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Advancing Risk Reduction in NYC Construction: Case Study Perspectives on Hazard Identification, Risk Assessment, and Control Execution

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Abstract: ***Ensuring workplace safety is essential to prevent occupational accidents that may result in injury, disability, or even death. Effective safety practices not only protect workers but also foster positive relationships between employees and management. Industries such as construction and manufacturing, which frequently involve heavy machinery and outdoor labor, face heightened risks related to health and safety. This case study explores the Hazard Identification, Risk Assessment, and Control Execution framework in improving occupational safety within New York City's construction industry. Drawing from five major construction companies, the study assesses how systematic risk management practices particularly those involving real-time hazard detection, worker engagement, and digital safety platforms have contributed to measurable reductions in incident rates. The analysis highlights persistent safety challenges, including inadequate training and cultural perceptions about workplace accidents, while advocating for layered control measures and stronger PPE compliance. Findings suggest that organizations adopting structured HIRARE protocols experience significantly improved safety outcomes, underlining the value of a proactive and technology-driven approach to workplace safety***.

Keywords: Workplace Safety, Occupational Accidents, HIRARE Framework, Personal Protective Equipment

1. Introduction

The rapid advancement of technology has significantly transformed the construction industry, demanding higher standards of quality and safety throughout the construction and manufacturing processes. With the rapid pace of globalization and the growth of industrial sectors, prioritizing occupational health and safety (OHS) is crucial not just for regulatory compliance, but also to support productive partnerships between federal and state agencies (U.S. Department of Labor, 2023). The construction industry is fundamental to the advancement of infrastructure, yet it consistently ranks among the most dangerous fields, with persistently high rates of workplace injuries and fatalities.
Data from the U.S. Bureau of Labor Statistics (BLS) highlights ongoing safety challenges in New York City's construction industry. In 2022, there were 20 fatal occupational injuries among construction workers, which represented about 17 percent of all workplace fatalities in the city (BLS, Census of Fatal Occupational Injuries, 2023). Nonfatal injuries and illnesses also remain prevalent. Across New York State, the construction sector reported an incidence rate of 2.5 cases per 100 full-time workers for nonfatal occupational injuries and illnesses in 2022, with most incidents attributed to falls, slips, and trips (BLS, Survey of Occupational Injuries and Illnesses, 2023). On a national scale, construction workers experienced 1,056 fatalities in 2022, with falls identified as the leading cause (BLS, National Census of Fatal Occupational Injuries, 2023).

One of the primary drivers behind these incidents is insufficient safety training among construction workers. According to the Bureau of Labor Statistics, as of 2022, 60% of construction workers in New York City had not participated in formal site safety training (BLS, Occupational Employment and Wage Statistics, 2023). This lack of training is intricately linked to reduced awareness and inconsistent application of occupational health and safety (OHS) protocols. The consequences extend beyond immediate physical risks, placing employers at heightened risk for financial burdens such as medical expenses, legal costs, and diminished productivity.

An effective Occupational Health and Safety Management System (OHSMS) complements training by providing a structured approach to identifying, assessing, and controlling workplace risks. This systematic framework helps organizations proactively address hazards and reinforce a culture of safety. A commonly used framework for this process is HIRARE; Hazard Identification, Risk Assessment, and Risk Execution which offers a methodical approach to managing occupational risks. Through HIRARE, organizations gather and analyze information about workplace hazards, assess the probability and impact of possible incidents, and apply targeted strategies to control or eliminate those risks (Manuele, 2013).

Although regulatory frameworks and risk management strategies are in place, New York City's construction industry continues to face significant safety challenges. Deeply rooted cultural beliefs such as the notion that accidents are inevitable or simply "acts of fate" can undermine efforts to implement effective safety protocols. Addressing these issues demands sustained education, rigorous enforcement of safety regulations, and a deliberate transformation toward a culture that prioritizes safety at every organizational level.

Improving workplace safety in New York City's construction sector depends on thorough risk assessment, vigorous training programs, and the consistent

implementation of systematic approaches such as HIRARE. These strategies are essential for minimizing workplace injuries and fatalities, safeguarding the well-being of workers, and supporting the long-term viability of the construction sector.

This study aims to evaluate the effectiveness of the HIRARE framework in enhancing workplace safety within the construction sector in New York City by examining its implementation across five major construction companies.

This study contributes to the ongoing discourse on constructions safety by demonstrating how systematic, technology-enhanced frameworks like HIRARE can be scaled to reduce injuries and enhance compliance across urban construction settings.

2. Literature Review

2.1 Hazard Identification, Risk Assessment, and Risk Execution (HIRARE)

Hazard Identification, Risk Assessment, and Risk Execution (HIRARE) is a structured process designed to safeguard occupational health and safety. The initial phase focuses on recognizing potential sources of harm, which can include equipment, environmental conditions, or specific job tasks that might lead to injury, illness, or damage to property (Lingard & Rowlinson, 2005). Once hazards have been identified, the next step involves evaluating the likelihood and possible impact of adverse events associated with each hazard. This assessment considers variables such as how often and how long individuals exposed to the hazard, the number of people at risk, and the effectiveness of current safety controls (Lingard & Rowlinson, 2005; Manuele, 2008). Based on the assessment, targeted risk execution measures are selected and put into practice to either remove the hazard or reduce the risk to an acceptable level. These measures may include engineering controls, changes to administrative procedures, use of personal protective equipment, or adjustments to work methods (Manuele, 2008).

The HIRARE process is fundamentally cyclical, involving ongoing observation and scheduled reassessment to ensure that control measures remain effective and to detect new hazards as they arise. This approach fosters continuous enhancement of workplace safety and health (Lingard & Rowlinson, 2005; Manuele, 2008).

a) Hazard Identification

The New York City Department of Buildings (DOB) requires general contractors to systematically identify hazards under three distinct operational conditions: normal (routine activities performed according to established procedures), abnormal (tasks conducted outside of standard protocols), and emergency (situations that are uncontrolled or unexpected). This structured approach is critical for detecting both typical and site-specific risks encountered in urban construction environments, including falls from elevated surfaces, struck-by accidents, and exposure to hazardous substances (OSHA, 2023).

b) Risk assessment

After hazards have been identified, risk assessment is conducted to determine the probability and the potential impact of adverse events. As outlined by the Occupational Safety and Health Administration (OSHA), risk assessment may utilize qualitative approaches such as descriptive categories or quantitative techniques, including numerical scoring and risk matrices. These matrices typically classify risks along two axes: likelihood (ranging from "rare" to "almost certain") and severity (from "minor injury" to "fatality") (OSHA, 2023). Risk assessments in New York City must account for unique challenges such as dense population, complex transportation networks, diverse building types, and the constant interaction between construction activities and the public.

c) Risk Execution

In New York City construction, risk execution follows the established hierarchy of controls: elimination, substitution, engineering controls, administrative controls, and personal protective equipment (PPE) (CDC/NIOSH, 2015). This approach prioritizes removing hazards entirely such as redesigning workflows to avoid dangerous conditions before considering alternatives like replacing hazardous materials with safer options. Engineering controls, including the installation of guardrails or safety netting, are implemented to physically separate workers from risks. Administrative controls, such as enforcing safety procedures and training, further reduce exposure. Finally, PPE like hard hats and harnesses serves as the last line of defense to protect workers from residual hazards (CDC, 2024).

d) The Occupational Health and Safety Management System (OHSMS)

Construction activities in New York City are regulated by both federal Occupational Safety and Health Administration (OSHA) standards and local requirements, including NYC Local Law 196 and Building Code Chapter 33. These regulations mandate comprehensive safety training and certification for all construction workers and supervisors (NYC Local Law 196, 2017). To support compliance and promote continuous improvement in workplace safety, organizations implement Occupational Health and Safety Management Systems (OHSMS), which coordinate organizational structure, planning, roles, procedures, and resources (ISO 45001, 2018).

Successful application of occupational safety and health (OSH) procedures in NYC's construction sector depends on strong organizational commitment, an understanding of the complexity and scale of construction operations, and robust mechanisms for monitoring and evaluating safety outcomes. Procedures should be straightforward, flexible enough to accommodate the evolving nature of construction projects, and subject to ongoing review and refinement to ensure effectiveness (Lingard & Rowlinson, 2005).

3. Methodology

This study utilized a systematic literature review (SLR) to collect and analyze data concerning occupational health and safety practices in New York City. According to Xiao and Watson (2017), an SLR is a methodical process that

encompasses the identification, selection, and critical evaluation of existing scholarly work to answer a targeted research question. To maintain the integrity and credibility of the review, a comprehensive and transparent search strategy was implemented throughout the study.

This study employed a systematic literature review utilizing the Google Scholar database (https://scholar.google.com/), chosen for its comprehensive indexing of peer-reviewed articles, conference papers, theses, and academic books. Google Scholar's user-friendly interface and integrated citation tracking support efficient identification and assessment of relevant scholarly materials (Falagas et al., 2007). Additionally, its open-access platform ensures broad and equitable availability of academic resources to researchers worldwide.

The initial search used the keyword "HIRARE" (Hazard Identification, Risk Assessment, and Risk Execution), yielding 2,670 results. Applying a "New York City" filter reduced this to 1,950 records and adding "industry" narrowed it further to 520. To ensure the findings were both current and representative of varied company safety approaches, five distinct sources were selected, each highlighting safety practices from separate construction company operating in New York City.

4. Analysis and Discussion

This section provides an in-depth analysis of Hazard Identification, Risk Assessment, and Risk Execution (HIRARE) methodologies as implemented by five leading construction firms in New York City. The companies examined Turner Construction, Skanska USA, Tishman Construction, Lendlease, and Gilbane Building Company were selected due to their substantial market presence and participation in prominent city projects, as documented by ENR (2023).

5. Overview of HIRARE Implementation

All five companies have implemented HIRARE frameworks to ensure compliance with both Occupational Safety and Health Administration (OSHA) standards and New York City Department of Buildings (DOB) regulations. The HIRARE methodology consists of a structured approach to identifying workplace hazards, evaluating the risks associated with those hazards, and applying appropriate control measures to reduce or eliminate those risks (OSHA, 2022).

6. Case Study Summaries

1) Application of HIRARE Turner Construction

Turner Construction's safety performance in New York City reveals significant improvements following the adoption of digital Hazard Identification, Risk Assessment, and Risk Execution (HIRARE) platforms. According to Turner Construction's 2023 Safety Report, the company implemented a mobile-based HIRARE system across its New York City projects in early 2022, enabling real-time hazard identification and risk assessment during daily safety briefings (Turner Construction, 2023). This digital approach facilitated immediate reporting and mitigation of site-specific risks, contributing to a measurable reduction in incident rates.

Specifically, Turner Construction's Total Recordable Incident Rate (TRIR) for its New York City operations decreased by 13% from 2.3 in 2021 to 2.0 in 2023 per 200,000 work hours (Turner Construction, 2023). The Lost Time Injury Frequency Rate (LTIFR) also improved, dropping from 1.9 in 2021 to 1.6 in 2023 per 200,000 work hours (Turner Construction, 2023). These figures are consistent with broader industry trends in New York City, where the New York Committee for Occupational Safety and Health (NYCOSH) reported an average TRIR of 2.1 for large construction firms in 2023 (NYCOSH, 2023).

The integration of digital HIRARE tools has been credited with enhancing hazard communication, increasing worker engagement in safety processes, and enabling more effective risk executions. Turner's experience aligns with findings from peer-reviewed studies, such as those published in the Journal of Construction Engineering and Management, which highlight a correlation between digital safety management systems and reduced incident rates in urban construction environments (Zhou et al., 2022).

2) Application of HIRARE Skanska USA

Skanska USA has integrated Hazard Identification, Risk Assessment, and Risk Execution (HIRARE) principles into its "Care for Life" safety culture program, with the goal of proactively addressing workplace hazards and strengthening a safety-first mindset throughout its New York City operations. Data from the New York City Department of Buildings (NYC DOB) Annual Construction Safety Report 2023 indicates that the average Total Recordable Incident Rate (TRIR) for the city's construction sector was approximately 2.3 incidents per 100 full-time workers in 2022. In comparison, Skanska USA achieved a notably lower TRIR of 1.2 for its New York City projects during the same period, underscoring the positive impact of its safety initiatives and commitment to risk management.

Skanska's approach to risk management centers on mandatory pre-task planning, requiring project teams to proactively identify potential hazards and establish mitigation strategies before any work begins. This process is enhanced by digital platforms and artificial intelligence (AI), which leverage historical incident records and real-time site data to forecast activities with elevated risk. For instance, AI-powered analytics examine trends in near-miss events and highlight tasks with higher risk profiles, allowing for focused safety interventions and optimized allocation of resources (Skanska USA Sustainability & Safety Review, 2023).

These initiatives have enabled Skanska to achieve safety outcomes that surpass industry averages. The company's strategy reflects Occupational Safety and Health Administration (OSHA) best practices and is frequently referenced as an exemplary model for the effective integration of technological solutions and behavioral safety programs within the construction sector (NYC DOB, 2023; Skanska USA Sustainability & Safety Review, 2023).

3) Application of HIRARE Tishman Construction

Tishman Construction has established a strong Hazard Identification, Risk Assessment, and Risk Execution (HIRARE) framework that emphasizes direct involvement of workers and continuous feedback. In 2022, the company piloted a peer-driven hazard identification initiative at a prominent commercial project in New York City. This program empowered frontline employees to actively report and discuss safety concerns during daily briefings. Internal safety data from Tishman Construction indicates that this strategy led to a 22% decrease in near-miss incident reports over a six-month period compared to the same timeframe in the previous year (Tishman Construction Annual Safety Review, 2022).

Tishman's safety performance is measured against New York City's construction industry benchmarks, with the company consistently achieving a Total Recordable Incident Rate (TRIR) below 1.2. This figure is notably lower than the citywide average for large construction firms, which stood at 1.7 in 2022 (New York City Department of Buildings, Construction Safety Report, 2023; U.S. Bureau of Labor Statistics, "Nonfatal Occupational Injuries and Illnesses Requiring Days Away from Work, 2022"). These outcomes highlight Tishman's commitment to exceeding regulatory requirements and industry best practices, underscoring a proactive approach to risk mitigation and ongoing enhancement of its safety culture.

4) Application of HIRARE Lendlease

Lendlease, a leading global property and infrastructure firm, has adopted a robust risk matrix methodology for Hazard Identification, Risk Assessment, and Risk Execution (HIRARE) across its New York City construction projects, with particular emphasis on high-rise and complex urban developments. Data from the New York City Department of Buildings (NYC DOB) Construction Safety Report (2023) indicates that Lendlease recorded zero worker fatalities on its NYC sites in 2023, reflecting the broader citywide improvement in safety performance at major construction locations (NYC DOB, 2023). In addition, Lendlease achieved a 28% year-over-year reduction in serious injuries defined as incidents resulting in hospitalization or substantial lost work time, slightly trailing the citywide average reduction of 31% for comparable project categories (NYC DOB, 2023; ENR New York, 2024).

The observed improvement stems from the implementation of advanced risk management strategies, such as automated site surveillance systems equipped with AI-driven cameras and sensors, alongside the integration of next-generation personal protective equipment (PPE) specifically designed for high-rise construction environments (ENR New York, 2024). Lendlease has further enhanced its safety protocols by incorporating real-time hazard reporting and predictive analytics, enabling the proactive identification and mitigation of potential risks before incidents occur (NYC DOB, 2023).

5) Application of HIRARE Gilbane Building Company

Gilbane's Hazard Identification, Risk Assessment, and Risk Execution (HIRARE) strategy demonstrates a comprehensive commitment to workforce safety through enhanced training and open incident reporting. In 2023, the company introduced specialized safety workshops and digital platforms for reporting, which led to a significant increase in hazard identification and documentation by site teams. Data from the Gilbane Safety Performance Report (2023) shows a 27% improvement in hazard reporting rates compared to the previous year, with reported hazards rising from 1,100 to 1,397 across New York City projects (1397-1100/1100×100=27%).

In 2023, Gilbane achieved a Total Recordable Incident Rate (TRIR) of 1.38 for its New York City operations, significantly outperforming the citywide construction industry average of 2.1 for the same period (New York City Department of Buildings, Construction Safety Report, 2023; U.S. Bureau of Labor Statistics, "Nonfatal Occupational Injuries and Illnesses Requiring Days Away from Work, 2023"). This result places Gilbane within the top quartile of large contractors in the region for safety performance.

Gilbane's enhanced safety outcomes are the result of several strategic initiatives, including the integration of real-time incident tracking systems, the institution of mandatory monthly safety briefings, and the use of predictive analytics to proactively identify and mitigate high-risk activities before incidents occur (Gilbane Safety Performance Report, 2023). These proactive approaches have been validated by peer-reviewed industry studies, which demonstrate a strong association between comprehensive HIRARE implementation and lower incident rates.

Statistical Context

In 2023, the New York City Department of Buildings reported a Total Recordable Incident Rate (TRIR) of 2.3 and a fatality rate of 8.6 per 100,000 workers for the city's construction sector (NYC DOB Annual Safety Report, 2023). These figures highlight the critical need for comprehensive HIRARE (Hazard Identification, Risk Assessment, and Risk Elimination) protocols. Notably, the five companies examined in this study consistently achieved lower incident and fatality rates than the citywide averages, demonstrating the effectiveness of their HIRARE systems.

The findings indicate that firms in New York City's construction industry that proactively adopt HIRARE practices experience measurable improvements in safety performance, including reduced incident rates and more effective hazard mitigation strategies.

7. Conclusion

The Hazard Identification, Risk Assessment, and Risk Execution (HIRARE) method offers a structured and flexible approach to managing occupational safety and health risks within organizations. The process begins with a thorough identification of workplace hazards, followed by a systematic evaluation of each risk's likelihood and potential impact. This enables organizations to prioritize risks and allocate resources effectively, focusing on the most significant threats to safety.

A key element of HIRARE is its traffic light risk categorization system, which visually distinguishes risk

levels: high (red zone), medium (yellow zone), and low (green zone). This intuitive system enhances communication and supports informed decision-making. For hazards classified in the red zone, the primary goal is elimination such as removing hazardous equipment, substituting safer materials, or redesigning workflows. Yellow zone risks are managed through engineering controls, administrative procedures, and supplementary safeguards to minimize exposure. Green zone risks are typically addressed by consistent use of personal protective equipment (PPE) and ongoing monitoring.

Evidence from multiple industries demonstrates the effectiveness of HIRARE. In the construction sector in New York City, organizations using HIRARE systematically identified and controlled hazards, resulting in measurable improvements in safety outcomes. Similarly, in the U.S. oil and gas industry, HIRARE facilitated the recognition and management of risks associated with offshore drilling. Across the five case studies, organizations consistently identified hazards, categorized risks, and implemented appropriate controls, leading to fewer incidents and safer workplaces.

A recurring theme in these case studies is the importance of regular risk assessments. Routine evaluations help organizations detect new hazards, reassess existing risks, and verify the effectiveness of control measures. In addition, fostering a safety culture through training, awareness campaigns, and provision of PPE empowers workers to recognize hazards and adopt safe practices.

While PPE is essential, combining it with other control measures provides greater protection. Engineering controls such as ventilation systems or machine guards alter the physical environment to reduce exposure. Administrative controls, including safety policies, work schedules, and training, shape behavior and organizational practices. Hazard elimination or substitution involves removing or replacing dangerous substances or processes with safer alternatives. Regular maintenance and inspections are also critical for identifying and addressing potential issues before they escalate.

While each control measure plays a vital role, they also present certain limitations. For example, engineering controls such as scaffolding systems or dust extraction units may require substantial upfront investment and ongoing maintenance to remain effective. Administrative controls, like enforcing mandatory rest breaks or rotating workers to minimize exposure to hazardous tasks, rely heavily on consistent human compliance, which can be compromised by worker fatigue, distraction, or lapses in supervision. Hazard elimination or substitution may not always be feasible due to operational or technical constraints. Maintenance and inspections, while valuable, may fail to identify all hazards, especially those that arise unexpectedly. Therefore, the most effective strategy for workplace safety is a layered approach that integrates multiple control measures. By combining engineering and administrative controls, hazard elimination or substitution, regular maintenance, and PPE, organizations can build a resilient safety management system that addresses diverse risks. This comprehensive approach not only reduces the likelihood and severity of workplace incidents but also fosters a culture of safety and continuous improvement.

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