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Evaluate Safety Management at High Rise Building.

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Abstract : *The research on high-rise construction site safety in Pune involved a detailed questionnaire distributed to key personnel, analyzing responses with SPSS software. The study identified five major factors impacting safety: management, unsafe working methods, unique industry challenges, human and natural elements, and unsafe equipment. Key issues included poor inspection practices, lack of warnings, inadequate policies, and disobedience of procedures, all linked to high accident rates. Recommendations include regular inspections, enhanced warning systems, robust safety policies, and strict adherence to procedures. Proper site management, adequate illumination, worker education, and motivation were also emphasized. Ergonomic considerations, proper ventilation, and emergency preparedness were highlighted to protect workers from health hazards and natural disasters, providing a comprehensive approach to improve safety on high-rise construction sites.*

Index Terms: *High Rise building, safety, SPSS.*

1. INTRODUCTION:

Effective planning and management are crucial to prevent unplanned or uncertain events, particularly in the construction industry, where accidents can occur unpredictably. Safety management, therefore, becomes essential to safeguard workers from injuries on job sites. Safety measures need to be integrated throughout all phases of a project, starting from the estimation phase to the completion of the work. The construction industry, despite its hazardous and physically demanding nature, significantly contributes to the economies of many developing countries. However, it faces substantial challenges due to the migration of workers seeking employment, which can lead to communication gaps, religious differences, and cultural disparities, all impacting safety performance.

In India, the enforcement of safety laws is often lax, and construction safety is a relatively new concept. Contractors frequently ignore basic safety rules, and there is a lack of stringent enforcement by authorities. To address these issues, the Indian government has enacted legislation such as the Compensation Act of 1923 (amended in 1962), the Minimum Wages Act, and the Workmen's and Contract Labor (Regulation and Abolition) Act of 1970. The National Building Code of India 2005 also provides guidelines for regulating construction activities. Despite these efforts, labor safety is often deprioritized by builders, contractors, and engineers, leading to high rates of occupational accidents and fatalities. Therefore, raising awareness about health and safety among employees and workers is crucial to enhance the effectiveness of safety practices.

The International Labor Organization (ILO) reports that 337 million occupational accidents occur annually worldwide, resulting in the deaths of 2.31 million workers and injuries to up to 160 million workers, causing an economic loss of around $1.2 trillion. In the Indian construction sector alone, fatalities range from 11,641 to 22,080 annually, contributing approximately 24.20% of occupational fatalities in the country. This high rate

of accidents is primarily due to the inadequate implementation of health and safety legislation and practices. Therefore, it is imperative to study the factors that cause accidents and develop strategies to reduce them, ultimately saving workers' lives and reducing economic losses.

2. LITERATURE REVIEW:

Identifying the root causes of accidents and evaluating safety practices in high-rise building construction is critical for improving safety standards and reducing incidents. Several factors, such as organizational structure, supervision, management, and site conditions, significantly impact health and safety practices. These factors can lead to incidents like falls from heights, slips, electrocution, being struck by objects, falling materials, and overexertion, all of which can result in fatal accidents. To mitigate these risks, various models and strategies have been proposed and evaluated in recent research. Below is a summary of key findings from the literature on safety at high-rise construction sites.

2.1 Risk Factors and Mitigation Strategies

Research has identified several critical risk factors in high-rise construction. Lingard, Cooke, and Blismas (2012) highlighted falls from heights, being struck by falling objects, and equipment-related accidents as the most common hazards. Their study emphasized the importance of fall protection systems, rigorous training programs, and continuous monitoring to reduce these risks. Zhou, Goh, and Li (2015) stressed the significant role of personal protective equipment (PPE) in ensuring worker safety. They found that proper use of helmets, gloves, harnesses, and other protective gear significantly reduces injury incidence, although compliance with PPE usage was inconsistent. This inconsistency suggests a need for better enforcement and education.

2.2 Safety Culture and Management Commitment

Choudhry, Fang, and Rowlinson (2016) reiterated the importance of a strong safety culture and management commitment in achieving high safety standards. Their findings indicated that projects with proactive safety management practices, where safety is prioritized by all levels of staff, tend to have lower accident rates. This underscores the necessity of cultivating a safety-first mindset among all stakeholders. Additionally, technological advancements play a significant role in improving safety. Li, Lu, and Hsu (2019) demonstrated how Building Information Modeling (BIM), drones for site inspections, and wearable sensors for real-time health monitoring enhance safety by identifying potential hazards early, improving communication, and providing valuable data for decision-making.

2.3 Training and Workforce Education

Effective safety training programs are crucial for maintaining high safety standards. Cheng, Ryan, and Kelly (2017) found that regular, comprehensive training makes workers more aware of potential hazards and better equipped to handle emergencies. They recommended continuous education and regular safety drills as essential components of any safety program. Case studies provide practical insights into the application of safety measures. Zhang, Teizer, and Lee (2018) analyzed accidents on high-rise construction sites and identified key lessons, such as the importance of thorough pre-construction planning, regular safety audits, and implementing corrective actions based on audit findings.

2.4 Psychological and Ergonomic Factors

Worker fatigue, stress, and ergonomic issues significantly impact safety in high-rise construction. Wang and Rajendran (2020) suggested improving working conditions, providing mental health support, and designing ergonomic workstations to reduce accidents and improve overall safety. Regulatory compliance also plays a crucial role. Gambatese, Rajendran, and Behm (2020) found that strict adherence to safety regulations and standards leads to significant reductions in accident rates. They emphasized the role of regulatory bodies in enforcing compliance and the need for regular updates to safety standards to reflect technological advancements and new safety insights.

2.5 Economic Implications and Future Trends

Investing in safety measures on high-rise construction projects has significant economic implications. Hallowell, Hinze, and Gambatese (2018) found that while there is an upfront cost associated with implementing

comprehensive safety programs, the long-term benefits, including reduced accident-related costs, improved worker productivity, and enhanced reputation, far outweigh the initial investments. Looking to the future, Wang, Goh, and Love (2021) discussed emerging trends in construction safety, such as the integration of artificial intelligence (AI) and robotics. Their study suggested that these technologies could further revolutionize safety practices by automating hazardous tasks, improving real-time hazard detection, and enhancing data analysis capabilities to predict and prevent accidents.

2.6 Accident Causation Models

Various accident causation models help identify the factors leading to accidents. These models include:

1. **Single Event Concept:** Attributes blame to the individual involved in the accident, focusing on individual accountability but with limited consideration of systemic or external factors.
2. **Determinant Variable Concept:** Uses statistical analysis to identify accident causation factors, requiring extensive data collection and statistical tools for data analysis.
3. **Domino Theory:** Views accidents as a series of events in a sequence, emphasizing the identification of events in the accident sequence and measures to eliminate or control these events.
4. **Fault Tree Analytical Methodology (FTA):** Uses a logical flowchart to map out all possible accident causes, involving the creation of a fault tree diagram and detailed analysis of potential failure points and interactions.
5. **Energy Barriers Targets Model:** Focuses on controlling energy release to prevent accidents, requiring analysis of energy flows and potential hazards, and implementation of barriers to control energy release.
6. **Management Oversight and Risk Tree (MORT):** Identifies contributing factors and failed barriers in accidents, requiring comprehensive system analysis and evaluation of failed barriers and factors.
7. **Petersen's Multiple Causation Model:** Considers human error as a primary cause of accidents, involving the identification of overload, traps, and decision-making errors, and analysis of factors leading to each type of error.
8. **Energy Damage Model:** Assesses potential energy release and its impact on safety, requiring evaluation of energy sources and potential hazards, and implementation of controls to prevent hazardous energy release.

2.7 Global and Regional Statistics

Accident statistics from various regions highlight the prevalence and causes of accidents in high-rise construction. In Europe, approximately 20% of all workplace accidents occur in the construction sector, with high-rise projects being a significant part. In the United States, the construction sector accounts for 21% of all workplace deaths. Falls are the leading cause of accidents in high-rise construction in Thailand and Malaysia, and China has a high rate of accidents in high-rise projects due to the need for improved safety management. In India, states like Maharashtra, Tamil Nadu, Karnataka, Delhi, Gujarat, and West Bengal report significant percentages of construction-related accidents, primarily due to falls and structural collapses.

The root causes of accidents and implementing effective safety practices in high-rise construction requires a multifaceted approach. This includes rigorous training, adherence to safety regulations, technological advancements, strong safety culture, and continuous monitoring and evaluation. By learning from past incidents and leveraging new technologies, the construction industry can enhance safety standards and reduce the incidence of accidents in high-rise projects.

3. METHODOLOGY

3.1 Methodology adopted for this dissertation work is as follows, Figure No.1

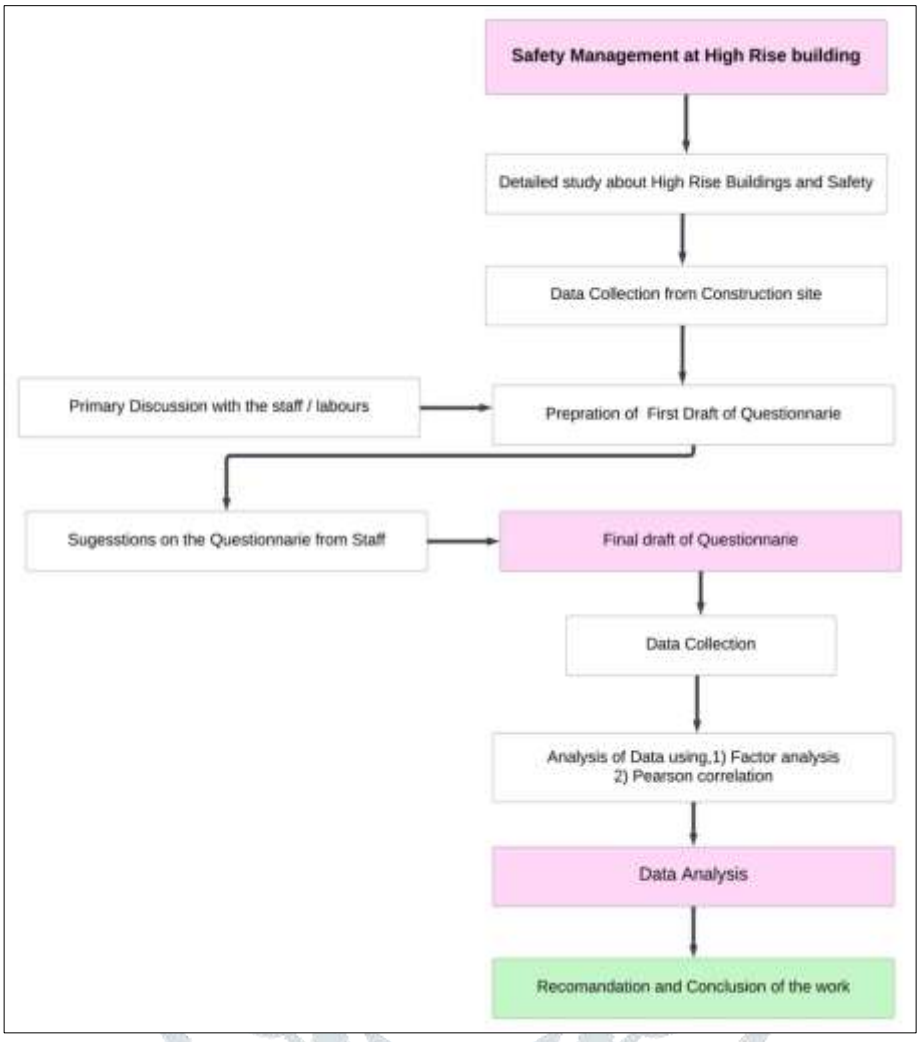

Figure No.1Methodology of the work

4. DATA COLLECTION AND ANALYSIS:

This study employed a comprehensive data collection approach to investigate safety practices at high-rise building construction sites in Pune. A review of existing literature on construction safety, including reports from the Health and Safety Executive and various academic journals, was conducted to inform the development of a detailed questionnaire. Following this, a pilot study was performed to refine the questionnaire, ensuring its effectiveness in capturing relevant safety insights.

The finalized questionnaire was distributed to key personnel involved in the construction projects, including Project Managers, Site Engineers, and Safety Officers. It consisted of 21 variables aimed at gathering in-depth information on safety practices and perceptions on the construction sites. The responses were collected using a Likert Scale, with options ranging from "Strongly Agree" to "Strongly Disagree," allowing for nuanced feedback on various safety aspects.

To analyze the collected data, SPSS software was utilized. This involved applying Cronbach's Alpha to assess the internal consistency of the questionnaire, which yielded a high reliability score of 0.916, indicating excellent internal consistency. Factor Analysis, including Principal Component Analysis (PCA) and Varimax Rotation, was performed to identify and categorize underlying factors affecting safety practices. The Kaiser-

Meyer-Olkin (KMO) Measure of Sampling Adequacy was 0.652, and Bartlett's Test of Sphericity was significant ($p < 0.000$), validating the suitability of the data for factor analysis.

The analysis revealed five major factors influencing safety: Management, Unsafe Methods of Working, the Unique Nature of the Industry, Human and Environmental Factors, and Unsafe Equipment. Pearson Correlation coefficients were calculated to determine the significance and strength of relationships between variables, with findings indicating that poor inspection, inadequate warnings, and poor safety policies were the most significant factors affecting safety at the construction sites.

CONCLUSION:

The research into safety hazards at high-rise building construction sites has identified several critical factors influencing accident rates. The analysis reveals that poor inspection practices, lack of warnings, and inadequate safety policies have the highest correlations with accidents, indicating these are primary areas of concern. Specifically:

1. **Inspection Practices**: Poor inspection (correlation coefficient 0.786) emerged as the most significant factor. Regular inspections—ideally daily or weekly—are essential to ensure adherence to safety standards and identify potential hazards promptly.
2. **Warning Systems**: The absence of effective warnings (correlation coefficient 0.772) significantly contributes to accidents. Implementing robust warning systems to alert workers about hazards is crucial to preventing injuries.
3. **Safety Policies**: Inadequate safety policies (correlation coefficient 0.758) also play a major role in accidents. Construction companies must establish and enforce comprehensive safety policies, including mandatory use of safety equipment and compensation measures for workers.

Additional critical factors include:

- **Procedural Compliance**: Disobedience of established procedures (correlation coefficient 0.757) and lack of experience among workers (correlation coefficient 0.734) necessitate rigorous training programs and adherence to safety procedures.
- **Site Management**: Poor site management (correlation coefficient 0.705) and inadequate illumination (correlation coefficient 0.696) further exacerbate safety risks, highlighting the need for effective site management practices and proper lighting.
- **Education and Motivation**: The lack of education (correlation coefficient 0.691) and insufficient motivation (correlation coefficient 0.687) among workers stress the importance of educational programs and motivational incentives to enhance safety compliance.

The Cronbach's Alpha score of 0.916 confirms the internal consistency and reliability of the data, while factor analysis has effectively identified critical areas requiring improvement. Recommendations derived from these findings include:

- Conducting frequent inspections and improving communication of hazards.
- Enhancing safety policies and ensuring adherence to procedures.
- Providing comprehensive training and improving site management.
- Addressing ergonomic issues and ensuring proper ventilation.

By implementing these recommendations, construction companies can substantially improve safety outcomes, mitigate risks, and ensure a safer working environment at high-rise building construction sites.

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