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Impact of Time Management on Safety Performance in Construction Projects

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Abstract *— Effective time management is a critical factor in the successful delivery of construction projects. In the construction industry, project schedules are closely linked to workforce productivity, operational efficiency, and site safety. When projects are subjected to schedule pressures, workers may be compelled to accelerate tasks, overlook safety procedures, or operate under stressful conditions, thereby increasing the risk of accidents and injuries. This research investigates the impact of time management practices on safety performance in construction projects. It explores the role of scheduling techniques such as the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) in promoting safer project execution through enhanced coordination, monitoring, and resource allocation. Using secondary data from project management literature and scheduling-based Health, Safety, and Environment (HSE) planning studies, the research analyzes the relationship between project timelines and safety outcomes. The findings indicate that effective scheduling enhances safety awareness, reduces unsafe behaviors, and supports the successful implementation of HSE measures. The research concludes that incorporating safety considerations into project schedules is essential for minimizing workplace hazards and improving overall project performance.*

Keywords *— **Time Management, Construction Safety, Safety Performance, Project Scheduling, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Health, Safety and Environment (HSE), Risk Management, Workplace Safety, Construction Project Management.***

I. BACKGROUND

Construction projects involve a wide range of interconnected activities that require careful planning, coordination, monitoring, and control. Unlike many other industries, construction operations are performed in dynamic environments where work conditions continuously change throughout the project lifecycle. The involvement of heavy machinery, elevated work areas, hazardous materials, multiple subcontractors, and large workforces increases the complexity of project execution and creates significant occupational health and safety risks. As a result, project managers must ensure that construction activities are completed not only within the established budget and schedule constraints but also in a manner that safeguards workers, equipment, and the surrounding environment.

In recent years, the construction industry has experienced rapid growth driven by urbanization, infrastructure development, and increasing demand for residential and commercial projects. However, despite technological advancements, construction continues to rank among the most hazardous industries worldwide. According to reports from international organizations such as the International Labour Organization (ILO) and Occupational Safety and Health Administration (OSHA), a significant proportion of workplace injuries and fatalities occur within the construction sector. Many of these incidents are associated with inadequate planning,

insufficient supervision, poor communication, and schedule-related pressures. Consequently, effective time management has emerged as a critical factor not only for project success but also for ensuring workplace safety and health.

Fig.1: Five-time management challenges in construction

(Source: https://firstbit.ae/blog/guides/time-management-strategies-in-construction-boosting-efficiency-and-productivity-on-the-job-site/)

Time management refers to the systematic process of planning, organizing, scheduling, monitoring, and controlling project activities to achieve completion within a specified timeframe. In construction project management, time is considered one of the three fundamental project constraints, alongside cost and quality. Effective time management ensures that project tasks are sequenced appropriately, resources are allocated efficiently, and project milestones are achieved according to schedule. More importantly, proper scheduling provides sufficient opportunities for safety inspections, workforce training, hazard assessments, emergency preparedness activities, and implementation of Health, Safety, and Environment (HSE) requirements.

When construction projects experience delays, managers often face pressure to accelerate activities to recover lost time. This situation may result in compressed schedules, overtime work, workforce fatigue, and increased stress levels among employees. Under such conditions, workers may rush tasks, bypass safety procedures, ignore personal protective equipment requirements, or take shortcuts to meet deadlines. Research has consistently shown that schedule pressure is strongly associated with unsafe behavior, reduced situational awareness, and increased accident rates. Therefore, project schedules must be designed not only to maximize productivity but also to maintain safe working conditions throughout project execution.

Modern construction management recognizes that safety should be integrated into project planning from the earliest stages rather than treated as a separate activity. This concept is often referred to as "Safety by Design" or "Prevention through Design." By incorporating safety considerations into project schedules, managers can proactively identify high-risk activities and allocate adequate time for preventive measures. Such measures may include safety inductions, toolbox talks, risk assessments, permit-to-work systems, equipment inspections, emergency response drills, and corrective action implementation. Integrating these activities into the project timeline ensures that safety remains an essential component of project operations rather than an afterthought.

Fig.2: Time Management Strategies for Construction Project Managers

(Source: https://www.slideteam.net/time-management-strategies-for-construction-project-managers.html)

The HSE scheduling assignment developed for Villas Construction provides a practical example of how safety-related activities can be embedded within a project schedule. The project incorporated a variety of safety management tasks, including workforce induction programs, hazard identification exercises, risk assessments, toolbox meetings, site inspections, safety audits, incident investigations, and corrective action reviews. These activities were scheduled alongside construction operations to ensure that adequate resources and time were available for their completion. The inclusion of HSE activities within the

project timeline demonstrated how effective planning can contribute to both operational efficiency and workplace safety.

To support project scheduling and decision-making, construction managers commonly utilize scheduling techniques such as the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT). The Critical Path Method identifies the sequence of project activities that directly influence overall project duration. Activities located on the critical path have no scheduling flexibility, meaning that delays in these tasks will delay project completion. By identifying critical activities, project managers can prioritize resources, monitor progress more effectively, and ensure that safety requirements are not compromised during critical operations.

Similarly, the Program Evaluation and Review Technique (PERT) provides a probabilistic approach to scheduling by considering uncertainty in activity durations. PERT utilizes optimistic, pessimistic, and most likely time estimates to calculate expected project durations and assess schedule risks. This methodology is particularly valuable in construction projects where weather conditions, material availability, labor productivity, and unforeseen site conditions can significantly influence project timelines. By incorporating uncertainty into project planning, managers can develop realistic schedules that reduce pressure on workers and improve overall safety performance.

The application of CPM and PERT within the Villas Construction project highlighted the importance of integrating safety considerations into schedule analysis. Critical safety-related activities such as risk assessments, inspection programs, and emergency preparedness measures were identified as essential components of project success. The analysis demonstrated that delays in safety activities could negatively impact both project performance and worker protection. Consequently, safety-related tasks were treated as project priorities rather than secondary administrative requirements.

Recent developments in digital construction technologies have further enhanced the relationship between time management and safety performance. Building Information Modeling (BIM), 4D scheduling, artificial intelligence (AI), drone monitoring, and Internet of Things (IoT)-based safety systems are increasingly being used to improve project planning and risk management. 4D BIM, which integrates three-dimensional models with project schedules, enables project teams to visualize construction sequences and identify potential safety hazards before work begins. This proactive approach allows managers to modify schedules, improve site logistics, and implement preventive measures that reduce workplace risks.

Artificial intelligence and predictive analytics have also emerged as valuable tools for construction safety management. By analyzing historical project data, AI systems can identify patterns associated with accidents, delays, and productivity issues. Project managers can then use this information to adjust schedules, allocate resources more effectively, and implement targeted safety interventions. Similarly, wearable devices and IoT sensors provide real-time monitoring of worker locations, environmental conditions, and equipment performance, allowing safety concerns to be addressed promptly before incidents occur.

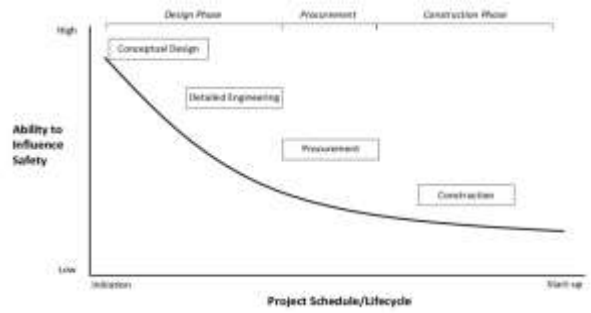

Fig.3: Time-safety influence curve, adapted and modified from Szymberski (1997)

(Source: Karakhan, Ali & Rajendran, Sathy & Gambatese, John. (2018). Validation of Time-Safety Influence Curve Using Empirical Safety and Injury Data—Poisson Regression. 10.1061/9780784481288.038.)

Another important aspect of time management is resource optimization. Construction projects require the coordination of labor, equipment, materials, and subcontractors. Poor scheduling can result in resource conflicts, idle time, congestion, and increased exposure to workplace hazards. Conversely, effective scheduling ensures that resources are available when needed, reducing delays and minimizing unsafe site

conditions. Proper resource allocation also enables project teams to conduct safety inspections, maintenance activities, and training programs without disrupting project progress.

Communication and coordination represent additional benefits of effective scheduling. Construction projects typically involve multiple stakeholders, including owners, consultants, contractors, subcontractors, suppliers, and regulatory authorities. Project schedules serve as communication tools that clarify responsibilities, establish expectations, and coordinate activities among all participants. When safety milestones are integrated into project schedules, stakeholders gain greater visibility of safety requirements and become more accountable for their implementation. This enhanced coordination contributes to a stronger safety culture and improved compliance with HSE regulations.

Furthermore, effective time management supports regulatory compliance and organizational sustainability objectives. Many national and international safety standards require documented planning, risk assessment, and monitoring processes. Integrating HSE activities into project schedules facilitates compliance with standards such as ISO 45001 Occupational Health and Safety Management Systems and ISO 14001 Environmental Management Systems. Compliance not only reduces legal and financial risks but also enhances organizational reputation and stakeholder confidence.

The findings from the Villas Construction HSE scheduling exercise demonstrate that time management and safety performance are closely interconnected. Well-structured schedules provide adequate time for safety planning, hazard identification, workforce training, and corrective actions. The use of CPM and PERT techniques improves project visibility, supports proactive decision-making, and reduces the likelihood of schedule-related safety risks. Furthermore, integrating safety activities into project timelines promotes accountability, strengthens HSE implementation, and contributes to a safer working environment.

In conclusion, effective time management is a fundamental requirement for successful construction project delivery and workplace safety. Construction schedules should not focus solely on productivity and project completion dates but should also incorporate comprehensive safety management activities. Modern scheduling techniques, combined with emerging digital technologies, provide powerful tools for balancing project efficiency and worker protection. The Villas Construction case research illustrates that integrating HSE activities into project schedules enhances operational control, minimizes workplace hazards, and improves overall project performance. As construction projects continue to increase in complexity, the integration of time management and safety planning will remain essential for achieving sustainable, efficient, and safe project outcomes.

II. LITERATURE REVIEW

The construction industry continues to be one of the most significant contributors to economic growth and infrastructure development worldwide. However, it is also recognized as one of the most hazardous industries due to the dynamic nature of construction sites, the involvement of heavy equipment, work at heights, and the coordination of multiple subcontractors. As construction projects become increasingly complex, effective project management practices have become essential to ensure successful project delivery while maintaining acceptable levels of workplace safety. Among the key dimensions of project management, time management has received considerable attention because it directly influences productivity, resource utilization, project performance, and worker safety. Recent studies have emphasized that project schedules should not only focus on achieving completion deadlines but should also incorporate safety requirements and risk management measures throughout the project lifecycle (PMI, 2023; Salzano et al., 2024).

Time management is generally defined as the systematic process of planning, scheduling, monitoring, and controlling project activities to ensure that project objectives are achieved within the specified duration. According to Kerzner (2022), effective time management enables project managers to coordinate resources, establish activity sequences, monitor progress, and respond proactively to project uncertainties. Construction projects rely heavily on scheduling tools such as Gantt Charts, the Critical Path Method (CPM), and the Program Evaluation and Review Technique (PERT) to manage project timelines

and allocate resources effectively. Efficient scheduling reduces uncertainty, improves communication among stakeholders, and facilitates better coordination of project activities. Recent research by Egbebi (2024) highlighted that advanced planning and scheduling practices significantly improve project performance by reducing delays, enhancing resource utilization, and supporting timely decision-making. Furthermore, schedule management allows project managers to allocate sufficient time for safety inspections, workforce training, hazard assessments, and emergency preparedness activities, thereby contributing to safer construction operations.

Construction safety performance refers to the effectiveness of measures implemented to prevent workplace accidents, injuries, illnesses, and unsafe working conditions. Safety performance is commonly measured through indicators such as accident frequency rates, lost-time injuries, safety compliance, near-miss reporting, and worker participation in safety programs. The construction sector consistently records higher occupational accident rates than many other industries, making safety management a critical concern for project stakeholders. A systematic review of occupational health and safety in construction projects found that inadequate planning, poor coordination, insufficient supervision, and weak project management practices remain major contributors to workplace incidents. The research emphasized that safety management should be integrated into project planning and execution processes rather than treated as an independent function.

Several researchers have identified a direct relationship between project scheduling and safety performance. Schedule pressure has been repeatedly recognized as a major factor contributing to unsafe work behavior. When projects experience delays, managers often attempt to recover lost time through schedule compression, overtime work, and accelerated activity execution. Although these measures may improve short-term productivity, they frequently increase worker fatigue, stress, and exposure to hazards. Research conducted on construction worker health and safety found that irregular schedules, extended working hours, and insufficient recovery periods negatively affect workers' physical and mental well-being, resulting in reduced concentration, impaired decision-making, and increased accident risk. The research concluded that realistic scheduling and workload management are essential for maintaining safe working environments.

The relationship between time management and safety performance can be explained through several mechanisms. First, effective scheduling provides sufficient time for safety training and competency development. Workers who receive regular safety training demonstrate greater awareness of hazards and improved compliance with safety procedures. Second, proper scheduling facilitates hazard identification and risk assessment activities before work begins. Third, realistic schedules reduce the likelihood of excessive overtime and worker fatigue. Finally, well-structured schedules improve communication and coordination among project stakeholders, ensuring that safety requirements are clearly communicated and implemented throughout project execution. Studies examining construction safety climate have shown that proactive planning and phase-specific safety interventions significantly improve safety performance and worker engagement.

Modern construction management increasingly emphasizes the integration of Health, Safety, and Environment (HSE) requirements into project schedules. The concept of Prevention through Design (PtD) advocates incorporating safety considerations during project planning rather than addressing hazards after construction activities commence. In practice, this approach requires project schedules to include safety-related activities such as workforce induction, toolbox talks, risk assessments, permit-to-work procedures, safety inspections, emergency drills, and corrective action programs. The Villas Construction HSE schedule reflects this approach by integrating emergency drills, toolbox meetings, inspections, and hazard assessment activities into the overall project timeline. Contemporary research supports this practice and suggests that projects that formally schedule safety activities experience improved safety compliance and lower accident rates than projects where safety is managed separately from project planning.

The Critical Path Method remains one of the most widely used scheduling techniques in construction management. CPM enables project managers to

identify activities that directly influence project completion and prioritize resource allocation accordingly. Although CPM is primarily designed to optimize project duration, recent research suggests that it can also contribute to safety management when safety-critical activities are incorporated into the project network. By identifying high-risk and time-sensitive activities, project managers can allocate additional supervision, inspections, and safety controls to critical operations. Similarly, the Program Evaluation and Review Technique (PERT) contributes to safety management by accounting for uncertainty in activity durations. Through the use of optimistic, pessimistic, and most-likely time estimates, PERT enables managers to develop realistic schedules and contingency plans, reducing the need for unsafe schedule acceleration when unexpected disruptions occur. Furthermore, recent optimization studies have proposed integrated time-cost-safety models that simultaneously consider project duration, cost efficiency, and safety risks during project planning. These models demonstrate that safety performance can be significantly improved when safety considerations are incorporated into scheduling decisions from the outset.

Recent advances in digital technologies have further strengthened the relationship between time management and safety performance. Building Information Modeling (BIM) has emerged as a powerful tool for integrating scheduling, safety planning, and project coordination. BIM-based 4D scheduling enables project teams to visualize construction activities over time and identify potential hazards before work begins. Guo, Zhang, and Amor (2024) reported that BIM applications significantly improve hazard identification, communication, safety planning, and risk management across the project lifecycle. Similarly, Salzano et al. (2024) found that BIM-based safety management transforms traditional reactive safety approaches into proactive systems capable of identifying and mitigating risks before incidents occur. These findings suggest that BIM enhances both project efficiency and workplace safety by supporting better decision-making and project coordination.

The integration of Artificial Intelligence (AI) with BIM and project scheduling systems represents one of the most significant developments in construction management research. Recent studies indicate that AI can analyze large volumes of project data to predict delays, optimize schedules, identify hazards, and recommend corrective actions. Datta et al. (2024) observed that AI and machine learning technologies are increasingly being applied during project planning and construction phases to improve productivity, project monitoring, and safety management. Similarly, research on AI–BIM integration found strong potential for automated scheduling, safety monitoring, and risk assessment applications within construction projects. AI-driven systems can continuously evaluate project conditions and support managers in balancing productivity requirements with safety objectives.

The growing adoption of Internet of Things (IoT) technologies, wearable sensors, drones, and digital twins has further expanded opportunities for integrating time management and safety performance. Real-time monitoring systems allow project managers to track worker locations, environmental conditions, equipment status, and project progress simultaneously. Emerging research proposes integrated BIM-AI-IoT frameworks capable of providing continuous safety supervision throughout the project lifecycle. Such systems combine schedule information, hazard data, and real-time monitoring to support predictive safety management and proactive decision-making. These developments represent a shift from traditional reactive safety management toward intelligent and data-driven construction safety systems.

Overall, the literature demonstrates a strong relationship between time management and safety performance in construction projects. Effective scheduling contributes to safer project environments by reducing schedule pressure, improving communication, supporting hazard identification, facilitating workforce training, and ensuring timely implementation of HSE activities. Conversely, poor scheduling often results in overtime, worker fatigue, schedule compression, and increased exposure to hazards. Although substantial research has examined project scheduling and construction safety independently, relatively limited attention has been given to their integrated impact on project performance. Moreover, the application of modern technologies such as BIM, AI, IoT, and digital twins to

simultaneously improve time management and safety performance remains an emerging area of research. This gap highlights the need for further investigation into how traditional scheduling techniques such as CPM and PERT, when combined with HSE planning and digital technologies, can enhance safety outcomes in construction projects.

III. RESEARCH METHODOLOGY

This research adopted a qualitative research approach based on secondary data analysis to investigate the impact of time management on safety performance in construction projects. A qualitative methodology was considered appropriate because the research aimed to explore and understand the relationship between project scheduling practices and workplace safety outcomes through the examination of existing literature, safety management studies, and project scheduling techniques. Rather than collecting primary data through surveys or interviews, the research relied on previously published academic sources and practical scheduling analyses to evaluate how effective time management contributes to improved safety performance in construction environments.

The research utilized secondary data obtained from a variety of reliable sources. These sources included construction project management literature, peer-reviewed research articles related to occupational health and safety, project scheduling studies, and industry publications focusing on construction management practices. In addition, the research incorporated findings from an HSE planning assignment that involved the preparation and analysis of a construction project schedule. The assignment provided practical insights into the integration of safety management activities within a project timeline and served as a case-based example for examining the relationship between scheduling and safety performance. The use of multiple secondary sources enhanced the credibility of the research by allowing the comparison and synthesis of findings from different studies and professional practices.

A significant component of the analysis was based on a structured HSE implementation schedule developed for a Villas Construction project. The schedule consisted of twenty project activities covering various stages of the project lifecycle, including project initiation, planning, execution, monitoring, control, and closure. Safety-related activities such as workforce induction, risk assessments, toolbox meetings, safety inspections, emergency drills, incident investigations, and corrective action implementation were integrated into the project timeline. This structured schedule provided a practical framework for evaluating how safety management activities can be effectively incorporated into construction schedules and how such integration may contribute to improved project safety outcomes.

To analyze the scheduling component of the project, two widely recognized project management techniques were employed: the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT). CPM was applied using fixed activity durations to identify critical activities that directly influenced overall project completion time. Through critical path analysis, the research examined how delays in specific project activities could affect project schedules and potentially influence safety management practices. Identifying critical activities also enabled the evaluation of whether safety-related tasks received adequate attention and resources during project execution.

In addition to CPM, the Program Evaluation and Review Technique (PERT) was utilized to address uncertainty in activity durations. PERT incorporates optimistic, most likely, and pessimistic time estimates to calculate expected activity durations and assess schedule risks. This technique was particularly relevant because construction projects often experience uncertainties related to weather conditions, labor productivity, material availability, equipment performance, and site-specific challenges. By considering these uncertainties, PERT provided a more realistic assessment of project timelines and highlighted the importance of contingency planning in maintaining both project efficiency and workplace safety.

The analytical framework for this research focused on evaluating the influence of scheduling practices on several key dimensions of construction safety performance. These dimensions included worker safety awareness, risk management effectiveness, emergency preparedness, inspection and monitoring systems, corrective action implementation, and overall safety performance. The framework examined how well-planned schedules support regular safety

training, hazard identification, risk assessments, inspections, and emergency response activities. Furthermore, the analysis explored how inadequate scheduling and schedule pressure could negatively affect safety performance by increasing worker fatigue, reducing compliance with safety procedures, and encouraging unsafe work practices.

The collected information was analyzed through a comparative and interpretive approach. Findings from the literature were compared with the results of the CPM and PERT scheduling analyses to identify common themes and relationships between time management and safety performance. Particular attention was given to evidence demonstrating how effective scheduling contributes to proactive safety management and how poor time management may increase workplace risks. The integration of theoretical knowledge and practical scheduling analysis provided a comprehensive understanding of the role of time management in supporting construction safety.

Overall, the adopted methodology provided a systematic approach for examining the impact of time management on safety performance in construction projects. By combining secondary literature analysis with practical scheduling techniques and HSE planning activities, the research was able to assess the significance of project scheduling in promoting safer working environments and improving overall project performance. The methodology also enabled the identification of best practices for integrating safety considerations into construction schedules, thereby contributing to more effective project management and risk reduction strategies.

IV. DATA ANALYSIS AND DISCUSSION

The analysis conducted in this research revealed a strong relationship between effective time management and safety performance in construction projects. The findings indicate that well-structured project schedules contribute significantly to the successful implementation of Health, Safety, and Environment (HSE) activities, thereby reducing workplace hazards and improving overall project outcomes. Through the application of scheduling techniques such as the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT), the research demonstrated that safety-related activities can be effectively integrated into project timelines to ensure that safety requirements are addressed systematically throughout the project lifecycle.

One of the most significant findings of the research was the successful integration of HSE activities within the overall project schedule. The Villas Construction project schedule incorporated essential safety-related activities, including workforce induction programs, hazard identification, risk assessments, toolbox meetings, procurement and distribution of personal protective equipment (PPE), site inspections, emergency preparedness drills, safety audits, incident reporting procedures, and corrective action implementation. By scheduling these activities alongside construction operations, project management ensured that safety measures were not treated as separate administrative tasks but rather as integral components of project execution. This integration enabled safety procedures to be completed before high-risk construction activities commenced, thereby minimizing the likelihood of workplace accidents and unsafe conditions.

The analysis further demonstrated that the inclusion of safety-related activities in project schedules promotes proactive rather than reactive safety management. Instead of responding to hazards after incidents occur, project teams were able to identify risks, implement preventive measures, and allocate resources for safety management in advance. The structured scheduling approach improved coordination among project participants and ensured that all stakeholders understood their responsibilities regarding safety implementation. As a result, the project maintained greater control over workplace hazards while simultaneously supporting project progress and productivity.

The Critical Path Method analysis provided valuable insights into the relationship between scheduling and safety performance. Several safety-related activities were identified as part of the project's critical path, including procurement of personal protective equipment, workforce induction and training, safety inspections, risk assessments, and corrective action procedures. Because activities on the critical path directly affect overall project completion, any delays in these tasks would result in delays to subsequent

project activities and potentially compromise workplace safety. The findings suggest that safety activities should be treated with the same level of importance as construction operations because their timely completion directly influences both project success and worker protection.

The CPM results highlighted that safety management cannot be viewed as an independent function operating separately from project planning. Rather, safety activities are interconnected with construction activities and contribute significantly to project performance. For example, delays in PPE procurement could prevent workers from safely performing assigned tasks, while delays in workforce induction could result in workers entering the site without adequate knowledge of safety procedures. Similarly, postponing inspections or corrective actions could allow hazardous conditions to remain unresolved, increasing the risk of accidents. These findings reinforce the importance of integrating safety considerations into project schedules from the earliest planning stages.

The research also identified several adverse consequences associated with poor time management and inadequate scheduling practices. Projects characterized by unrealistic deadlines, insufficient planning, and schedule compression were found to experience increased safety risks. One of the most common outcomes of poor scheduling was excessive schedule pressure, which often forced workers and supervisors to prioritize productivity over safety. Under such circumstances, workers may rush activities, ignore safety procedures, bypass inspections, or take shortcuts in order to meet project deadlines. These behaviors significantly increase the likelihood of accidents, injuries, and near-miss incidents.

Another major consequence of poor time management is worker fatigue. When projects fall behind schedule, organizations frequently rely on overtime work and extended shifts to recover lost time. While this approach may temporarily improve productivity, it often results in physical exhaustion, mental stress, and reduced concentration among workers. Fatigue negatively affects decision-making abilities, hazard recognition, and situational awareness, thereby increasing the probability of human error. The findings suggest that projects with excessive overtime requirements are more vulnerable to workplace accidents and safety violations than projects operating under realistic schedules.

The analysis also revealed that poor scheduling can lead to inadequate communication and coordination among project stakeholders. Delays in project activities often create confusion regarding responsibilities, priorities, and work sequences. As a result, safety information may not be communicated effectively, and workers may be unaware of emerging hazards or changes in work procedures. Insufficient time for safety meetings, toolbox talks, and inspections further weakens safety management systems and reduces opportunities for hazard identification and risk mitigation.

In contrast, projects that implemented effective scheduling practices experienced numerous benefits related to safety performance. Proper scheduling improved compliance with safety regulations and organizational HSE requirements by ensuring that safety activities were planned and monitored systematically. Workers received timely safety training and participated in regular toolbox meetings, which enhanced their awareness of workplace hazards and safe work practices. Furthermore, scheduled inspections and audits enabled management to identify and address safety concerns before they developed into serious incidents.

The findings also indicated that effective scheduling strengthened communication and collaboration among project teams. Clearly defined timelines and activity sequences improved coordination between contractors, supervisors, safety personnel, and workers. This enhanced communication contributed to a stronger safety culture in which safety responsibilities were clearly understood and actively supported by all project participants. Improved communication also facilitated the implementation of corrective actions, ensuring that identified hazards were addressed promptly and effectively.

Another significant advantage of effective scheduling was the reduction in accident frequency and unsafe work practices. Projects with structured schedules demonstrated better control over project activities, allowing safety procedures to be implemented consistently throughout the construction process. The assignment-based Gantt chart and precedence diagram illustrated how systematic scheduling

creates opportunities for regular monitoring, risk assessments, inspections, and emergency preparedness activities. These planning tools provided a clear visualization of project activities and their relationships, enabling managers to coordinate safety interventions at appropriate stages of the project lifecycle.

The Program Evaluation and Review Technique (PERT) analysis further contributed to the research by addressing uncertainty within construction schedules. Unlike CPM, which assumes fixed activity durations, PERT incorporates optimistic, most likely, and pessimistic time estimates to account for variability in project activities. Construction projects frequently encounter uncertainties related to weather conditions, labor productivity, equipment availability, material deliveries, and unforeseen site conditions. The PERT analysis demonstrated that considering these uncertainties allows project managers to develop more realistic schedules and contingency plans.

The use of PERT enhanced proactive safety management by enabling managers to anticipate potential delays and their impact on project activities. By identifying schedule risks in advance, project teams could allocate additional resources, adjust work sequences, and implement preventive measures without compromising safety standards. This approach reduced the need for emergency schedule recovery measures such as excessive overtime or accelerated work practices, both of which are commonly associated with increased safety risks. Therefore, PERT proved to be an effective tool for balancing project efficiency with worker safety.

The overall findings of the research confirm that effective time management has a positive and substantial impact on construction safety performance. Well-planned schedules provide the necessary structure for implementing safety programs, conducting inspections, delivering training, and maintaining compliance with HSE requirements. The integration of safety activities into project schedules ensures that safety considerations are addressed proactively rather than reactively. Furthermore, the findings emphasize that safety management should be viewed as an integral component of project management rather than a separate administrative function.

The research also highlights the importance of avoiding unrealistic project deadlines and excessive schedule pressure. Construction organizations that prioritize productivity at the expense of safety may achieve short-term gains but often face higher accident rates, increased project disruptions, and greater financial losses in the long term. Conversely, organizations that combine effective scheduling practices with comprehensive safety planning are more likely to achieve successful project outcomes, improved workforce well-being, enhanced regulatory compliance, and sustainable operational performance.

In conclusion, the data analysis demonstrates that effective time management serves as a critical foundation for construction safety management. The application of CPM and PERT techniques, combined with the integration of HSE activities into project schedules, supports safer working environments and more efficient project execution. The findings provide strong evidence that organizations should incorporate safety planning into project scheduling processes to minimize workplace hazards, improve safety performance, and enhance overall project success.

V. CONCLUSIONS

This research examined the impact of time management on safety performance in construction projects by analyzing the relationship between project scheduling practices and the implementation of Health, Safety, and Environment (HSE) activities. The findings demonstrate that effective time management is a critical factor in achieving both successful project delivery and improved workplace safety. Construction projects operate in complex and dynamic environments where numerous activities must be carefully coordinated to ensure that project objectives are achieved without compromising worker health and safety. As a result, project schedules play an important role not only in controlling project duration but also in supporting the systematic implementation of safety measures throughout the project lifecycle.

The research findings indicate that proper scheduling significantly enhances safety performance by ensuring that essential HSE activities are incorporated into project plans and completed at the appropriate stages of construction. Activities such as workforce

inductions, hazard identification, risk assessments, toolbox meetings, safety inspections, emergency preparedness drills, incident investigations, and corrective actions were successfully integrated into the project schedule. This integration enabled safety procedures to be implemented proactively rather than reactively, thereby reducing workplace hazards and improving compliance with safety requirements. The research confirms that construction projects that allocate adequate time for inspections, inductions, emergency planning, and corrective actions are more likely to maintain safer working environments and achieve better overall project outcomes.

The application of the Critical Path Method (CPM) and the Program Evaluation and Review Technique (PERT) further demonstrated the importance of effective scheduling in construction safety management. CPM analysis identified critical activities that directly influenced project completion and highlighted the significance of prioritizing safety-related tasks within the project schedule. Delays in activities such as PPE procurement, worker training, inspections, and corrective actions were found to have direct implications for both project performance and site safety. Similarly, PERT analysis proved valuable in addressing uncertainties associated with construction projects by incorporating optimistic, most likely, and pessimistic activity duration estimates. This approach enabled more realistic planning, improved risk management, and reduced the likelihood of schedule-related safety issues.

The research also identified several negative consequences associated with poor time management practices. Inadequate scheduling, unrealistic deadlines, and excessive schedule pressure were found to contribute to unsafe work practices, worker fatigue, reduced compliance with safety procedures, and increased accident risks. When projects experience significant delays or compressed schedules, workers often face pressure to complete tasks more quickly, which may encourage shortcuts and non-compliance with established safety protocols. Furthermore, extended working hours and overtime can lead to physical and mental fatigue, reducing worker concentration and increasing the probability of human error. These findings reinforce the importance of realistic project planning and effective schedule management as essential components of construction safety performance.

The assignment-based analysis demonstrated that systematic scheduling enhances both operational efficiency and workplace safety. The use of Gantt charts, precedence diagrams, CPM networks, and PERT analysis provided a structured framework for coordinating project activities and monitoring progress. More importantly, these scheduling tools supported the systematic implementation of safety measures throughout the project lifecycle by ensuring that HSE activities received adequate attention, resources, and time allocation. The findings therefore support the view that safety management should not be treated as a separate administrative function but rather as an integral component of mainstream project management practices.

Overall, the research concludes that time management plays a fundamental role in improving safety performance in construction projects. Effective scheduling techniques such as CPM and PERT support better coordination, monitoring, communication, resource allocation, and implementation of HSE activities. Construction organizations that integrate safety planning directly into project schedules are more likely to reduce workplace hazards, improve worker awareness, strengthen regulatory compliance, and achieve successful project outcomes. Consequently, project managers should ensure that safety-related activities receive equal importance alongside productivity, cost, and quality objectives during project planning and execution.

In light of the findings, it is recommended that future construction projects continue adopting advanced project management and scheduling techniques to strengthen safety performance and minimize project risks. The growing use of digital technologies such as Building Information Modeling (BIM), Artificial Intelligence (AI), and predictive scheduling tools presents new opportunities for integrating safety management with project planning processes. By combining effective time management practices with comprehensive safety planning, construction organizations can create safer working environments, improve project performance, and contribute to the long-term sustainability of the construction industry.

VI. FUTURE RESEARCH

Based on the research findings, literature review, methodology, and conclusions presented in the research, future research should focus on examining the relationship between time management and safety performance using primary data collected from actual construction projects, including surveys, interviews, and field observations, to validate the findings obtained through secondary data analysis. Future studies may also investigate the effectiveness of advanced digital technologies such as Building Information Modeling (BIM), Artificial Intelligence (AI), Internet of Things (IoT) devices, digital twins, and predictive analytics in integrating project scheduling with real-time safety management. Additionally, comparative research across different types of construction projects, such as residential, commercial, industrial, and infrastructure developments, could provide deeper insights into how scheduling practices influence safety outcomes under varying project conditions. Further studies should explore the impact of organizational culture, leadership commitment, workforce competency, and contractor management on the relationship between time management and safety performance. Longitudinal studies examining project schedules and safety performance throughout the entire project lifecycle would also help identify causal relationships between schedule pressure, worker behavior, fatigue, and accident occurrence. Finally, future research should develop and evaluate integrated time-cost-safety optimization models that combine traditional scheduling techniques such as CPM and PERT with modern digital technologies to support proactive decision-making, improve HSE implementation, and enhance overall construction project performance.

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