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Analysis Lean Construction Management and Slab-Cycle Productivity

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ABSTRACT: This study focus on lean-construction interventions at a ground-plus-seven-storey residential building in Titwala, Mumbai Metropolitan Region, and formulates a prospective Phase-II evaluation framework. Value stream mapping (VSM), workplace organization (5S) and Pareto-based defect prioritization to address RCC slab-cycle delay, off-site material handling, and post-de-shuttering defects. Its reported cycle time declined from 42 to 19 days (a derived 54.76% reduction); labour cost fell from INR 241,200 to INR 189,300 (21.52% reduction), and material savings of INR 34,000 were reported. This paper focused the observations from monitoring measures, including percent-plan-complete, constraint removal, rework frequency and normalized unit costs. The resulting framework offers a applicable procedure for assessing whether the documented benefits are transferable to subsequent project phases.

KEYWORDS: lean construction; value stream mapping; 5S; Pareto analysis; RCC slab cycle; residential buildings; Titwala; construction productivity.

I. INTRODUCTION

Schedule uncertainty, poor site logistics, fragmented subcontracting, and rework remain persistent sources of construction inefficiency. Lean construction shifts managerial attention from isolated task completion toward continuous flow, reliable handoffs, systematic waste identification, and value creation. For repetitive RCC activities, small delays at material delivery, formwork, reinforcement, inspection, or casting can propagate across successive floors. The Titwala G+7 case documented by Maske and Valunjkar (2020) provides a useful example of combining VSM, 5S, and Pareto analysis. The present paper does not replicate their field experiment; instead, it transparently reanalyses their reported indicators and develops a future-phase measurement protocol.

The contribution is threefold: (i) calculation of normalized time and cost improvements from baseline and improved values; (ii) an integrated interpretation of logistics and quality-related waste indicators; and (iii) a clearly prospective 2025 Phase-II evaluation plan that avoids confusing historical evidence with newly collected data.

II. LITERATURE REVIEW

Lean construction is grounded in production-system thinking and the management of variability, waste, and flow. Koskela (1992) established the transformation-flow-value perspective that underpins later lean-construction methods. Ballard (2000) developed the Last Planner System as a production-control approach emphasizing reliable commitments and executable assignments. Salem et al. (2006) described field implementation and assessment of lean construction techniques, while Aziz and Hafez (2013) discussed performance improvement through lean thinking. These works motivate combining planning reliability with operational waste control.

Value stream mapping identifies the sequence and elapsed time of process steps and distinguishes productive work from non-value-adding delay. The 5S method addresses sorting, orderly storage, cleaning, standardization, and sustained discipline. Pareto analysis prioritizes a limited number of recurring defect types for focused corrective action. Renuka et al. (2020) also identify implementation difficulties for lean construction in Indian projects, emphasizing the importance of organizational adoption rather than treating lean as a collection of isolated tools.

For the Titwala project report an initial slab cycle of approximately 42 days, substantial waiting and transport waste, and the use of off-site steel storage roughly two hours from the construction location. They report an improved future-state cycle of 19 days following process changes. These observations provide the empirical baseline for the calculations below; no additional project-specific historical data are assumed.

III. STUDY AREA AND EVIDENCE PROVENANCE

Table 1: Study Area and Evidence Provenance

Characteristic	Information / status
Project location	Titwala, Mumbai Metropolitan Region, Maharashtra, India
Building type	Residential, ground plus seven storeys (G+7)
Identified constraints	Slab delays, inadequate site infrastructure, RCC de-shuttering defects
Lean methods	VSM, 5S, Pareto analysis

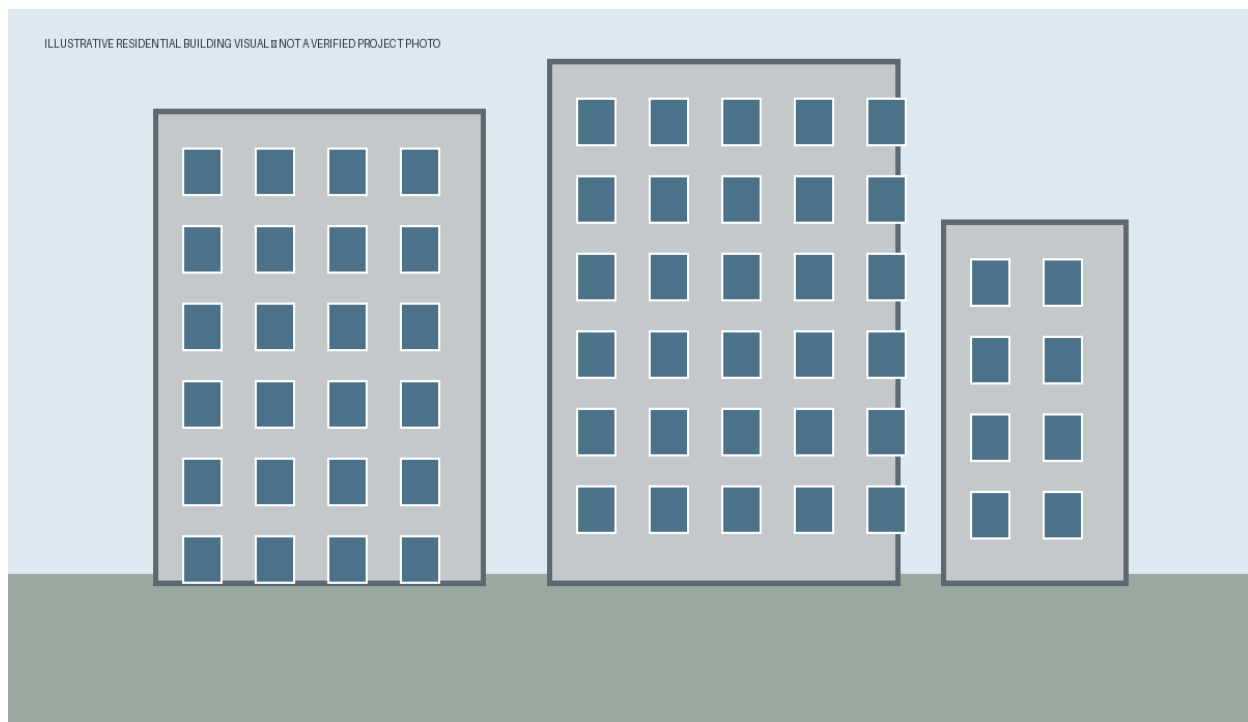


Figure 1: 3D View of Building

3.1 Titwala G+7 project details

Case-study location: Titwala, Mumbai Metropolitan Region, Maharashtra, India. Building configuration: ground plus seven floors (G+7). This study described an eight-month planned completion period and investigated RCC slab-cycle delays, site-infrastructure layout and post-de-shuttering defects.

3.2 Construction-stage



Figure 2: Two views of a multi-storey reinforced-concrete residential building under construction, showing slab/formwork activity, green safety netting, scaffolding, a tower crane, and on-site material handling

The photographs illustrate the structural construction phase of a multi-storey building. Visible features include an exposed reinforced-concrete frame, upper-floor temporary formwork and scaffolding, green perimeter safety nets, a tower crane, a material delivery truck and workers handling construction materials. From a lean-construction perspective, these observable site elements provide useful context for assessing material flow, access constraints, safe handling, workspace organization and the coordination of slab-cycle operations. The photographs alone do not establish project identity, slab-cycle duration, labour productivity, safety compliance or the effectiveness of lean interventions.

3.3 Evidence boundaries and framing

Residential Building (G+7), Titwala, Mumbai · 2025 Phase 2 is the designation used for this proposed primary & secondary-data follow-up. The reported 42-to-19-day slab-cycle comparison and labour-cost values

3.4 Lean Construction System Architecture

The following block diagram organizes the proposed lean management system. I

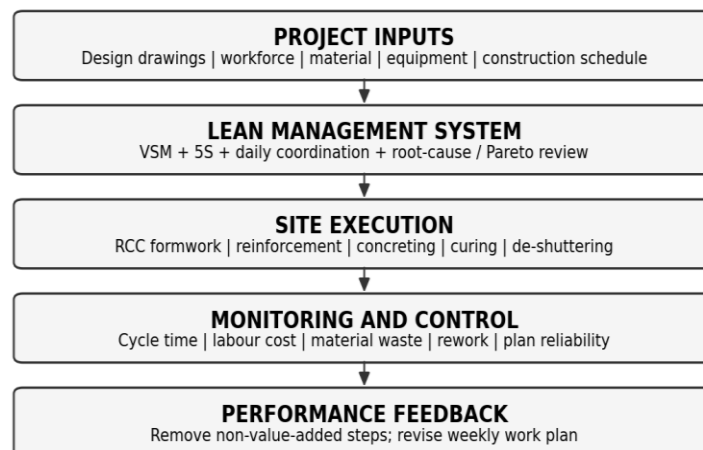


Figure 3: Lean construction management

IV. METHODOLOGY

The method is a secondary-data case analysis rather than primary field research. First reported time, labour cost, material savings, and waste-indicator endpoints are transcribed. Second, percentage changes are computed as $100 \times (\text{baseline} - \text{improved})/\text{baseline}$. Third, waste indicators are compared category by category without aggregating potentially non-exclusive denominators. Finally, a prospective Phase-II measurement matrix is specified for future data collection. The same measurement unit, work scope, and observation rules must be maintained before interpreting future-phase changes as causal impacts.

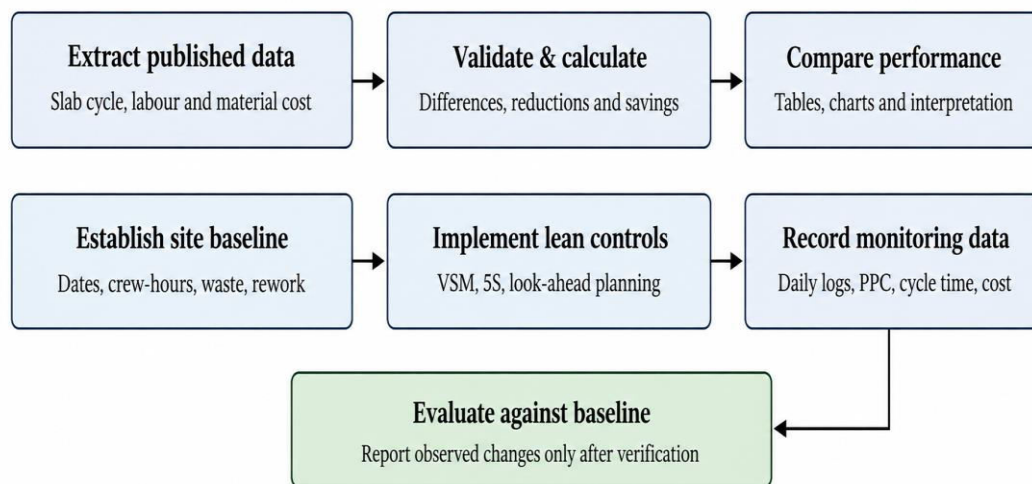


Figure 3: Analytical workflow

For the 2025 Phase-II protocol, the baseline should include slab start/end dates, crew hours, reinforcement and concrete quantities, inspection approvals, rework events, delivery trips, and a dated photographic log. A weekly look-ahead plan and a constraint register would make it possible to assess workflow reliability.

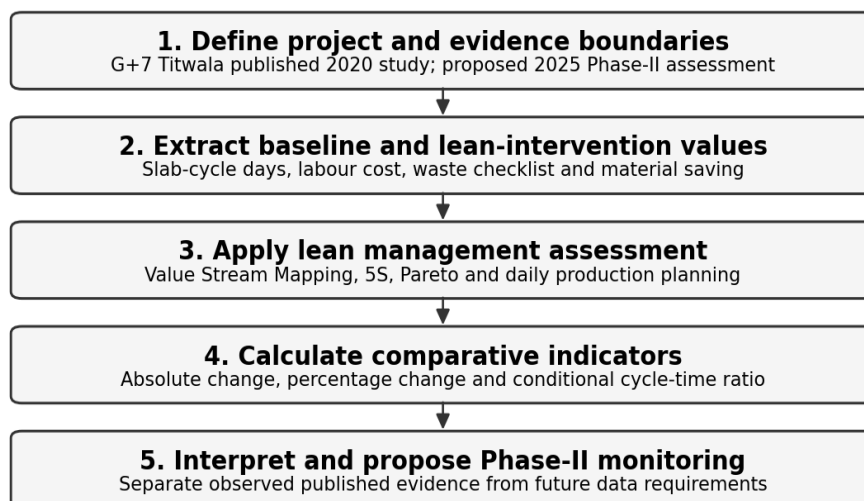


Figure 4: Flow Chart of Methodology

V. QUANTITATIVE ANALYSIS

5.1 Slab-cycle performance

The current-state slab cycle lasted 42 days and the reported improved state lasted 19 days. The absolute reduction is 23 days. The derived percentage reduction is $(42-19)/42 \times 100 = 54.76\%$, while the ratio of baseline to improved cycle duration is 2.21.

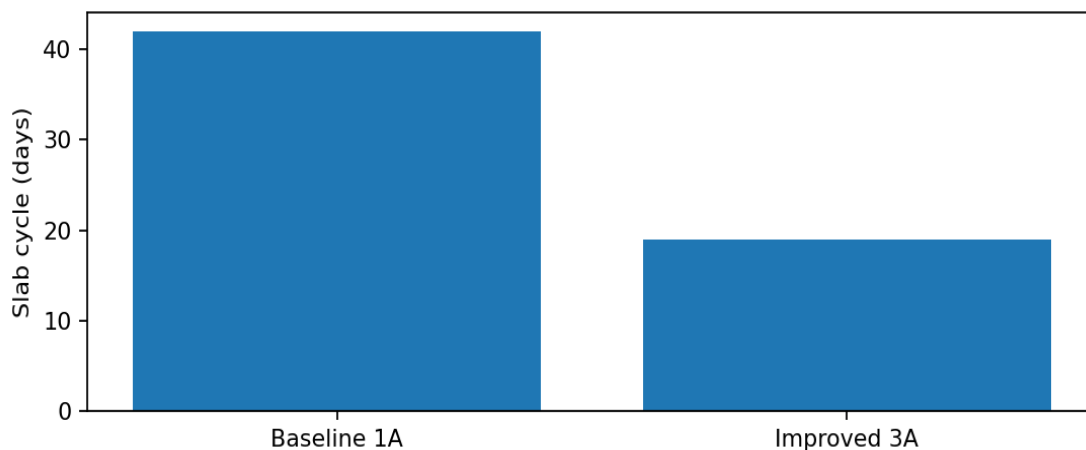


Figure.5. RCC slab-cycle comparison

5.2 Labour-cost performance

Reported labour expenditure fell from INR 241,200 for slab 1A to INR 189,300 for slab 3A, an absolute saving of INR 51,900. The derived proportional decrease is 21.52%. This comparison should not be interpreted as a whole-building project-cost saving, because it refers to the reported slab-level labour figures.

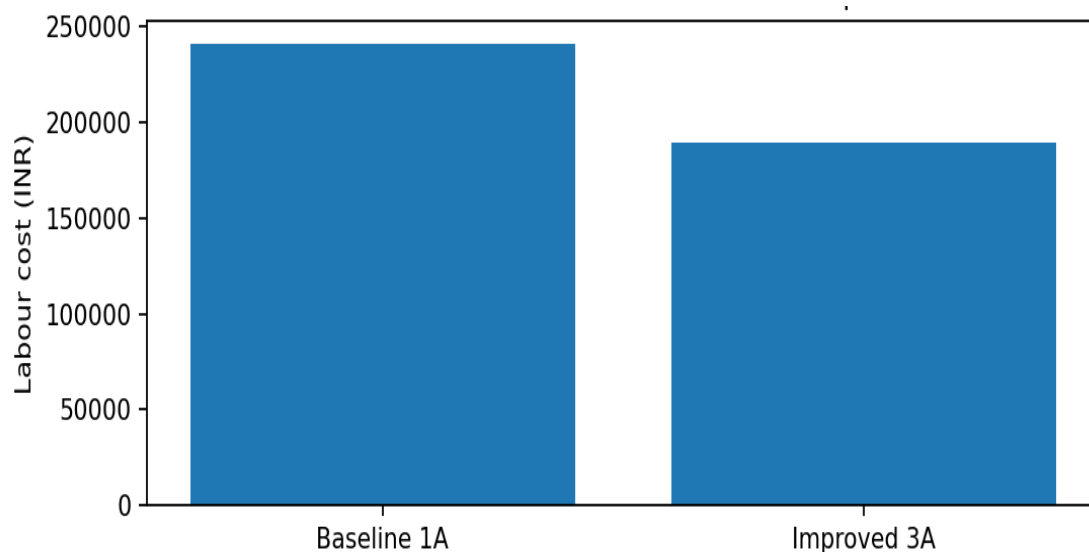


Figure.6. slab-level labour-cost endpoints

Table 1: Calculated performance measures

Indicator	baseline	improved	Derived difference
Slab-cycle duration	42 days	19 days	-23 days (-54.76%)
Slab-level labour cost	INR 241,200	INR 189,300	-INR 51,900 (-21.52%)
Material-cost saving	Not specified	INR 34,000 saving	Percentage not computable
Relative cycle throughput	1.00 baseline	2.21 × baseline	Derived reciprocal of duration

5.3 Waste and quality indicators

The source reports improvements in seven selected waste categories. Waiting decreased from 100% to 0%, transportation from 87.5% to 22.5%, defects from 50% to 22.5%, and inventory excess, motion, excess processing, and overproduction were each reported to reach 0%. These percentages follow the source's own waste checklist definitions; they are not shares of one common total and must not be summed.

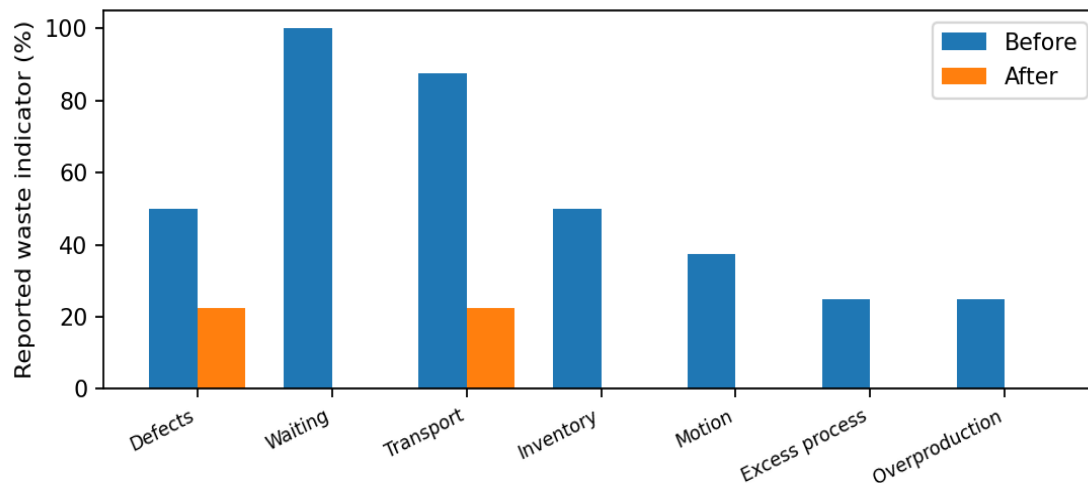


Figure 7: before after waste checklist indicators

Table 2: Waste-indicator endpoints reported

Waste indicator	Before (%)	After (%)	Change (percentage points)
Defects	50	22.5	-27.5
Waiting	100	0	-100
Transportation	87.5	22.5	-65
Inventory excess	50	0	-50
Motion	37.5	0	-37.5
Excess processing	25	0	-25
Overproduction	25	0	-25

5.4 Consolidated Quantitative Results and Derived Metrics

Table 3 Percentage reductions are calculated as $(\text{baseline} - \text{comparison}) / \text{baseline} \times 100$. The implied cycle-frequency ratio ($42/19 = 2.21$) is conditional on identical slab scope and does not establish measured productivity or whole-project completion improvement.

Table 3: Independently calculated descriptive indicators

Indicator	baseline	comparison	Derived measure
Slab-cycle duration	42 days	19 days	23 days saved; 54.76% reduction
Labour cost	INR 241,200	INR 189,300	INR 51,900 saved; 21.52% reduction
Material-cost saving	Not reported as paired endpoints	INR 34,000 saving reported	No defensible percentage without baseline
Conditional cycle-frequency ratio	1.00 (reference)	2.21 (42 / 19)	Scenario ratio only; not measured output

The observed reductions support the interpretation that waste-identification and workflow improvements can coincide with shorter activity cycles and lower slab-level labour expenditure. However, the cited comparison does not isolate a causal treatment effect, and it must not be extrapolated automatically to every slab, building, or 2025 project phase.

VI. CASE-STUDY PROTOCOL

G+7 project this study should prospectively collect paired cycle records before and after interventions, while controlling for floor geometry, concrete volume, weather, crew size, and subcontractor changes.

Table.4. Analysis measurement matrix

Performance dimension	field record	Recommended analysis
Time	Slab casting dates and task start/end logs	Median cycle days; confidence interval
Labour	Trade-wise crew hours and payroll	Labour-hours per m ² slab
Material	Rebar issue/return and concrete reconciliation	Waste kg or m ³ per unit output
Planning reliability	Weekly promised vs completed assignments	Percent plan complete (PPC)
Quality	De-shuttering inspection photographs and defect logs	Defects per 100 m ² and rework hours
Site logistics	Delivery times, travel distances, queue logs	Waiting minutes per delivery

The Phase-II protocol should include date-stamped views of the steel yard, material access route, reinforcement storage, slab formwork, concreting operations, and de-shuttering defects.

VII. DISCUSSION

The time reduction reported in the Titwala study is substantially larger than the relative labour-cost reduction. This is plausible because calendar duration can be strongly affected by nonproductive waiting, transport, and work sequencing even when direct labour spending falls less sharply. The original report links transport-related inefficiency to steel storage away from the site and associates defect-control improvements with systematic de-shuttering reporting. The observed endpoints are consistent with those mechanisms but do not by themselves prove that lean tools alone caused the entire difference.

The prospective 2025 framework adds stronger comparability requirements. For example, a 19-day cycle for a smaller slab and a 42-day cycle for a larger slab would not support a like-for-like efficiency claim. Future observations should therefore normalize by slab area, concrete volume, reinforcement tonnage, and crew-hours. In addition, interrupted weather days, inspection holds, and supply delays should be logged separately. These steps improve external validity and reduce the risk of attributing every improvement to VSM or 5S.

The case illustrates the managerial complementarity of tools: VSM exposes waiting and process bottlenecks; 5S improves workplace accessibility and reduces unnecessary handling; and Pareto-based reporting focuses attention on recurring RCC defects. Together they suggest a process-control strategy rather than a one-time cost-cutting exercise. The generalization of the findings is nevertheless constrained by a single project, nonrandom intervention timing, incomplete raw task logs, and the absence of independently verified 2025 measurements.

VIII. CONCLUSION AND FUTURE RESEARCH

A transparent analysis of the Titwala G+7 residential project indicates a 23-day (54.76%) reduction in reported slab-cycle duration and INR 51,900 (21.52%) reduction in slab-level labour cost between the cited baseline and improved observations. The original authors also report INR 34,000 in material savings and reductions in several checklist-based waste indicators. These findings support further investigation of VSM, 5S, and Pareto analysis as complementary construction-management tools, while remaining calculated.

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