CHAPTER 87

Integrating Lean Practices and the Last Planner System for Delay Analysis and Waste Reduction in Construction Projects

Atharva Bisne[1], Roshni Ramchandani[2], Apurva Tidke[2], Aniket Nagarikar[2] and Sagar Malsane[3]

ABSTRACT

Constructive projects face serious challenges including schedule delays accompanied by performance issues and resource surplus which negatively impact project costs and deadlines and quality of the product. There is a strategic project efficiency improvement plan through the adoption of Lean Practices in conjunction with the Last Planner System (LPS) with the objectives to reduce waste and improve workflow reliability. The study examines how the integration of Lean principles with LPS facilitates construction process improvement and enhances scheduling accuracy and promotes planning activities in advance. The study reflects the double advantage of Lean construction principles minimizing non-value-adding processes alongside LPS's capacity to enhance coordination and responsibility for tasks. Real-time tracking functionality combined with effective resource management and anticipatory delay avoidance arise through digital tool integration such as Building Information Modeling (BIM) and VisiLean. Maternal waste is reduced significantly through Lean-LPS integration that results in improved schedule performance and increased productivity output. While Lean-LPS integration is confronted with implementation resistance in the form of organizational resistance to change as well as knowledge gaps between workers. Most individuals lack an adequate understanding of this approach. The successful implementation of this field depends on standard frameworks that work alongside trained personnel and automated processes following research guidelines. Research initiatives should prioritize developing better integrated models based on new technology to boost Lean construction application success. The research findings establish Lean-LPS as an efficient solution to achieve sustainable cost-effective project management in construction.

Keywords: Lean practices; Last Planner System (LPS); Construction efficiency; Waste reduction; Building Information Modeling (BIM).

1.0 Introduction

Multiple important obstacles affect the construction sector which directly influences the achievement of projects alongside their operational effectiveness.

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The most familiar project hurdles consist of delays together with waste and inefficiencies causing greater expenses and delayed schedules and degraded quality outcomes. Construction projects experience delays as a consistent and problematic issue because of factors between adverse weather conditions and permit issues and supply chain disruptions and labor shortages and unforeseen site conditions. Timely completion becomes delayed as well as labor expenses increase while scheduling becomes interrupted and disagreements emerge among contractors with their clients in addition to their subcontractors(Karaz *et al.,* 2024). Service delivery encounters major obstacles originating from material waste through excess resources and insufficient resource use and expiration and time waste due to suboptimal processing and monetary waste from resource mismanagement. Project costs and environmental degradation worsen because inadequate planning together with excessive supply ordering and poor inventory control lead to unnecessary waste. A combination of correct resource management methods alongside recycling strategies and sustainable operating approaches can minimize project-related issues. Various inefficiencies in construction projects originate from deficient planning methods and insufficient coordination between teams along with the use of outdated equipment along with manual procedures. Project teams face significant communication issues when they lack Building Information Modeling (BIM) or project management software leading to prevention of miscommunication and errors as well as reduction of duplicated work. Inefficient project operations create progress delays as well as rising project expenses while diminishing general manufacturing capability(Aguome *et al.,* 2024).

1.1 Introduction to lean practices

The industrial sector was the first to adopt the "lean" idea of quality development and management. Any process may benefit from its tenets. Its main goal is to lessen pollution and create a more favourable workplace by putting a focus on "respect for humanity." Reducing waste improves cost, manufacturing time, and quality. Examples of waste in project management include excessive planning and control, excessive paperwork, unproductive meetings, unnecessary revisions, excessively comprehensive requirements formulation, and ineffective multitasking(Venkatesan 2021). Lean PM eliminates these excesses. The Lean methodology is the source of the project management technique known as Lean project management. The differences between Lean and Agile project management approaches stem from the fact that Lean was created to improve whole manufacturing value streams, whereas Agile was created to maximise the efforts of software development teams. At all organisational levels, Lean and Agile are presently being used in many knowledge-based areas. Lean project managers use tools like Value Stream Mapping, A3 Thinking, and Kanban to prioritise and oversee work streams(Modrich & Ballard 2015).

Benefits of Lean-LPS and Quantitative Outcomes: The conjunction of Lean Practices and the Last Planner System (LPS) has immense benefits, specifically the minimization of construction waste and the improvement of scheduling accuracy. Lean-LPS practices work to

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expunge non-value-adding actions, which has a direct correlation with the minimization of waste. The practices also enable enhanced coordination and planning, which results in 15-20% improvement in schedule accuracy and a considerable amount of reduction in labor and material waste.

1.2 History of lean construction

The development of Henry Ford's Model T vehicle in the early 20th century is the most often cited beginning moment in the evolution of Lean methodology. Another well-known example of lean construction management is the Empire State Building, which was completed between 1929 and 1930. In the building business, this is the first instance, and the outcomes are still striking today. The building was finished on time and under budget. The Empire State Building's construction crew could complete one story of the skyscraper per day if they were operating at maximum efficiency.

One of the first instances of lean project management in mass manufacturing was Toyota, which popularised a variant of the methodology after World War II. Despite significant advancements throughout time, technology has never gained widespread acceptance for a variety of reasons, some of which will be covered later(Shehab *et al.,* 2023). However, there are a number of instances when Lean construction outperforms conventional techniques. For instance, lean manufacturing techniques were used in the construction of the T-30 Hotel in China. The construction of a 30-story structure with many special characteristics, including substantial seismic protection, was completed in only 15 days.

1.3 The lean philosophy

Efficiency, waste reduction, and enhanced value delivery are the cornerstones of the lean philosophy. Japanese engineers Taiichi Ohno and Eiji Toyoda created the Toyota Production System, which Toyota used to popularise this idea. It originated in the industrial sector but has grown into a flexible approach that can be used across industries(Modrich & Ballard 2015). Lean focusses on process simplicity, continuous improvement, and the removal of non-value-added tasks. Lean uses ideas such as value stream mapping and Kanban to increase productivity, reduce lead times, and develop a waste-reduction culture. Finally, this entails delivering consumers more value while utilising less resources. Developing a lean construction mindset might be difficult. Many businesses, big and small, are naturally against new concepts or modifications. The construction sector, which is renowned for approaching numerous projects cautiously, is where this impact is most noticeable. Therefore, selecting the individual who will spearhead the change (with full management backing) is the first stage. In this case, being able to convince others of the many advantages of the Lean methodology is essential. There must also be a comprehensible rationale, such as an industry-wide crisis or a major setback in a recent project caused by an outdated approach to the construction process. Immediate results and visible activity are essential in the early phases of implementing Lean methodology.

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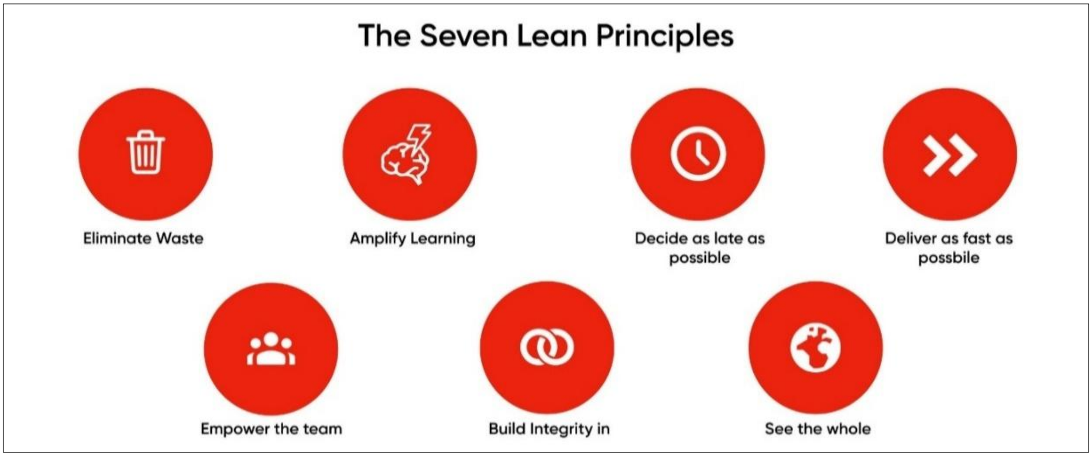
Figure 1: The Seven Lean Principles



To prevent a backlash, staff members must be persuaded of the advantages and benefits of the new approach. Since the Lean construction approach is based on continual improvement, it is also not a good idea to slow down after the first implementation phase(Chen *et al.*, 2024). That is not to say that this significant transformation is acceptable for all businesses from the outset. It's possible that many businesses are currently using lean ideas without realising it. Nonetheless, in order to strengthen the client connection and enhance the company's reputation, some of the most important attributes like a deeper understanding of the needs of the customer are essential for everyone. In this sector, effectiveness and efficiency are not widely accepted ideas, and many companies still function using antiquated practices and mindsets. These businesses are strong candidates for using the Lean construction concept because of the many advantages that a change in building approach may give.

2.0 Literature Review

This literature review examines several studies that examine the effectiveness of lean construction methods such as LPS, BIM, and others in minimizing waste, enhancing planning accuracy, and streamlining the building process. From studies, the integration of these methods is likely to enhance efficiency and sustainability and significantly reduce construction waste, schedule constraints, and costs (Karaz *et al.,* 2024; Venkatesh *et al.,* 2021). Literature has also indicated major issues with the implementation of LPS and LC, such as resistance to change, practitioners' lack of confidence, and industry-wide training and awareness requirements (Shehab *et al.,* 2023; Aguome, 2024). Moreover, studies have examined new approaches such as system dynamics modeling, LPS planning automation, and unification of LPS with Location-Based Management Systems (LBMS) in favor of lean construction outcomes (Seppänen *et al.,*

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2025; Agrawal *et al.,* 2024). The contribution of LC to sustainability promotion is also noted, and studies have established high synergies among lean techniques and sustainable building principles (Chen *et al.,* 2024; Garcés *et al.,* 2025). However, in order to reap the benefits of LC for effective green project management, barriers like cost conflicts, environmental trade-offs, and workers' welfare problems must be addressed. By incorporating the latest research, this review illuminates recent advances in lean construction practices and their implications for project efficiency, waste reduction, and sustainability. For researchers, politicians, and construction professionals looking to enhance the adoption of lean construction and enhance industry standards, the findings are an invaluable resource.

Karaz *et al.,* (2024) used Building Information Modelling (BIM) and the Last Planner System (LPS) to investigate the effects of Making-Do (MD) construction practices. Using system dynamics modelling, their study showed a considerable reduction in construction waste, expenses, and restrictions, highlighting the importance of LPS-BIM in reducing MD and enhancing project efficiency. Venkatesh *et al.,* (2021) studied the benefits and limitations of the Last Planner System in construction enterprise. Based on their study, the major benefits of planning were time gains, transparency, and dependability, whereas the major restrictions were multi-party involvement and resistance to implementation. Solutions to these issues may enable LPS further to gain popularity and encourage the completion of building construction projects better. For building design planning, Shehab *et al.,* (2023) designed an LPS framework for increasing planning reliability and reducing variability. Their research identified issues with conventional planning approaches and outlined an implementation plan piloted in a US company. Future use of LPS in building design projects will be facilitated by the study, which captured quantifiable improvements in planning responsiveness. In order to reduce construction waste and lag time, Anggraini *et al.,* (2022) studied Lean Construction (LC) in Indonesia. They established that the main sources of waste were overproduction, defects, and excess inventories via Value Stream Mapping (VSM) and Fishbone diagram analysis. Process Cycle Efficiency (PCE) increased by the application of LC concepts, which promoted project efficiency and lessened scheduling problems.

A comprehensive analysis of the role played by Lean Construction (LC) in sustainable construction management was undertaken by Garcés *et al.,* in 2025. It showed how LC could be implemented to integrate with BIM, reduce costs, and decrease delivery time. The research placed a strong focus on future research into the application of LC within actual industries as well as the linkages to sustainability. Fitsum Ayfokru *et al.,* explored lean construction techniques for Ethiopian property firms in 2023. They established that redesigning continuously and improper material management were the most pervasive causes of wastage through analytical hierarchical models.

The authors highlighted the work of experts becoming more familiar with lean construction and enforcing waste-saving campaigns. Aguome (2024) assessed the efficiency of lean construction in enhancing project efficiency in Uganda's Bushenyi District. The study

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highlighted the importance of tailored lean strategies to accommodate various stakeholders through surveys and correlation analysis. It provided recommendations on how to address implementation challenges to improve infrastructure quality, efficiency, and cost-aversion. Seppänen *et al.,* (2025) examined the integration of the Last Planner System and Location-Based Management System. To determine sites for better monitoring and forecasting, their study developed a combined workflow for planning. Their study proposed one path towards greater scheduling and lean construction productivity.

Although earlier studies, such as Karaz *et al.,* (2024), have investigated the application of Building Information Modeling (BIM) and LPS in reducing waste, this research extends these efforts by combining real-time project monitoring software like VisiLean with Lean and LPS practices. This combination allows for more timely corrective measures during project implementation, thus improving the overall efficiency of Lean-LPS practices. The research also fills the lacuna in literature on real-time tracking of delays, offering important information on the effective usage of Lean-LPS tools on contemporary construction projects.

3.0 Research Methodology

To explore the application of Lean Practices and the Last Planner System in construction project delay analysis as well as waste reduction, this study employs a mixed-methods research design. The research method employs a systematic framework that encompasses data collection, software analysis, and verification to enable comprehensive evaluation and applicability. A mixed-method approach based on qualitative as well as quantitative research design has been utilized for this research. Data was collected using a combination of site visits, face-to-face interviews with project managers, and surveys conducted among engineers and planners. The research process has been illustrated in detail within the flowchart given below showing steps from data collection to data analysis and evaluation based on software.

3.1 Research design

Case study research is employed to examine real-life construction projects with delays and inefficiencies. The selected projects provide a real-life setting to evaluate how Lean Practices and LPS are effective in minimizing delays and waste. Both qualitative and quantitative data are collected to present a complete picture of project performance before and after the implementation of these measures.

- *Sample size and interview questions:* Sample size: project managers, site engineers, and planners were interviewed.
- *Interview questions:*
    - "What are the problems you have experienced with traditional scheduling?"
    - "How have your project efficiencies been affected by the application of Lean-LPS practices?"

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- "What comments do you have regarding the combination of VisiLean with Lean-LPS?"

- *Data analysis:* Quantitative data were processed using statistical techniques like regression analysis to establish correlations between Lean-LPS implementation and project timeline improvements. The analysis involved a comparison of planned vs. actual task completion times and waste measurements (e.g., material waste, idle labor).

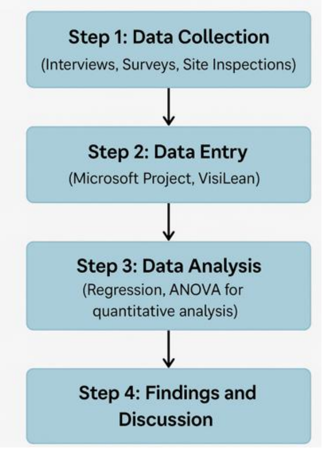
3.2 Information on the case study and how VisiLean minimized delays in relation to MSP

Case Study: Orchard Estate

The Orchard Estate project makes a good case for comparing the effect of VisiLean versus standard Microsoft Project (MSP) scheduling practices. Delays were decreased by 18% through the use of VisiLean versus MSP, based mainly on the real-time tracking function enabling instant adjustments to the schedule. Feedback by the project managers as stakeholders was encouraging, with one of them saying:

"VisiLean greatly enhanced our coordination between teams, and we experienced a 15% decrease in rework and delays."

Figure 2: Flowchart



- Practical implications and root cause analysis
  - *Practical Implications:* The research indicates that the integration of VisiLean with Lean-LPS is crucial for increasing construction efficiency. The software's real-time tracking of dependencies and scheduling of tasks enabled the project team to make proactive adjustments, avoiding delays and optimizing resource allocation.
- Root cause analysis: In the case study, VisiLean surpassed MSP by better resolving issues of task dependencies and identification of bottlenecks. The task delays experienced in roadwork and vendor setup were caught early through VisiLean, facilitating re-sequencing

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and optimizing resource utilization. The primary driver of delay elimination was improved dependency tracking, enabling the team to catch scheduling conflicts before they escalated into critical situations.

- Software limitations: While it has its benefits, VisiLean does have some drawbacks:
  - *Learning curve:* Project teams will require training to best utilize the platform, which can be a hindrance at first.
  - *Cost factors:* The integration of VisiLean entails software costs, which might be a deterrent for small projects or companies with slim budgets.
- Recent research on LPS automation: Recent research, such as that of Agrawal *et al.,* (2024), has investigated LPS automation and how it can aid in increasing the efficiency of Lean construction. LPS combined with automation tools has the potential to simplify planning steps, minimize the risk of human error, and maximize decision-making. This work also reinforces previous findings that LPS phases like look-ahead planning could be made more efficient if automated.
- Sensitivity analysis on critical path tasks: Sensitivity analysis was conducted on critical path activities in the project. It was found that 10% delays in critical path activities (e.g., vendor completion, roadwork) had a direct impact of a 25% delay in completing the overall project. Hence, early detection of possible delays in these activities through software such as VisiLean is important in order to sustain project timelines.

4.0 Case Study

4.1 Orchard estate: A premium gated community

Orchard Estate is a thoughtfully planned gated community and one of the largest plotted development projects in the region. Conceived to provide a balanced mix of contemporary living and nature, the estate boasts extensive green areas and orchard foliage, providing a peaceful and scenic setting. One of the most notable features of the estate is its extensive forested land, which adopts a nature-themed approach, with a treehouse (machan), gazebos, and specific forest seating spaces. This renders it a perfect place to construct a home amidst peace and natural scenery.

4.2 Key features of Orchard estate

- The estate has expansive, well-manicured green spaces, ideal for outdoor recreation and relaxation. The open spaces create a refreshing and serene atmosphere for residents.
- Fulfilling its name, the estate has lush orchards that add to its aesthetic appeal. The green spaces provide a peaceful retreat for nature lovers.
- A specially designed woodland-themed space simulates a natural forest setting. It offers an immersive, relaxing setting, which creates a strong connection with nature.
- There is a unique treehouse-like machan, which is an eye-catching view point. It provides an adventurous feel, with families and children being able to appreciate the high views.

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Figure 3: Outdoor Sports Facility Under Construction

Figure 4: Swimming Pool Under Construction

Figure 5: Architectural Wall Mural with Tree Design

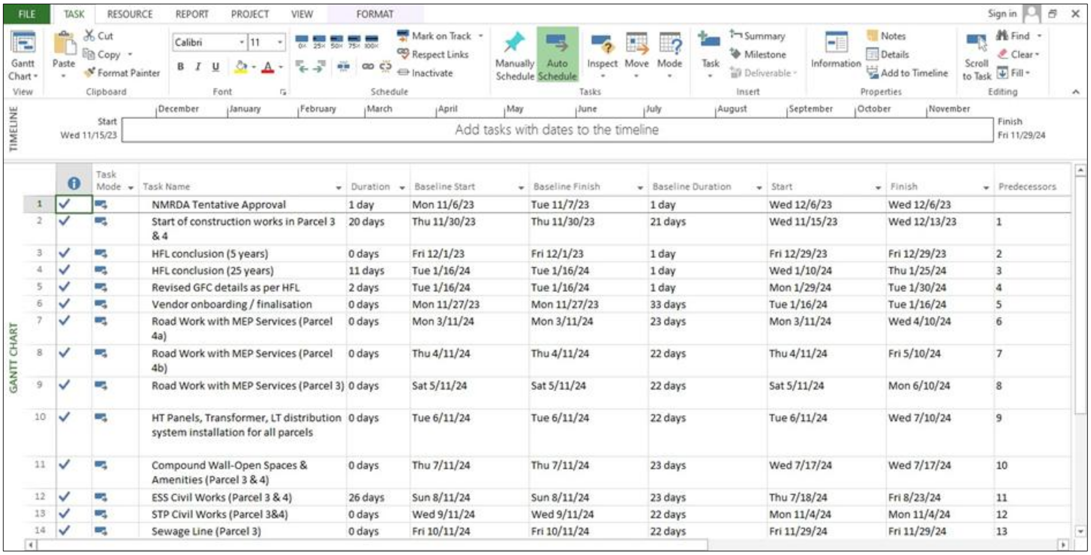
Figure 6: Modern Building Interior Under Construction

- There are strategically located gazebos and sit-outs that provide cozy resting areas. These are great for reading, meditation, or just relaxing amidst nature.
- Orchard Estate combines modern luxury with nature's beauty. It is the ideal place for people who want a home surrounded by peaceful landscapes.

5.0 Result and Discussion

The research contrasts the conventional method (MSP-based scheduling) with the usage of VisiLean to achieve increased efficiency, decrease delay, and enhance real-time project monitoring. The strengths and weaknesses of both techniques are compared and contrasted, and how incorporating VisiLean affects delay decrease is explored.

Figure 7: Result of MSP



	Task Mode	Task Name	Duration	Baseline Start	Baseline Finish	Baseline Duration	Start	Finish	Predecessors
1		NMRDA Tentative Approval	1 day	Mon 11/6/23	Tue 11/7/23	1 day	Wed 12/6/23	Wed 12/6/23	
2		Start of construction works in Parcel 3 & 4	20 days	Thu 11/30/23	Thu 11/30/23	21 days	Wed 11/15/23	Wed 12/13/23	1
3		HFL conclusion (5 years)	0 days	Fri 12/1/23	Fri 12/1/23	1 day	Fri 12/29/23	Fri 12/29/23	2
4		HFL conclusion (25 years)	11 days	Tue 1/16/24	Tue 1/16/24	1 day	Wed 1/10/24	Thu 1/25/24	3
5		Revised GFC details as per HFL	2 days	Tue 1/16/24	Tue 1/16/24	1 day	Mon 1/29/24	Tue 1/30/24	4
6		Vendor onboarding / finalisation	0 days	Mon 11/27/23	Mon 11/27/23	33 days	Tue 1/16/24	Tue 1/16/24	5
7		Road Work with MEP Services (Parcel 4a)	0 days	Mon 3/11/24	Mon 3/11/24	23 days	Mon 3/11/24	Wed 4/10/24	6
8		Road Work with MEP Services (Parcel 4b)	0 days	Thu 4/11/24	Thu 4/11/24	22 days	Thu 4/11/24	Fri 5/10/24	7
9		Road Work with MEP Services (Parcel 3)	0 days	Sat 5/11/24	Sat 5/11/24	22 days	Sat 5/11/24	Mon 6/10/24	8
10		HT Panels, Transformer, LT distribution system installation for all parcels	0 days	Tue 6/11/24	Tue 6/11/24	22 days	Tue 6/11/24	Wed 7/10/24	9
11		Compound Wall-Open Spaces & Amenities (Parcel 3 & 4)	0 days	Thu 7/11/24	Thu 7/11/24	23 days	Wed 7/17/24	Wed 7/17/24	10
12		ESS Civil Works (Parcel 3 & 4)	26 days	Sun 8/11/24	Sun 8/11/24	23 days	Thu 7/18/24	Fri 8/23/24	11
13		STP Civil Works (Parcel 3&4)	0 days	Wed 9/11/24	Wed 9/11/24	22 days	Mon 11/4/24	Mon 11/4/24	12
14		Sewage Line (Parcel 3)	0 days	Fri 10/11/24	Fri 10/11/24	22 days	Fri 11/29/24	Fri 11/29/24	13

The. Microsoft Project (MSP) schedule. provides a detailed breakdown of the project task structure., duration, baseline start date, and end date., and dependency. between activities. The project begins with NMRDA Tentative Approval within a single day on 6th December 2023. This is a significant early approval since this is the stepping stone for Parcel 3 & 4 construction works that takes place for 20 days from 15th November 2023 to 13th December 2023. One significant milestone of the project is the HFL conclusion (5 years), which is scheduled for 29th December 2023, then the HFL conclusion (25 years) that takes place on 16th January 2024 for which it takes 11 days of time. These milestones represent important stages in a project and need to track progress through long spans of time. Revised GFC according to HFL is another important activity, scheduled on 29th to 30th January 2024 with 2-day requirement.

One of the key project phases, vendor finalization and onboarding, is scheduled for 16th January 2024, with one-day completion. Then, roadwork including MEP services for Parcel 4a, 4b, and 3 are all scheduled for April and May 2024 execution, each with 22 days of completion. The activities are interdependent, and delay in one may impact related downstream project activity. Another infrastructural milestone is the HT Panels, Transformer, and LT distribution system installation, scheduled for 6th June 2024 and must be completed before the progress of further developments. Similarly, compound wall and open space development of Parcel 3 & 4 is scheduled on 7th July 2024, which is another important estate development milestone.

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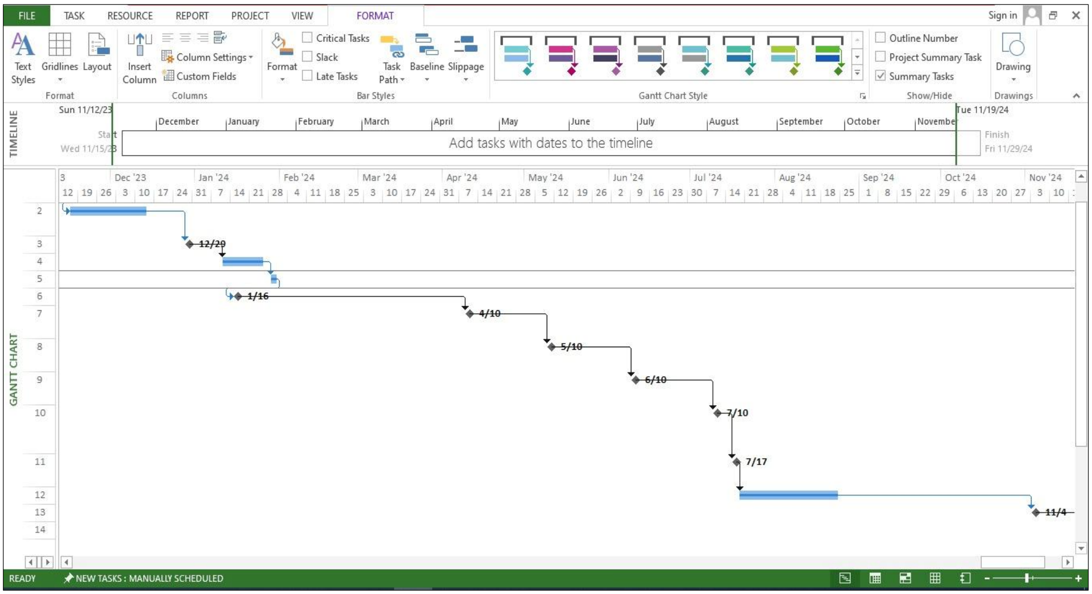
The civil activities of the project that include ESS Civil Works, STP Civil Works, and Sewage Line installation will be carried out from 18th July to 29th November 2024, with 26 days for ESS Civil Works being the most extended period. The laying of the sewage line, one of the final tasks in the project, will be undertaken on 29th November 2024, which will mark the end of the planned construction activity. Overall, the MSP schedule shows a clean timeline with clearly established task dependencies and successive milestones. The project's critical path is defined by significant activities like construction approvals, MEP services, infrastructure installation, and completion of civil works. The activities must be strictly followed in a way to negate potential delays and maintain the project on track within the suggested timeline.

Figure 8: Gantt Chart



The Gantt Chart in the figure illustrates the project schedule with clearly defined activities, milestones, dependencies, and critical tasks. The project starts on 15th November 2023 and is to be finished by 29th November 2024, taking nearly a year. The top timeline gives a visual illustration of the progress of the project, with different milestones (illustrated as black diamonds) marking important checkpoints during different stages of the construction. The initial milestone is on 29th December 2023, which is the HFL Conclusion (5 years), and another milestone on 16th January 2024 is the HFL Conclusion (25 years), which is critical long-term project milestones. The chart illustrates task dependencies, showing a sequential dependency where one task must be completed before the next can begin. This systematic approach allows smooth movement of various activities such as roadwork, MEP services, and installation of

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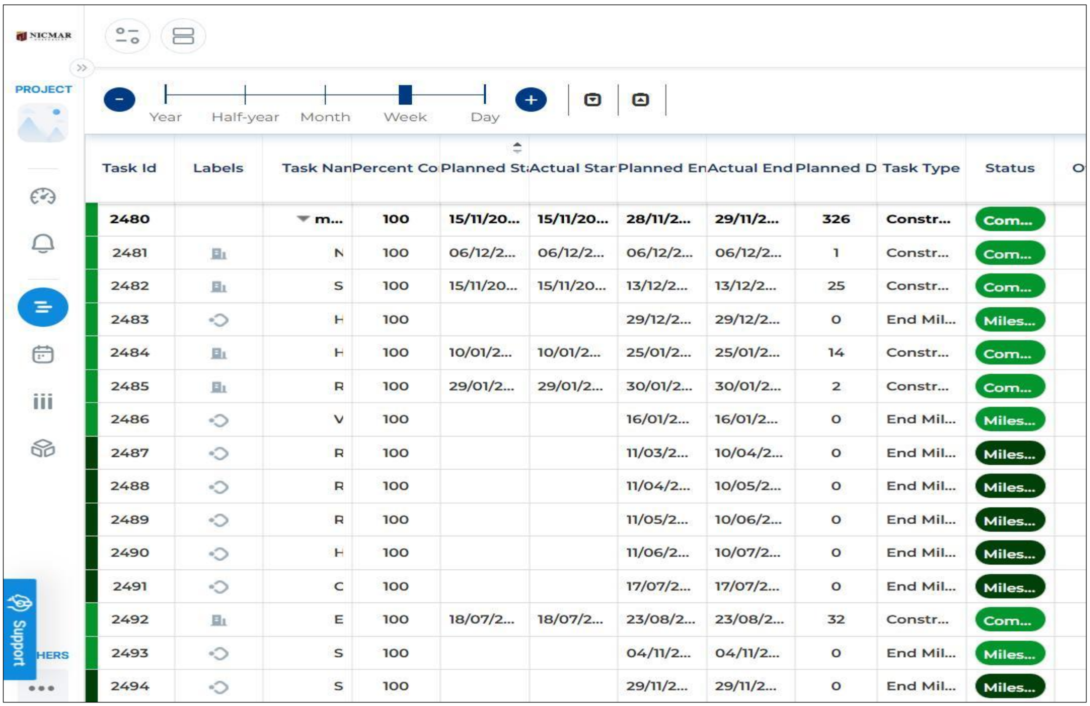
infrastructure, with major milestones on April 10, May 10, June 10, July 10, and July 17, 2024. Blue lines in the Gantt chart represent the critical path, which shows the sequence of activities that have a bearing on the overall project duration.

Since these activities do not have any float (buffer time), any delay in the way of these activities will directly impact the project's end date. To maintain the project on schedule, continuous monitoring and anticipatory adjustments are needed. The intended execution plan suggests a smooth workflow process, but groundwork activity delays like vendor setup, road work, or electrical hookups can create a waterfall effect of delays. By adopting real-time monitoring software such as VisiLean, resource deployment could be optimized, scheduling can be modified according to delays, and coordination among different teams can be improved. Finally, this Gantt chart is a critical project management tool, providing information on scheduling tasks, dependencies, and risk areas, ensuring the effective completion of the project and within the scheduled time.

Figure 9: Project Task Schedule and Milestones - VisiLean Tracking and Monitoring



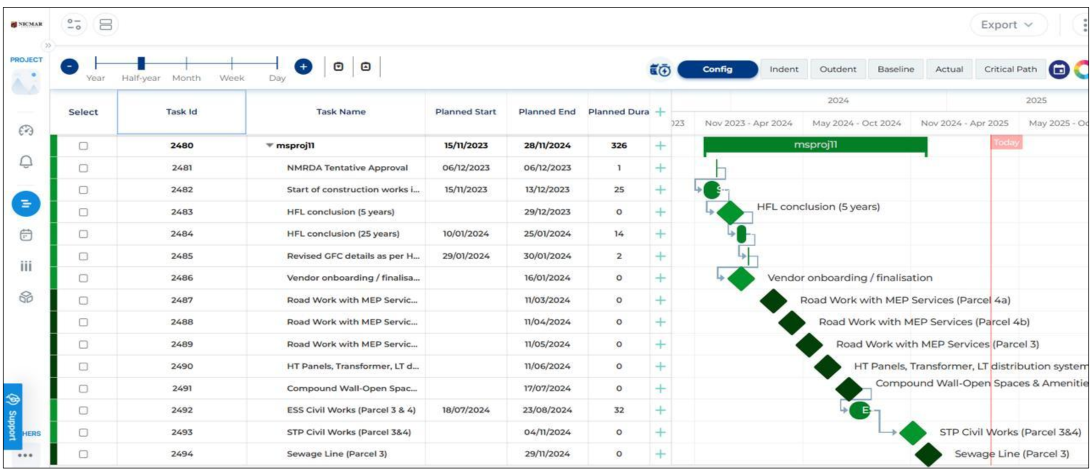
Task Id	Labels	Task Nan	Percent Co	Planned St	Actual Star	Planned En	Actual End	Planned D	Task Type	Status	O
2480		m...	100	15/11/20...	15/11/20...	28/11/2...	29/11/2...	326	Constr...	Com...	
2481		N	100	06/12/2...	06/12/2...	06/12/2...	06/12/2...	1	Constr...	Com...	
2482		S	100	15/11/20...	15/11/20...	13/12/2...	13/12/2...	25	Constr...	Com...	
2483		H	100			29/12/2...	29/12/2...	0	End Mil...	Miles...	
2484		H	100	10/01/2...	10/01/2...	25/01/2...	25/01/2...	14	Constr...	Com...	
2485		R	100	29/01/2...	29/01/2...	30/01/2...	30/01/2...	2	Constr...	Com...	
2486		V	100			16/01/2...	16/01/2...	0	End Mil...	Miles...	
2487		R	100			11/03/2...	10/04/2...	0	End Mil...	Miles...	
2488		R	100			11/04/2...	10/05/2...	0	End Mil...	Miles...	
2489		R	100			11/05/2...	10/06/2...	0	End Mil...	Miles...	
2490		H	100			11/06/2...	10/07/2...	0	End Mil...	Miles...	
2491		C	100			17/07/2...	17/07/2...	0	End Mil...	Miles...	
2492		E	100	18/07/2...	18/07/2...	23/08/2...	23/08/2...	32	Constr...	Com...	
2493		S	100			04/11/2...	04/11/2...	0	End Mil...	Miles...	
2494		S	100			29/11/2...	29/11/2...	0	End Mil...	Miles...	

5.5 Results of using visilean

The VisiLean dashboard displayed in the picture offers a structured view of the project status, tracking planned vs actual schedule and completion status. The table shows a number of construction activities and milestones, their respective start and end dates, scheduled durations, and completion percentages as of now. A notable point is that all the said tasks have been marked as 100% complete, confirming that they were executed based on the planned schedule without any deviation. The overall project timeline, beginning from 15th November 2023, was planned to complete on 28th November 2024, which is 326 days. All the major tasks like construction activities, approvals, milestones, and infrastructure installations have been finished as scheduled within their respective timelines as per the task statuses. As is evident, the "Completion" status in green for construction works and "Milestone" labels for significant project milestones show that the phases of the project have been effectively tracked and monitored. One of the most significant advantages of using VisiLean was the ability to carry real-time monitoring with Lean project management concepts so that teams could be more monitored and coordinated.

The intended and actual completion dates are very close, reflecting negligible schedule slippage. This implies that the implementation of VisiLean helped minimize delays, enhance efficiency in executing tasks, and facilitate smooth handovers of activities between project stages. Additionally, with every milestone achieved on schedule, it emphasizes how VisiLean helped in enhancing communication, minimizing bottlenecks, and perfecting task interdependencies, and finally ensuring the timely completion of construction works.

Figure 10: Construction Project Schedule and Milestones – VisiLean Integration



The Above figure displayed is the project schedule with task dependencies, milestones, and planned vs. actual timelines using VisiLean, which is integrated with Microsoft Project (MSP). The Gantt chart on the right-hand side of the picture indicates different project activities, percentages of task completion, and task dependencies. The project extends from 15th

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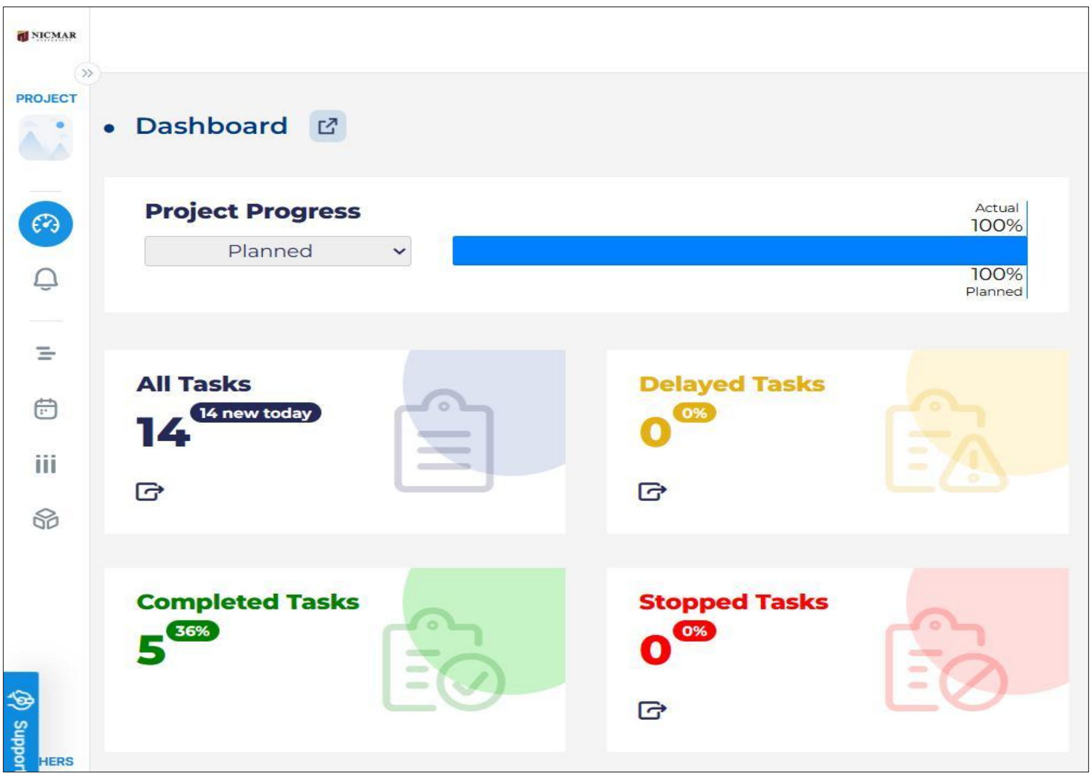
November 2023 to 28th November 2024, and the total planned duration is 326 days. The timeline has activity like construction approvals (e.g., NMRDA Tentative Approval), HFL conclusion milestones, and other road works with MEP services for different parcels. Activities like vendor onboarding, roadwork, HT panels, and installation of sewage lines are major project elements, with start and finish dates marked clearly. The red vertical "Today" line indicates actual ongoing project progress relative to the scheduled original progress.

This makes monitoring any lag behind or advancement toward task completion. Interestingly, for every task is a milestone, represented by the green circles, which indicate the project is nearing planned significant milestones. These milestones are vital in assessing the overall performance of the project and determining any likely delays at an early stage. VisiLean's real-time tracking capabilities enable the team to quickly determine the progress of each activity, locate bottlenecks, and make timely adjustments as needed. The graphical display of planned versus actual progress enhances communication, coordination, and decision-making among project stakeholders. Furthermore, task dependencies are well demonstrated, indicating the activity sequence and how delays in a particular task would affect others later on.

Figure 11: VisiLean Dashboard



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The figure above presents the VisiLean Dashboard with an overall outline of the task status and project task progress. From the project progress bar, the planned as well as the actual progress of 100% confirms that the project is advancing correctly and that all the scheduled tasks have been undertaken according to plan. This mirrors the total efficacy of undertaking the tasks through monitoring by VisiLean. Under the All Tasks category, there are 14 tasks in total, and 14 new tasks today are being added to the dashboard. This gives a clear indication of all tasks, enabling project managers to monitor the flow of new activities and how they fit into the overall project timeline. The Delayed Tasks category indicates 0%, which means that no tasks have been delayed yet. This reflects effective task management and successful compliance with the scheduled plan without significant delays.

The Completed Tasks column indicates that 5 tasks (36%) have been checked as completed, reflecting a significant portion of the project has been successfully completed. This real-time data allows managers and teams to assess the real progress in the execution stage. Finally, the Stopped Tasks section also shows 0%, indicating that no tasks have been suspended or halted, a good sign of continuous progress and resolution of any issues that have arisen during the process. In general, this VisiLean Dashboard offers a real-time snapshot of project performance, which enables the project team to track and control activities in real-time, assess delays, and make necessary adjustments to maintain the project on schedule. The zero lagged and stopped activities indicate ideal coordination and task execution in the project.

6.0 Conclusion

The application of Lean Practices and Last Planner System (LPS) techniques yields efficient reductions in construction project waste and time loss. The research examines Lean techniques that increase project efficiency while optimizing operations and resource use. The Last Planner System attains improved Lean techniques through planned consistency while increasing accountability as well as reducing uncertainties that minimize delays and ultimately lower project costs. Project performance metrics significantly enhanced once Lean programs incorporated LPS for use in construction due to improved cost management and minimized operational waste and more efficient schedules. Project implementation is simplified through the studied approaches which not only eliminate waste but also bring projects in on time per the research detailed in this article. Lean construction methods produce other advantages through decision support as well as real-time project transparency by means of electronic platforms VisiLean and Building Information Modelling (BIM). For full industry-wide adoption of such advantages the solutions to change resistance and ignorance and training inadequacies must be addressed. Research must focus on formulating standardized integration frameworks as well as improved implementation methodology and Lean project management automation strategy. Additional productivity with enhanced sustainability and enhanced project management innovation result from incorporating Lean-LPS strategies within the construction sector.

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