reactive to proactive safety management.^{13,14,32}

Conclusion

This paper provides a comprehensive overview of the perceived effectiveness of Near Miss Reporting Systems (NMRS) in enhancing safety on construction sites, as well as their relationship with other organizational safety practices and indicators. The results of a survey conducted among 475 construction workers in India consistently indicate that the NMRS can be perceived as a highly effective method in the accident prevention process, enhancing safety awareness, fostering a sense of safety, and positively influencing job satisfaction.

The statistical analysis revealed robust positive correlations between the perceived effectiveness of NMRS and critical safety management interventions, particularly open safety culture, safety audits, active safety professionals, and effective employee engagement. Although safety incentives and training are also associated with positive outcomes, the information here clarifies that NMRS success is firmly grounded in a more comprehensive, holistic safety management system. An open reporting culture largely depends on the psychology of safety and trust, which in turn is facilitated by leadership that encourages non-punitive reporting and aligns safety strategies with systemic dynamics. The promotion of worker participation brings a dramatic improvement in the quantity and quality of reports.

Most importantly, a five-year historical data analysis revealed that the frequency of near-miss reporting had an inverse proportional relationship with actual accident rates, confirming that proactive reporting brings direct benefits to safety. The findings are relevant to the theory and practice of safety because they enlighten on the essential counterbalance that must exist between the

perceptions of workers, the organizational behaviour and the effectiveness of NMRS in high-risk construction. NMRS can also serve as a priceless tool in active safety management, helping to avoid an accident and develop a culture of prevention. Its effects on more downstream outcomes such as job satisfaction, however, seem more indirect, only becoming manifest with the integration of the strategy in broader strategies. Effective safety audits ($r=0.428$) and active safety professionals ($r=0.381$) turned out to be the greatest facilitators and extrinsic motivators such as posters ($r=0.212$) and incentives ($r=0.268$) were less correlated indicating that NMRS engagement seems to be more strongly reinforced by culture and procedure. Nevertheless, within its limitations, this study conclusively demonstrates that NMRS is a revolutionary tool that can easily be used in enhancing construction safety. The subject of future research should be a scalable and adaptive NMRS model that incorporates advanced analytics.

Limitations and Future Research

The research offers valuable insights, although its cross-sectional nature does not permit the establishment of causal links. Perception data may be subject to self-report bias, and the sample is not extensive in its applicability (18 units, Northern India); thus, the findings may not be generalizable. Future studies should conduct longitudinal research to collect data on changes over time, conduct intervention-based research, and consider the integration of digitalization/technology in reporting. Additionally, a qualitative approach may provide further insight into the motivation of workers to report and their perceptions.

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