Study the Principal of Construction to Improve Efficiency, Case Study of Sai Sangam Holding Karad

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Abstract - India's construction industry is a key driver of national development, yet it often grapples with issues such as project delays, budget overruns, poor resource utilization, and inadequate quality oversight. This research aims to explore essential construction management principles that can enhance overall project performance and operational efficiency. It emphasizes critical success elements like strategic planning, effective coordination, detailed scheduling, safety adherence, and consistent progress tracking. The study further investigates the role of modern approaches—such as lean construction and the 5S methodology—in reducing waste, improving productivity, and streamlining workflows. Additionally, it evaluates sustainable building practices for their potential to lower environmental impact and improve the use of resources. A multi-method research approach is adopted, including literature analysis, expert insights, questionnaires, data interpretation, and Indian project case studies. The expected outcome is a robust, practical framework offering actionable insights to boost construction efficiency during the planning, implementation, and evaluation phases, tailored to the specific hurdles of the Indian market while drawing from international best practices.

***Key Words*: lean , VSM, 5s system, construction industry, productivity**

1. INTRODUCTION

Construction management principles are essential guidelines that structure the planning, coordination, and execution of construction projects. These principles, when understood and applied effectively, help manage project complexity, optimize resource use, and ensure successful delivery within the constraints of time, cost, quality and resource management. A fundamental principle is scope management, which involves defining and controlling all work required in the project. It ensures that all stakeholders have a shared understanding of deliverables, thereby preventing scope creep, enhancing client alignment, and improving predictability of time and cost. Managing time (schedule) is a crucial aspect, emphasizing the importance of timely project completion through efficient scheduling techniques like critical path method (CPM) and program evaluation and review technique (pert). Proper time management minimizes delays, enhances resource deployment, and enables tracking of milestones. Cost management encompasses planning, budgeting, estimating, and controlling expenditures. Tools like earned value management (EVM) integrate cost, scope, and schedule performance, supporting informed decision-making, preventing overruns, and aligning resource use with the project budget [1]

Equally important is quality management, which ensures that construction outcomes meet required standards and stakeholder expectations. By emphasizing quality planning, assurance, and control often supported by frameworks like total quality management (TQM) rework and waste are reduced, client satisfaction improves, and the final product meets long-term performance goals. Resource management addresses the strategic allocation and monitoring of human, material, equipment, and financial resources. Techniques such as resource leveling and smoothing help avoid bottlenecks and underutilization, ensuring efficient operations and timely availability of materials and labor. Another key principle is risk management, which focuses on identifying, assessing, and mitigating potential threats to project objectives. Through structured tools like risk registers and contingency plans, projects can better withstand uncertainty, maintain continuity, and ensure stable progress.

Moreover, communication and stakeholder management play a pivotal role by facilitating transparent, effective information exchange and coordination across project teams. Clear communication strategies and stakeholder engagement help reduce conflicts, improve accountability, and align project actions with shared goals. In modern practice, these traditional construction management principles are increasingly integrated with lean construction methodologies, which emphasize eliminating non-value-adding activities, enhancing process flow reliability, delivering value from the client's perspective, and fostering continuous improvement (kaizen). When combined, these principles and lean approaches create a structured and responsive management system that promotes operational efficiency, cost-effectiveness, and timely, high-quality project delivery.

2. RESEARCH GAP

Despite the growing body of literature on construction management and efficiency improvement, there are important research gaps, particularly in the context of the Indian construction industry. Many existing studies focus mainly on isolated aspects such as cost planning or control, but few adopt a holistic approach that integrates fundamental construction principles, modern tools such as Lean construction and 5S methodology and sustainability practices. In addition, although international best practices are well documented, their contextual adaptation and practical implementation in Indian projects are not sufficiently explored. Limited empirical investigation has been carried out that quantifies the direct impact of construction management principles on the key project parameters, such as time, cost, quality and use of resources in India. In addition, the integration of sustainable construction practices with efficiency improvement strategies remains little investigated, especially in relation to how green materials, energy efficiency techniques and waste management influence the general performance of the project. In addition, there is a lack of structured frames that combine conventional principles, modern methodologies and sustainability in a unified model to improve construction efficiency. The absence of evidence based on cases of Indian projects that have successfully implemented such integrated strategies highlights the need for more contextual and data - based research. This study aims to unite these gaps through the development of an integral practical framework adapted to unique challenges and opportunities in the Indian construction sector.

3. RESEARCH METHODOLOGY

This study employs a structured research methodology integrating literature review, expert consultation, data collection, statistical analysis, and case study evaluation to enhance construction project efficiency and performance.

The **literature review** focuses on fundamental construction management principles, including planning, scheduling, resource optimization, risk management, and quality assurance. It also compares international best practices with challenges specific to the Indian construction context. **Expert interviews** were conducted with project managers, engineers, and architects to gather professional insights on improving coordination, productivity, and operational performance.

Comprehensive **data collection** through surveys targeted contractors and project professionals across India to examine key parameters such as time, cost, quality, and resource utilization. The **statistical analysis** evaluates the correlation between management practices and project outcomes, particularly the impact of Lean Construction and 5S methodologies.

An in-depth **case study** of an Indian commercial project demonstrated measurable improvements in time, cost, and quality performance. Based on these findings, a **framework** was developed to integrate modern construction practices, promote sustainable resource use, and enhance project efficiency across all stages.

Fig-1 Methodology

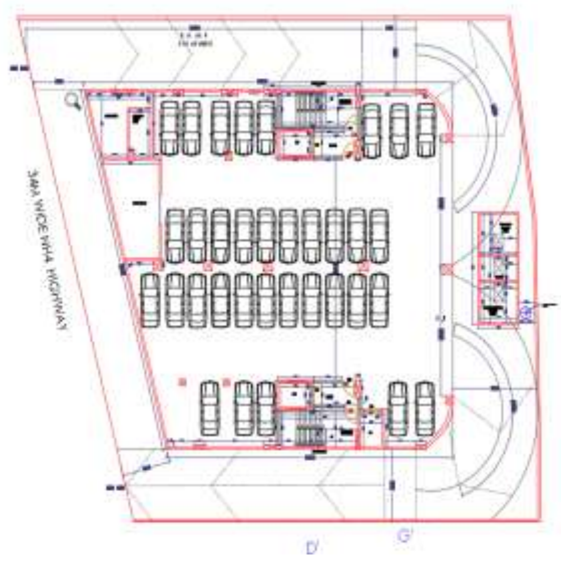

Fig-2 Typical basement floor plan

4. DETAILS OF CASE STUDY

The proposed commercial project at Sai Sangam Holdings, Karad, Maharashtra, India, consists of two basements and six floors, with an estimated budget of approximately ₹24 crore. The project emphasizes waste reduction to enhance service delivery for both internal and external stakeholders. The projects are of different scale, complexity and functionality encompassing such projects as mid-rise living and high-rise multi-purpose buildings. Such case studies are the basis of the assessment of VSM and 5S system lean tool that can be used to improve the efficiency of construction and reveal the overruns of time and costs.

Table No. 1 Project Detail

Project type	2 Basement +G+5 Floor building
Total built-up area	6492 sqm
Construction duration	24 month
workers on site	52
Labour	130
Engineers	26
Supervisors	13
Major materials used	Cement
	Steel
	Block
	Sand
	Concrete

Fig-3 Typical Lower basement plan

5. IMPACT OF CONSTRUCTION PRINCIPLES ON PROJECT PERFORMANCE

The data is organized into four core dimensions of construction performance: **Time, Cost, Quality, and Resource Management**. Within each dimension, several factors are identified as influencing project outcomes. For every factor, the weight (W) reflects either the number of respondents or the cumulative weighted score, the mean denotes the average rating on the Likert scale (typically ranging from 1 to 5), and the Relative Importance Index (RII) expresses the relative significance of the factor on a scale from 0 to 1, derived using a standard formula:

Table No. 2 Impact of Construction principles

Category	Factors	W	Mean	RII
Time	Lack of coordination between project entities	131	4.37	0.87
	Supervision and inspection delays	120	4.00	0.80
	Unrealistic scheduled dates	111	3.70	0.74
	Inventory and logistics issues	102	3.40	0.68
	Improper project delivery system and contract type	72	2.40	0.48
	Overcrowded work areas	66	2.20	0.44
Cost	Improper resource allocation	74	2.47	0.49
	Irregular documentation and tracking of reworks and change orders	73	2.43	0.49
	Communication barriers resulting in lack of trust and disputes	88	2.93	0.59
	Inadequate risk identification and prioritization	86	2.93	0.57
	External factors (force majeure, political)	99	3.30	0.66
Quality	Ambiguity in contract documents	87	2.90	0.58
	Lack of skill and experience of workforce	108	3.60	0.72
	Less emphasis on safety and environmental factors	86	2.87	0.57
	Ignorance of building performance aspects in early stages	85	2.83	0.57
	Lack of considering modular or prefabricated construction	113	3.77	0.75
	Interoperability issues with software	84	2.80	0.56
	Lack of automation and integration of technologies	87	2.87	0.58
Resource Manage-ment	Non-involvement of all stakeholders in early project phases	80	2.67	0.53
	Lack of motivation and poor attitude of the workforce	114	3.77	0.76
	Improper resource allocation	102	3.40	0.68
	Lack of skill and experience of workforce	103	3.43	0.69
	Overcrowded work areas	88	2.93	0.59

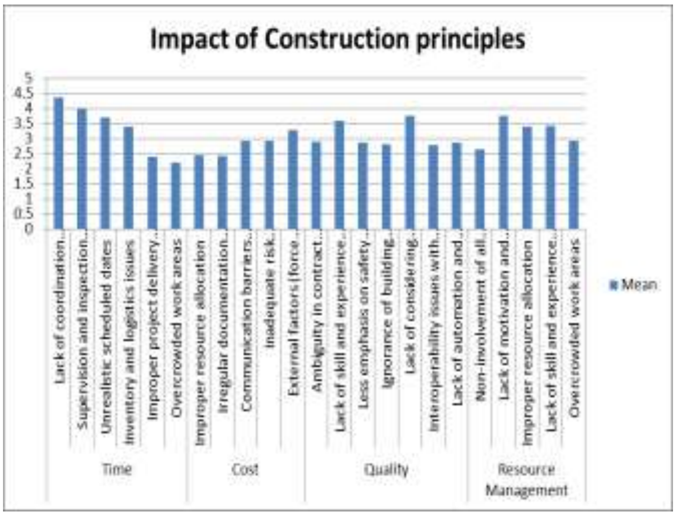

Chart No. 1 Mean Impact of Construction Principles

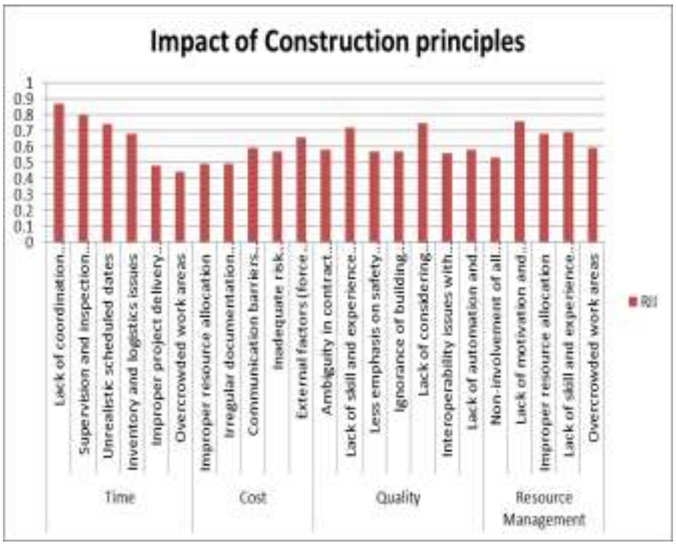

Chart No. 2 RII Impact of Construction Principles

a. Time Factors

- **Most critical issue:** Lack of coordination between project entities scored the highest RII of **0.87** (Mean = 4.37), showing it is the most significant contributor to time overruns.
- Supervision and inspection delays followed with an RII of **0.80**, also indicating a high impact.
- Unrealistic scheduled dates and inventory and logistics issues had moderate importance with RII of **0.74** and **0.68** respectively.
- Improper project delivery systems and overcrowded work areas had low RIIs of **0.48** and **0.44**, indicating relatively lower influence on time delays.

b. Cost Factors

- External factors (force majeure, political*)* topped this category with RII of **0.66**, showing major influence on cost fluctuation.

- Communication barriers (RII = **0.59**) and risk mismanagement (RII = **0.57**) were moderately significant.
- Improper resource allocation (RII = **0.49**) and irregular documentation (RII = **0.49**) were identified as lower-priority cost-affecting issues.

c. Quality Factors

- Lack of consideration for modular or prefabricated construction was the top concern with **RII = 0.75**, emphasizing the need for modern construction methods.
- Lack of workforce skill and experience (RII = **0.72**) was another major contributor to quality degradation.
- Ambiguity in contract documents and lack of automation or integration had moderate RIIs (≈ **0.58**).
- Ignorance of building performance and less emphasis on safety scored lower RIIs (≈ **0.57**), indicating room for improvement but lower perceived urgency.

d. Resource Management Factors

- Lack of motivation and poor workforce attitude had a significantly high RII of **0.76** (Mean = 3.77), making it the top concern in resource management.
- Lack of skill and experience (RII = **0.69**) and improper resource allocation (RII = **0.68**) were moderately high in influence.
- Non-involvement of stakeholders in early phases had the lowest RII in this category at **0.53**, suggesting limited but notable impact.

e. Recommendations

- Improve inter-entity coordination through integrated project delivery (IPD) systems or BIM.
- Invest in workforce up skilling and engagement programs to reduce quality and resource inefficiencies.
- Adopt prefabrication and modular techniques where feasible to enhance construction quality and speed.
- Strengthen documentation and communication protocols, especially for cost control.
- Mitigate external risks via early contingency planning and political risk assessment.

6. Challenges barriers faced Lean & 5S Implementation

This table presents a quantitative evaluation of the key **challenges and barriers** experienced during the implementation of **Lean** and **5S methodology** in construction or organizational settings. For each identified barrier, three indicators are reported:

- **Sum**: The total score obtained across respondents (reflecting cumulative concern).
- **Mean**: The average rating on a 5-point Likert scale.
- **RII (Relative Importance Index)**: A normalized metric used to rank the importance of each challenge on a 0–1 scale.

This data is likely collected via survey responses from construction professionals, project managers, or industrial staff familiar with Lean/5S practices.

Table No. 3 Challenges barriers faced Lean & 5S Implementation

Category	Sum	Mean	RII
Resistance to Change	109	3.63	0.73
Lack of Management Commitment	88	2.93	0.59
Inadequate Training & Awareness	78	2.60	0.52
Short-term Mindset	86	2.87	0.57
Overemphasis on Tools Over Philosophy	98	3.27	0.65
Complex Existing Processes	83	2.77	0.55
Lack of Cross-functional Collaboration	94	3.13	0.63
Poor Data and Metrics	87	2.90	0.58
Technical Integration Issues	114	3.80	0.76
Limited Resources	108	3.60	0.72
Cultural Misfit	93	3.10	0.62
Sustainability Challenges	103	3.43	0.69
Lack of Customization	99	3.30	0.66
Low Employee Engagement	91	3.03	0.61
Ineffective Communication	89	2.97	0.59

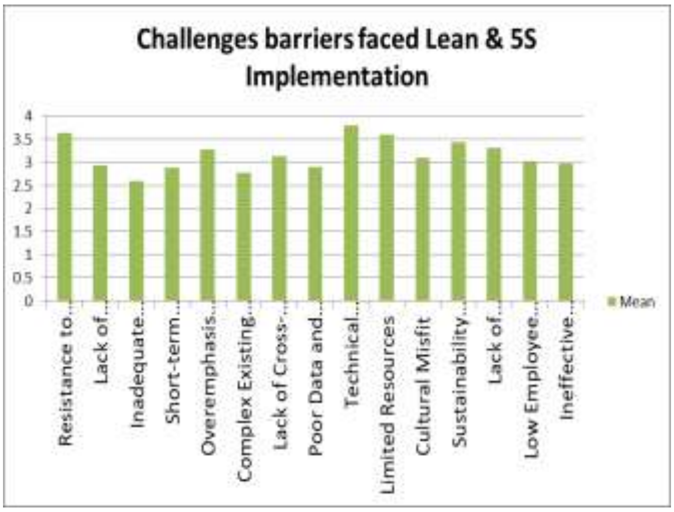

Chart No. 3 Mean- Challenges, Barriers & Technical Complexities

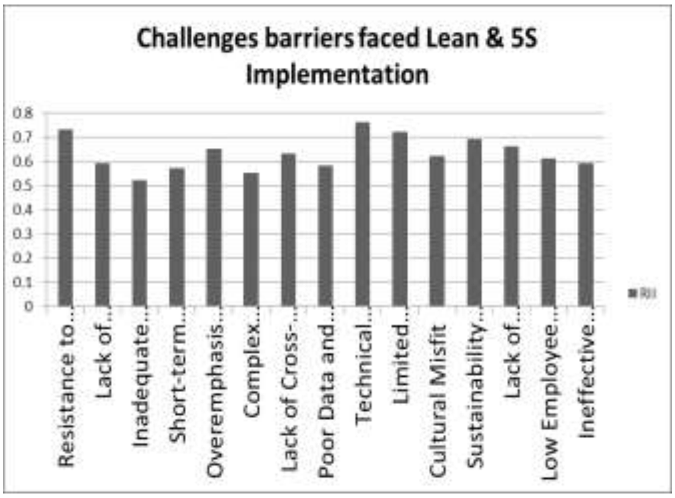

Chart No. 4 RII- Challenges, Barriers & Technical Complexities

1. **Top 5 Barriers Based on RII**:

- Technical Integration Issues – RII = 0.76 (Mean = 3.80): The most significant barrier, indicating serious challenges in integrating Lean/5S with digital tools, ERPs, or project software.
- Resistance to Change – RII = 0.73 (Mean = 3.63): Reflects strong psychological and cultural resistance from employees.
- Limited Resources – RII = 0.72 (Mean = 3.60): Points to constraints in manpower, time, budget, or skills.
- Sustainability Challenges – RII = 0.69 (Mean = 3.43): Shows that maintaining Lean improvements over time is difficult.
- Lack of Customization – RII = 0.66 (Mean = 3.30): Suggests that Lean/5S methods are often applied without tailoring to the organization's specific needs.

2. **Moderate Barriers (RII ≈ 0.58 to 0.65)**:

- Overemphasis on Tools Over Philosophy (0.65)
- Lack of Cross-functional Collaboration (0.63)
- Cultural Misfit (0.62)
- Low Employee Engagement (0.61)
- Lack of Management Commitment & Ineffective Communication (both 0.59)
- Poor Data and Metrics (0.58)

3. **Least Influential Barrier**:

- Inadequate Training & Awareness – RII = 0.52 (Mean = 2.60): Although important, this was rated the lowest, indicating either some basic training exists or its impact is undervalued by respondents.

4. **Recommendations**

- Invest in technical integration by ensuring Lean and 5S practices align with digital platforms like BIM, ERP, and project tracking tools.
- Conduct change management workshops to reduce psychological resistance and improve cultural acceptance.
- Ensure management commitment through leadership involvement, communication, and performance monitoring.
- Customize Lean/5S applications to the specific workflows and constraints of departments or industries.
- Maintain momentum by creating feedback loops, sustainability KPIs, and recognition systems for continuous improvement.

7. **Implementation of Value stream mapping**

We calculate stream value mapping technique sin brickwork and concrete work :

Brickwork:

As per actual site record 100 block mortar mixing required 0.5 hours

Block laying required 3.5 to 4 hour for 1000 bricks in 2 labour

25 km 500 bricks vehicle transport time 0.5 hours

Maximum waiting time 1 hour for mortar curing

Rework 0.1 hours per 1000 block

- Required Total cycle time per 1000 bricks = 6.1 hour
- Value added time = mortar mixing + block laying = = 4.5 hour (73%)
- Non value added time = waiting time+ transport+ rework =1.6 hour (26%)

Concrete work :

As per actual site record each floor have 811 sqm area for slab concrete.

Required time to order of quantity - 2 hour

Delivery to site - 1 hour and Waiting time – 30 min or 0.5 hours

Site Preparation before concrete work – 3.5 hour

Required time concrete pouring is 3 hour and waiting time to pour concrete 15 min or 0.25 hours

Vibrating - 45 min or 0.75 hour

Leveling of concrete - 2 hour

Curing time - 170 hour

Inspection – 1 hour

- Non value added time = order of quantity + Delivery to site + Site Preparation + Inspection

= 7.5 hours

- Value added time = concrete pouring + Vibrating + Leveling = 3+45min + 2 = 5.75 Hours
- Total cycle time = Curing time + value added + non value added

= 183.25 hours

- Concrete lead time = waiting time + waiting time to pour concrete

= 45 min or 0.75 hours

Based on the VSM values added and non value added activities, the study reveals the following key takeaways:

The application of Value Stream Mapping (VSM) in brickwork and concrete work helps assess process efficiency by identifying value-adding and non-value-adding activities.

- For 1,000 bricks, the total cycle time is **6.1 hours**, with **73%** value-added time and **26%** non-value-added time, mainly due to transport, waiting, and minor rework.
- In concrete work, the total cycle time is **183.25** hours, dominated by **170** hours of curing, with **5.75** hours value-added and **7.5** hours non-value-added time.

Blockwork shows higher efficiency than concrete work overall.

Implementing Lean strategies such as 5S process, proper scheduling, and process standardization can help minimize waste and improve productivity.

VSM effectively identifies inefficiencies, supports better planning, and enhances time and cost performance in construction projects.

Table No.4 Summery of Stream value mapping of 1000 brick work and concrete work for one floor

Sr. No	Total cycle time (hour)	Value added time (hour)	Non value added time (hour)
Block work	6.1	4.5	1.6
Concrete	183.25	5.75	7.5
Concrete lead time	0.75ours		

8. Implementation of 5-S System

1. Sort (Seiri):

During the some stage in the initial inspection, it was discovered that unused tool, damaged system, and immoderate cloth stacking occupied almost 500 m² of garage area within the basement location. Unused shuttering plates, damaged tools, and overstocked bricks not only ate up valuable storage however additionally obstructed employee motion and hoist operations. To cope with this, all non-essential tool and scrap materials were looked after and removed, which includes about 6 tons of scrap metal, damaged formwork, and wood waste. As a end result, storage space availability increased by way of **59.6%,** and the common cloth seek time reduced from **22 mins to 6 mins** per worker in line with day, drastically improving operational performance.

2. Set in Order (Seiton):

The next step worried organizing equipment and materials to enhance accessibility. First of all, equipment were scattered throughout multiple floors, cement baggage have been stored without defensive covers, and metallic rods had been mixed without length identification. To accurate this, a coloration-coded labeling device turned into added for smooth identification — green for cement, Yellow for bricks, Blue for steel, and Orange for sand and aggregates. Additionally, storage zones have been marked with painted boundaries and signage, and vertical racks had been created to segregate rebars by using diameter. those actions streamlined the workflow, lowering material retrieval time from **15 mins to just 3 mins** consistent with request and boosting productivity through minimizing pointless downtime.

3. Shine (Seiso):

workplace cleanliness and system upkeep had been prioritized subsequent. The web page formerly suffered from dirt, cement spillage, and cutting debris, which induced 4 minor accidents according to month and confined employee movement. Everyday cleaning schedules were carried out, with give up-of-day cleansing teams assigned to every ground. Waste containers had been installed every 12 meters in corridors and basement zones to promote cleanliness. Furthermore, weekly protection checks for mixers, hoists, and bar bending machines were installed. Those projects led to a reduction of place of work accidents from four in step with month to at least one according to month, and tool downtime decreased by 35%, leading to better tool availability throughout peak work hours.

4. Standardize (Seiketsu):

To ensure consistent practices, popular operating approaches (SOPs) were developed and applied. Previously, non-uniform dealing with practices caused 8% material wastage, in particular in cement and urban utilization. The brand new SOPs protected cement stacking limits (most 10 bags consistent with stack with covers), standardized metallic slicing lengths to reduce offcuts, and segregation of waste into recyclable and landfill classes. A complete of 52 people and 13 supervisors had been trained in these strategies. Laminated "5S & SOP" charts have been also posted at each ground's entry point. The standardization caused a measurable reduction in fabric wastage and progressed usual hard work performance due to constant work practices.

5. Sustain (Shitsuke): Initially, the 5S implementation become maintained efficiently for best three weeks before old behavior resurfaced. To counter this, month-to-month 5S audits had been brought with scoring sheets for each floor. A "satisfactory 5S floor" award turned into set up to encourage groups via small incentives, and 5S compliance turned into introduced as a KPI in subcontractor overall performance evaluations. Those measures successfully sustained the 5S tradition on-site and advocated continuous improvement. Over time, those sustained efforts contributed to a discount of **18 days** inside the overall schedule, reflecting the lasting effect of disciplined implementation.

Table No. 5 Summary table

Parameter	Before 5S	After 5S	Improvement
Storage space occupied	500 m²	210 m²	58% freed
Time wasted searching for tools/materials	22 min/day	6 min/day	13.9 labor hours saved/day
Workplace accidents	4/month	1/month	75% reduced
Tool downtime due to maintenance	28 min/day	18 min/day	35% reduced
Material wastage	8%	3%	₹1,25,000 saved
Overall labor productivity	Baseline	+14–17%	Higher efficiency
Construction duration	24 months	23.4 months	18 days saved

9. CONCLUSIONS

- The take a look at presents a comprehensive evaluation of things influencing creation overall performance thru the application of Lean production principles, the 5S technique, and cost circulation Mapping (VSM). based totally on Relative importance Index (RII) analysis and overall performance dimensions, it is obtrusive that powerful time control, professional body of workers development, and system optimization play a essential function in improving usual challenge efficiency. among all diagnosed troubles, lack of coordination among undertaking entities (RII = 0.87) and supervision delays (RII = 0.80) emerged as the most crucial concerns. those findings absolutely highlight that timely communique, collaboration among stakeholders, and systematic venture planning are essential to prevent schedule overruns and make sure smoother execution.
- In phrases of first-class overall performance, the look at well-knownshows that modernization and group of workers competency are vital drivers of improvement. The absence of modular or prefabricated construction practices (RII = 0.75) and the shortage of staff skill (RII =0.72) imply the pressing want for innovation and technical up skilling. these insights emphasize that making an investment in current production technology and everyday talent-enhancement applications can considerably improve first-rate requirements, minimize mistakes, and boom productiveness. aid control issues are also deeply inspired by means of human elements together with workforce motivation and mind-set (RII = 0.76), signifying that behavioral components are similarly important as technical measures in attaining challenge fulfillment.
- Cost-related challenges, though extraordinarily moderate, are specifically driven by way of outside impacts and communication gaps. With external elements recording an RII of 0.66 and communication breakdowns at 0.59, it becomes clear that hazard management and transparent data drift are important to control fee overruns. A robust framework for stakeholder engagement and outside risk mitigation can, therefore, cause improved monetary performance in construction projects.
- The take a look at additionally diagnosed numerous demanding situations faced at some stage in Lean and 5S implementation. amongst these, virtual compatibility troubles (RII = 0.76) constitute the maximum dominant barrier, pointing toward the urgent want for better integration between Lean gear and current virtual systems. Cultural resistance to trade

(RII = 0.73) and restrained aid availability (RII = 0.72) in addition underline the importance of fostering a supportive organizational culture and ensuring adequate sources for non-stop improvement. Sustainability and adaptability issues (RII = 0.69) suggest that many organizations battle to hold Lean practices over time, regularly due to inflexible implementation or poor comply with-up mechanisms. leadership dedication, effective verbal exchange, and inter-departmental collaboration, which recorded RIIs between 0.59–0.63, must be strengthened to create a protracted-term Lean lifestyle. even though training scored a rather lower RII (0.52), it remains an critical thing for enhancing Lean focus and practical execution.

- The cost flow Mapping (VSM) outcomes further validate the capability of Lean gear in figuring out inefficiencies. In brickwork, 73% of the cycle time changed into fee-brought, at the same time as 26% was non-price-brought, mainly because of waiting and delivery delays. Concrete paintings, ruled with the aid of curing time, exhibited full-size non-fee-adding intervals. these insights affirm that Lean practices which includes 5S, right scheduling, and workflow standardization can lessen waste, improve cycle instances, and beautify average system performance.
- The 5S gadget implementation yielded fantastic upgrades across key performance parameters. storage area utilization advanced via 58%, place of business accidents reduced by seventy 5%, and tool downtime fell by way of 35%. cloth wastage reduced from 8% to 3%, resulting in substantial fee savings, even as labor productiveness extended by means of 14–17%. moreover, assignment length turned into decreased by way of 18 days, reflecting the effectiveness of Lean-pushed control.

In end, the integration of Lean creation, 5S, and VSM strategies demonstrates a effective synergy that complements productivity, great, protection, and fee performance in production initiatives. with the aid of addressing coordination problems, promoting innovation, empowering the staff, and fostering leadership-pushed cultural alternate, creation groups can acquire sustainable growth and operational excellence.

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