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GOOD SAFETY, HEALTH, AND QUALITY PERFORMANCES IN CONSTRUCTION INDUSTRY: MRT JAKARTA PHASE 2 CP203 THROUGH BEST 5S PRACTICES

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ABSTRACT

The construction industry in Indonesia has experienced significant growth in recent years. One of the major ongoing projects is the Jakarta MRT Phase 2, which extends from the already operational Phase 1, spanning approximately 16 kilometers since March 2019. Phase 2 is divided into two segments, 2A and 2B, with CP203 being part of Phase 2A.

This study focused on implementing high discipline standards through the 5S methodology to enhance safety, health, and quality performance. Prior to the implementation of 5S in 2022, Motion (40%) and Extra-Process (30%) were the most common waste types occurred. However, as of January 2025, these issues have been completely eliminated. Awareness campaigns and management training have contributed to the development of an activity tracker, further strengthening the progress achieved.

With a workforce of 754 individuals, including contractors and consultants, and a project duration of 1,165 days, the initiative has successfully maintained a record of 1,165 days without any lost time incidents or reported cases. The findings demonstrate 5S's effectiveness in minimizing waste and mitigating risks while aligning with Lean principles to optimize "Safety, health, and quality."

KEYWORDS

Safety, Health, and Quality, 5S, Lean principles

INTRODUCTION

Transportation projects are vital for urban development, enhancing connectivity and accessibility across communities. However, these projects typically involve extended

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timelines, expansive geographic coverage, substantial costs, and considerable environmental disruptions (Al Heet et al., 2020). From the perspective of Lean Construction, workforce injuries and the resulting disruptions are classified as waste (Leino et al., 2015).

Safety is a primary concern in construction projects, and integrating Lean principles with risk mitigation strategies can significantly enhance safety management (Saurin et al., 2002). The 5S methodology, a core tool of Lean Construction, provides a systematic approach to organizing and maintaining an efficient, orderly work environment. Its five components Seiri (Sort), Seiton (Set in order), Seiso (Shine), Seiketsu (Standardize), and Shitsuke (Sustain) offer a structured framework for workplace improvement (Hafey, 2010).

Although research has established a link between effective housekeeping and safety performance, the application of 5S in the construction industry remains relatively underexplored, particularly regarding its impact on safety and health conditions. Studies indicate that a considerable proportion of construction-related injuries, such as slips and falls, could be prevented through better workplace organization (Haslan et al., 2005). This underscores the potential of 5S as a proactive strategy for minimizing hazards and enhancing overall site safety.

Table 1: The Definitions of 5S (Leino, et al., 2015)

Type of S	Definitions
Sort	The very first step challenges consist of four main activities: Go through all items in each section, place red tag on 'questionable' items, store red tagged items in dedicated area, dispose items that have not been reclaimed after one week, and maintain log to track tagged items
Set in Order	Define dedicated location for every item. Store items together and in right sequence if they are used together. Also store infrequently used items away from the point of use. It is important to dedicate locations for items
Shine	Means cleaning the working environment. Set cleaning and inspection schedule per section to plan implementation and tracking of cleaning activities. Conduct periodic schedule implementation tracking
Standardized	Set up a 5S checklist for implementation and continuous monitoring. List all activities, specify their corresponding 'S', indicate their required frequency, and track their completion and potential improvements cleaning the working environment. Set cleaning and inspection schedule per section to plan implementation and tracking of cleaning activities. Conduct periodic schedule implementation tracking
Sustain	The last S means ensuring all the standard performance could performs continually

The Behavior-Based Safety (BBS) approach aims to reduce injury rates by focusing on individual behavior rather than addressing the root causes of safety issues (Bertelsen, 2004). Behavior-Based Safety (BBS) versus Lean Safety. BBS is a topic that has been developed for a quiet long time. It is temporarily redirecting the compliance-based safety culture and reduces the injury rate. In addition, that during BBS audit people are doing it 'to them' rather than 'with them.' This violates the Lean concept of employee engagement used to build trust.

In the construction fields, work-crew practices usually examine how is the procedure and the actual work is done, communicated, and how the workforce solve the work conditions (Mitropoulos, et al., 2007). The good sign of the workforce commitment is when they are willing to contribute making a decision that related to their job progress (Coffey, 2000).

This study focuses on addressing these challenges within the context of the MRT Jakarta Phase 2 project, where 5S principles were implemented to reduce risks and eliminate waste. The integration of Lean Construction tools, such as goal setting and feedback monitoring, plays a crucial role in enhancing safety outcomes in construction projects. As part of this

initiative, the TR safety observation method and daily Gemba walks were utilized to monitor and resolve both completed and outstanding safety concerns (Laitinen et al., 1996).

Furthermore, the existing literature on the application of the 5S methodhology for incident prevention remains limited. This study aims to analyze and implement 5S practices as a primary approach to enhancing safety, health, and quality performance in construction projects, with a specific focus on MRT Jakarta Phase 2 CP203. By applying 5S, this research seeks to eliminate waste within the project area and mitigate potential risks that could affect safety and quality outcomes.

METHODOLOGY

This research involved direct observation to obtain real data from December to January. It combined both quantitative and qualitative data, utilizing direct observation and interviews to complete and analyze the findings. The correlation between the needs for 5S implementation, process, and risk analysis, and mitigation strategies were examined to enhance safety, health, and quality performance.

This research linked each performance indicator safety, health, and quality to reliable data. The safety indicator was associated with data on falls, slips, and trips, while the health indicator was linked to dust and air quality (indoor and outdoor) indexes. The quality indicator was represented by data on defects and customer satisfaction through quality production.

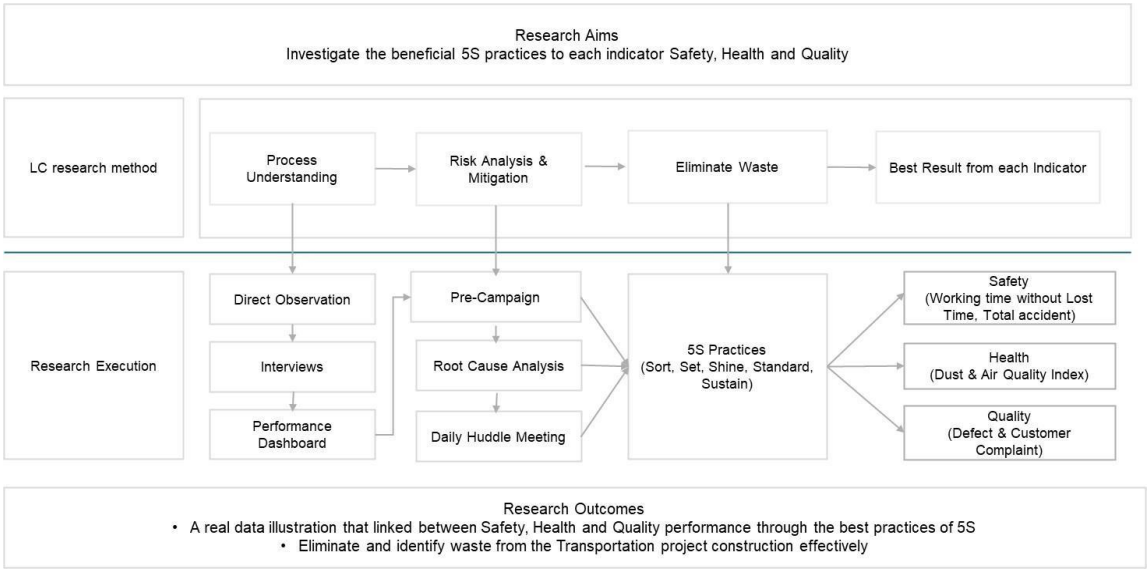

Figure 1: Research Methodology

RESULTS AND DISCUSSIONS

Results

The ultimate objective of the 5S program was to create a better working environment in terms of safety, health, and quality by eliminating waste and helping the project team mitigate potential risks. Secondly, it was discovered that better 5S implementation, focusing on good housekeeping, can strengthen the workflow, improve productivity, and enhance both worker and customer satisfaction. This research focuses on quick-win actions to improve safety, health, and quality performance in MRT Jakarta Phase 2. Regarding risk analysis and mitigation, the MRT Jakarta Phase 2 project has identified 137 ongoing construction potential risks (January 2025), as shown in Table 2.

Table 2: Number of Potential Risk at Construction MRT Jakarta Phase 2 Activities

Number	Construction Activities	Risk Item
1	Architecture Work	29
2	Entrance Work	5
3	Permanent Staircase	6
4	Platform Work	10
5	Over Track Exhaust Duct Installation	12
6	Tunnel Work	75

Station and Tunnel work are the main areas of concern because the MRT Jakarta Phase 2 CP203 is largely underground. This includes 685 meters of twin bored tunnels, 645 meters of cut-and-cover tunnel structure, and two underground stations Glodok Station and Kota Station with a total length of 471 meters, including electrical works associated with the station buildings. This is why station and tunnel work contribute significantly to the potential risks in the project. Based on actual customer complaints that occurred, several issues always arose from those works, even though the total number of findings decreased in 2022. Table 3 shows the opportunities for improvement, specifically at Glodok Station and Kota Station. The impact items were classified by three indicators linked to this research topic: Quality, Health, Safety, and Environment,

Table 3: Opportunity for Improvement in Construction MRT Jakarta Phase 2 Activities

`	Impact Item	Year of Finding		Description
		2021	2022	
1	Safety, Health Environment	3	2	1. Unsafe action from Heavy Equipment moving – 2 cases (2022) 2. Falling Object (2021) 3. Inconsistence of material storage (2021) 4. Soil Delivery disruption due traffic restrictions (2021)
2	Quality	4	1	1. Public utility impaired (2022) 2. Finding uncharted underground facility (2021) 3. Delay of design permit process (2021) 4. The work of the subcontractor did not reach the expected quality (2021) 5. Rework of disposal area due elevated changes (2021)

The 5S methodology, which is a key Lean technique, must involve and strengthen the engagement of all site workers, including contractors, subcontractors, and vendors. This supports the enhancement of both individual and team understanding of critical and potential safety issues, fosters a safety culture, and contributes to improved safety performance (Delbecq, et al., 1971).

Based on Table 3. Opportunity for Improvement in Construction's area, there was 56% of improvement happened. The Opportunity for improvement had been reduced and mitigated by the project team. They are immediately solving the items through 5S implementation though it is not proper yet. This research used Figure 2 shows the Root Cause analysis through

Fishbone Diagram that been used as the reference before doing 5S at the Project Area.

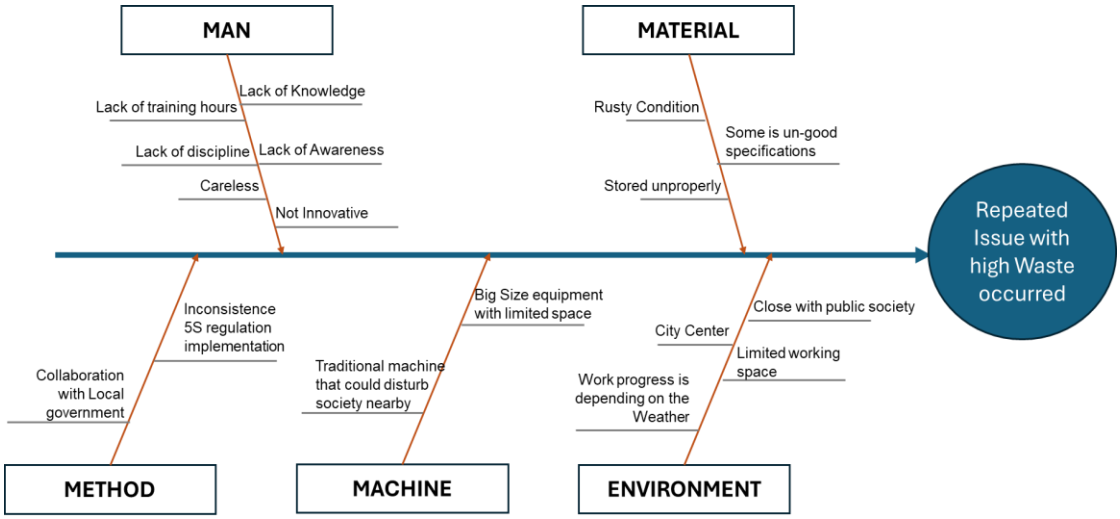

Figure 2: The Fishbone Diagram

Quality, Health, Safety, and Environment (QHSE) risk mapping is a crucial process for organizations aiming to proactively manage potential risks that could impact their operations, employees, and overall success. By conducting QHSE risk mapping, businesses can develop effective strategies to mitigate or control these risks, ensuring a safe and healthy work environment, compliance with regulations, and sustainable practices.

The objective is to utilize 5S as a Lean principle method to eliminate the recurring waste that occurred in the MRT Jakarta Phase 2 project, particularly at Glodok Station and Kota Station, in order to achieve the best safety, health, environmental, and quality outcomes.

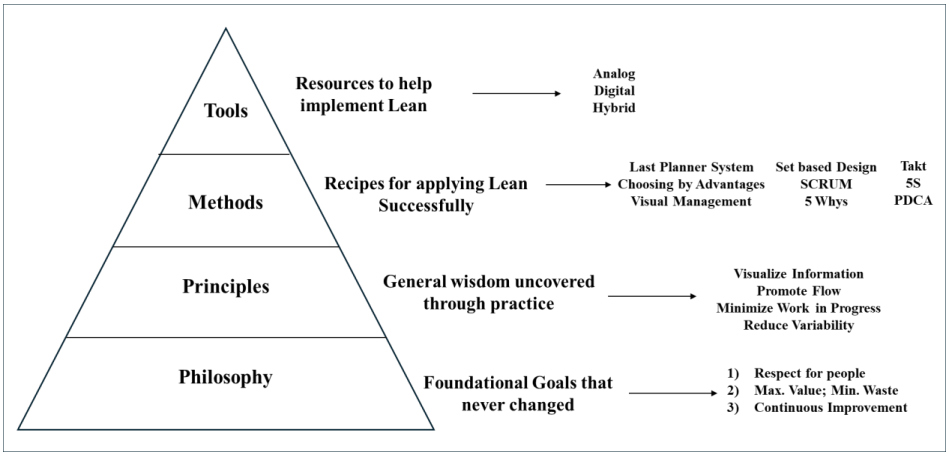

Figure 3: The Lean Construction Pyramid (Lean Construction Institute. 2023)

The detailed definitions of the 5S methodology utilized in this research as tools can be seen in Table 3. Based on the Lean philosophy diagram, 5S is an effective method to eliminate waste in the project area. The strength of 5S lies in its simple, visual concept, which is easy to understand, though it still requires additional methods to enhance performance outcomes. The successful utilization of 5S involves all related parties, the project team is required to carry out two phases: Stage I and Stage II. Stage I includes "Sort" and "Set in Order," while Stage II focuses on "Shine," "Standardize," and "Sustain." The implementation of each phase depends on the maturity of the area. Once Stage I is completed, the project leader can proceed with Stage II.

The implementation of 5S at the MRT Project Phase 2 began with training and campaigns led by the internal team. Staff were encouraged to join and complete the training workshops. The purpose of the training was to ensure that every team member understood how to effectively implement 5S on the shop floor. The visual campaign, applied at both Glodok and Kota Stations, can be seen in Figure 4.

Figure 4: 5S Visual Management Awareness Installed at both Glodok and Kota Station

Visual management is also applied to track the total performance achievement, as shown in Figure 5: The Health, Safety, and Environment Performance Board. This board is installed at both Glodok and Kota Stations, right at the center of the project area, including safety rules, the current working time without lost time incidents, the total number of accidents (including near misses), the air quality index, and the total number of running defects.

Figure 5: Health, Safety, Environment and Quality Performance Board

In addition to displaying the campaign and performance board, evaluation plays a crucial role in ensuring that standards are followed, and achievements are continuously improved, as emphasized in the Lean Philosophy pyramid. Therefore, the project team also conducts Daily Huddle Meetings, which are attended by the Project Management team, including the Project Manager, Site Operational Manager, Site Engineering Manager, Site QHSSE Manager, and other team members, as their commitment drives this process. The evaluation is conducted daily and is directly led by the Project Manager. The Daily Huddle activities at both Glodok and Kota Stations are shown in Figure 6.

Figure 6: Daily Huddle Meeting in Front of Performance Board at Glodok and Kota Station

ELIMINATE WASTE

In the MRT Jakarta Phase 2 project, the eight types of waste identified are closely related to the 8 Eliminate Waste principles, which include defect, overproduction, waiting, non-

utilized talent, transportation, inventory, motion, and extra-processing. The correlation between these types of waste and the risks that occurred at Glodok and Kota Stations aims to identify the most dominant waste, allowing for effective preventive measures. For instance, reducing motion waste can be achieved through Seiton (proper arrangement), while minimizing waiting waste can be supported by Seiri (sorting and organizing materials and information efficiently). By implementing the 5S principles, the project team can enhance efficiency and reduce waste, ultimately preventing delays and additional costs in the project.

The MRT Jakarta Phase 2 project team enhanced security by installing CCTV cameras at critical locations and implementing body checks for all personnel entering the site. Additionally, the classification of security personnel was upgraded to include specialists certified in anti-terrorism procedures. With these measures in place, similar risks can be minimized in the future, ensuring a safe working environment and the smooth progress of the project.

Table 4: Waste Identification from Each Risk Occurred

Impact item	Description	Waste Category
Health, Safety and Environment	1. Unsafe action from Heavy Equipment moving – 2 cases	Motion
	2. Falling Object	Motion
	3. Inconsistence of material storage	Extra Process
	4. Soil delivery disruption due traffic restrictions	Motion
Quality	1. Public utility impaired	Defect
	2. Finding uncharted underground facility	Extra Process
	3. Delay of design permit process	Waiting
	4. The work of the subcontractor did not reach the expected quality	Defect
	5. Rework of disposal area due elevated changes	Extra Process

Based on Table 4, we can get the dominant types of waste that occurred at MRT Jakarta Phase 2, specifically at Glodok and Kota Stations. The following waste types were identified: Motion (40%), Extra Process (30%), Defect (20%), and Waiting (10%). Most of the items that had occurred are correlated and classified as waste. Therefore, simple and quick management actions are urgently required to be implemented in the project area to address and eliminate waste and also to improve and speed up the project productivity.

The implementation of 5S as the method, following the Lean Construction Pyramid (Figure 2), has proven to be effective and beneficial at MRT Jakarta Phase 2. After the implementation of 5S in both Glodok and Kota Stations, each indicator related to safety, health, and the environment showed significant improvement, with no repeated risk items occurring. The risk items been eliminated and support the project productivity. By the end of January 2025, the project productivity was 0.9% ahead from the major scheduled plan. It shows the effectiveness and contribution from the 5S implementation on the project production. Best practices for implementing 5S in this project area, including at both stations, can be seen in Table 5.

Table 5: Best 5S Practice at MRT Jakarta Phase 2 at Glodok and Kota Station

Type of S	Activities
Sort	1. All types of pipes are sorted by size & must be labeled. 2. There was a full body harness rack with their label 3. Material scaffolding is stored properly 4. Safety campaign signage availability 5. Checklist items availability
Set in Order	1. Safety net on barrier has been installed properly 2. All material stored neatly as per area setting 3. Install the blower to ensure proper air circulation underground. 4. Warning signs are posted properly to raise the awareness
Shine	1. Set Housekeeping schedule for each personnel by daily
Standardized	1. Inspections tools and heavy equipment 2. The protruding rebar used to protect the ram on the access way 3. Cable management 4. The protruding rebar used to protect rebar 5. Evacuation route availability
Sustain	Do Periodic tracking all the 5S activities

Initially, after receiving training from internal management, employees and workers analyzed their project shop floor. This activity helped them identify limitations when implementing 5S. From Table 5, the activities conducted by the project team are clearly outlined. While employees and workers found the first two S's (Sort and Set in Order) to be the most challenging, sustaining the practices and maintaining the standard were identified as the most difficult tasks. This research period was calculated and measured until January 2025, this Project could maintain 1,165 running days without lost time incident and any case record, 0 defect cases happened including customer complaint and all the Air & Dust quality is follow per regulation.

Discussions

1. Implementation of 5S Practices to Enhance Safety, Health, and Quality in MRT Jakarta Phase 2 CP203

The implementation of 5S in the MRT Jakarta Phase 2 CP203 project plays a crucial role in improving safety, health, and quality performance. This study developed a conceptual illustration linking the application of best 5S practices with optimal project outcomes. Prior to 5S implementation, the project faced significant challenges due to inefficiencies and waste that negatively impacted performance. A total of 137 risk items were identified, primarily in the Safety, Health, and Environment category, followed by Security, Legal, and Social Politics, and lastly, Quality. These risks created various hazards that threatened worker safety, increased costs, and led to delays in project completion. By adopting the 5S methodology, the project aimed to systematically reduce these risks through workplace organization and process standardization.

Table 7: The Comparison of Total Risk item Before and After 5S Implementation

Impact Item	Before 5S Implementation		After 5S implementation
	2021	2022	(January 2025)
Safety, Health Environment	3	2	Mitigated
Quality	4	1	Mitigated

Previous studies have shown that implementing 5S practices significantly improves construction site efficiency and safety. For instance, research by Alkaissy et al. (2021) demonstrated that the application of 5S in large-scale construction projects resulted in a 30% reduction in workplace incidents, emphasizing the importance of systematic organization in mitigating risks. Similarly, a study by Bojjou & Chapi (2021) highlighted that integrating 5S with Lean Construction principles enhances worker productivity and fosters a safety-conscious culture, leading to long-term improvements in project performance. These findings align with the results of this study, where 5S implementation led to a notable reduction in risk items, improving safety, health, and quality at the MRT Jakarta Phase 2 CP203 project.

2. Evaluating the Impact of 5S Practices on Waste Reduction and Risk Mitigation in Construction

The effectiveness of 5S in waste elimination and risk mitigation was evident in the significant improvements observed at MRT Jakarta Phase 2 CP203. Before the implementation of 5S, the project faced persistent waste-related challenges, including inefficient processes and disorganized workspaces, which led to increased risks and reduced productivity. Table 8 illustrates the waste occurrences before and after 5S implementation, showing that critical waste items, such as Motion, Extra Process, Non-Utilized Talent, Defect, and Making Do, were eliminated. These findings highlight how 5S played a pivotal role in streamlining project activities and ensuring a safer and more efficient work environment. By eliminating unnecessary movement, reducing defects, and optimizing resource utilization, the project achieved improved workflow and minimized disruptions.

Several studies support these findings, reinforcing the impact of 5S on waste reduction and safety performance. A study by Chan et al., (2022) found that 5S implementation led to a 25% decrease in material waste and a significant reduction in safety hazards in construction projects. Additionally, Shou et al. (2019) reported that integrating 5S with Lean methodologies resulted in a 40% improvement in workflow efficiency and a reduction in non-value-adding activities. These studies confirm that structured workplace organization through 5S effectively mitigates risks and enhances productivity, aligning with the success of the MRT Jakarta Phase 2 CP203 project.

Table 8: The Comparison of Waste Occurrences (items) Before and After 5S Implementation

Waste Item	Before 5S Implementation	After 5S Implementation
Motion	4	Eliminated (0)
Extra Process	3	Eliminated (0)
Defect	2	Eliminated (0)
Waiting	1	Eliminated (0)

Despite these successes, this study suggests further research on dominant waste types, particularly "Extra Process" and "Defect," to explore their correlation with inefficient process systems. A comprehensive management review should be conducted to identify underlying causes and implement additional Lean methods, such as the Last Planner System, to provide a holistic understanding of factors contributing to waste. By addressing these inefficiencies at the root cause level, construction projects can further enhance their ability to prevent waste recurrence and improve overall performance. The successful integration of the 5S model in this project underscores the importance of management commitment, clear communication, and regular evaluations. Consistent monitoring and reporting to the Headquarter Office are recommended to ensure that health, safety, environmental, and quality standards align with Lean Philosophy principles and promote continuous improvement.

In terms of sustaining performance, this research emphasizes the need for the internal project team to adopt a step-by-step approach to continuous improvement, ensuring long-term customer satisfaction. The study also highlights the potential for expanding 5S applications beyond the current scope by integrating additional Lean Construction principles to further optimize efficiency.

CONCLUSIONS

Based on the results of this study, the implementation of 5S practices in the MRT Jakarta Phase 2 CP203 project has proven effective in improving safety, health, and quality performance by reducing waste and risks. Before the implementation of 5S in 2022, waste issues such as Motions and Extra-Process accounted for 40% and 30%, but by January 2025, these problems were eliminated. Awareness campaigns and management training have supported achieving these positive outcomes, with a total of 754 workers operating for 1,165 days without any lost-time incidents or recorded cases. This study highlights the critical role of Lean principles, particularly 5S, in fostering a disciplined work environment and enhancing safety, health, and quality in construction results that the project was 0.9% ahead of the masterplan schedule.

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