

Project Planning: Advanced Techniques and Process Waste Removals – A Review

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Abstract - In the 1950s, Era of project management as we know it began. construction industry of India was valued more than 2.7 trillion Rs in the 4th quarter of 2020, directly influencing GDP. The traditional methods of construction technology are lacking in their results and somehow puts a gap in managing activities. That is why new construction management systems should be adopted by the construction Organizations. The goal of this research is to enhance India's construction sector by using lean concepts to reduce non-value-adding operations (wastes), Cost and Time. In Construction management Project monitoring is just as important as project planning, we see a lack of monitoring in a variety of Indian contexts, as a result of which projects are harmed and their value is diminished. "TIM WOODS" is Eight different wastes in lean construction strategy for reducing process waste in which includes components like transportation, inventory movement, waiting, overproduction, over-processing, faults, and skills which were identified and a process is designed to eliminate these wastes. The use of lean methodologies is one of the most effective ways to reduce waste. We can reduce construction waste by employing lean building ideas, where the last planner system (LPS) is proved the most effective methods among all the lean tools. As a result, the purpose of this study is to use advanced construction techniques, smart formats to conquer the drawbacks of traditional building methods and reduce process waste.

Key Words: Lean Construction, Last planner system, Process waste, TIMWOOD

1. INTRODUCTION

Construction projects are difficult to manage because practically every project is different. The combination of many variables can have unintended implications that affect project performance. [1] Because most Indian contractors are unprepared to overcome the upcoming demand for infrastructure growth, building projects regularly encounter time and cost overruns, conflicts, & poor quality. [2] The slim approach was employed in the construction of Venice. They employed the continuous flow approach for warship

construction, and Henry Ford used the similar concept for the production of the Ford vehicle in 1914, but it failed due to design faults. The Takt time idea was utilized by German aircraft, which signifies available production time based on client expectations. After, Toyoto combined the idea of Takt time with lean principles to achieve the highest production results. Koshleka was the first to apply the lean construction idea. [3] Using principles such as lean construction, some big construction organizations have started to study waste reduction & process optimization challenges, the majority of enterprises have yet to do so. It is critical to evaluate and quantify the quantity of waste existing on Indian building sites before applying lean principles, which place a strong emphasis on waste removal. [4] Lean process is known as a "method of designing production processes to reduce waste of resources, time, and labor in order to maximize value." Adopting lean concepts will be benefitted in the long run for the project, one that will pay off with advantages and a reliable return on investment. Applying lean concepts to the construction industry can help to increase profit and project quality in a timely manner. "Drive greater value by using less of everything," is the core goal of the lean management principle. Building projects can benefit from the application of lean manufacturing technologies. The dedication of senior management to the implementation of these tools is one of the most critical aspects in Lean success. [5][6][7] Though there have been some studies in developing countries using lean concepts and technologies, knowledge about wastes generated in the construction process & lessons learned on inserting the LPS are lacking. The researchers attempt to incorporate lean principles by spot nonvalue adding operations (i.e., Wastes) in order to search a feasible result to this issue and enhance the Indian construction sector.

1.1 Objective of the Study

- 1 To critically examine the traditional way of project planning concerning Project Progress.
- 2 To identify and mitigate loopholes in traditional construction and to find a solution regarding the traditional construction system with the help of lean tools.

1.2 Need of the Study

Wastage, Delays, and Cost overruns are major concerns in the traditional construction system, which can be mitigated by utilizing lean principles and the system can be improved by enhancing the traditional system's processes and employing lean principles in it, which will benefit the Indian construction industry.

2. Literature Review

Alan Mossman (2009) [8] discussed lean process and lean design as Waste elimination by-product. lean design, and lean production management. Observation also stated that the definition of waste will differ from person to person and that first owner's value can be second owner's waste. How a different goal of producing value for customers and end-users is more likely to result in more efficient waste removal and increased customer satisfaction. The last planner is treated as a production & relationship management tool. Last Planner was used as a creative process, and some lessons were drawn from that perspective, before looking at the waste reduction methods included into the Last Planner System. Project promise, the end-result, value.

Amin Nikakhtar, Alireza Abbasian Hosseini, Kuan Yew Wong, Amir Zavichi (2015) [9] discussed that The construction sector is afflicted by a variety of challenges like decreased productivity and schedule delay which reduces customer's value. The high rate of waste generation is one of the construction industry's most common, unresolved, and complex difficulties. The use of lean methodologies is one of the most effective ways to reduce waste. Waste reduction is one of the basic concepts of lean thinking. While computer modeling & simulation is applied in effect to implement a reduction in risks, time & cost. Project managers often conceive about 'waste' in terms of physical construction waste, but lean thinking believes that there are wastes buried in construction process, such as non-value-adding activities and waiting time. In lean construction, waste from the construction process is a major concern. Waste generated as a result of the nature of the industry and waste caused by non-value-adding activities are the two main categories. Using a case study in the reinforcing process, examine the capability of lean construction concepts to reduce construction process waste. construction processes were improved and waste generated during the processes was reduced.

Marie E. Aarrestad, Ase I. Nesteby, Jardar Lohne, Rolf A. Bohne (2016) [10] Through the production and operation of buildings, the building sector accounts for 40% of worldwide energy consumption and 30% of global yearly greenhouse gas emissions. Lean construction approaches believe to decrease waste in the manufacturing process, hence increasing the finished product's consumer value. BREEAM is the commonly applied method for assessing the

environment for infrastructures. Main goal of this research was to see how the LPS established pull-effect could be used to mitigate the issues that come with a management push strategy. As an output the probability of a decrease in extra costs connected to BREEAM-NOR standards was discovered, better communication, reduction in misunderstandings, and higher sustainability were also discovered. By reducing waste and optimizing the process, value can be increased for all parties associated, which includes the owner, client, contractor & society at large.

P. Abhiram and SS. Asadi (2016) [11] Focused on construction waste generated throughout the construction process. It is also founded that waste was generated mostly in the operational stage & followed by material procurement & handling stages. The benefits of increased competition in the construction industry have resulted in the creation of a mix of high quality, project speed, and low price. According to the research, worker errors are the most common waste, followed by waste due to improper construction design, delayed delivery, errors, re-work, improper planning, overproduction, manufacturing defects waste from unequal cash flows, crew waiting, inspection, and so on. Waste owing to storage concerns, waste while waiting for directions, waste during machinery installation Waste as a result of ordering materials that do not meet the project requirements as indicated in the design documents, Excessive production generates waste, as does inappropriate handling and storage, as well as waste resulting from over-compulsion. As per the results, 30% of respondents are using lean techniques, 40% are willing to implement lean techniques in the future and 26% are using lean techniques only if it's required. The findings stated that by using the lean methodology in the construction field causes like construction time & construction cost can be reduced, Quality and work efficiency will be increased as a result waste can be minimized. So that waste rework is reduced.

Mr. Nikhil P. Shingate and Dr. M. N. Hedao (2017) [2] According to the traditional construction system, the construction sector suffers from poorer productivity, poor quality, inadequate safety management, poor communication, cost, and schedule overrun. Last Planner System control lacking traditional management constraints in CPM method like information and material flow by considering dynamic nature of construction industry. LPS is considered a Bottom-up approach while the traditional construction system Top-down approach was used. The principles of the Last Planner system are as follows: planning should be done in full detail as the work goes in more closely, planning should be done in collaboration with them who will perform the work, analysing & removing limitations on the planned tasks working as team, making reliable commitments, and learning from work breakdowns that have occurred. Last Planner system has five primary parts master planning, phase planning, Six-week Look ahead to planning, weekly work planning, and percent plan completion (PPC).

Mohamed Saad Bajjou and Anas Chafi (2017) [12] According to the Construction Industry Institute (CII), between 25 percent and 50 percent of the cost of construction is wasted due to the inadequacy of the traditional management system in the United States. According to Koskela, the traditional method concentrates solely on steps of conversation or processing activities, neglecting non-value-added activities, which was resulting in uncontrolled production. By adapting the new philosophy of lean, the study was focused on 3 criteria: site organization, generating value and avoiding waste, planning and mutual coordination. The majority of traditional construction sites use the management mode "Push" rather than "Pull." It results in higher storage and material (or equipment) management prices. In traditional construction, the implementation of a push schedule is the primary source of process waste, but in lean construction, the use of a pull schedule reduces waste from on-site construction. In lean LPS is the main tool of planning & mutual coordination, it facilitates communication and participation by considering the constraints of stockholders. Overprocessing, Defects, Waiting, Unused employee creativity, Work accidents, Overproduction, Inventory, Transportation difficulties, and displacements are the nine basic forms of construction waste. As a result, the author discovered that LPS is a useful tool that may be used instead of a traditional planning system (a push planning system). Its goal is to increase people's involvement while also decreasing waste caused by inefficient task syncing.

Mohammed A. Abdelmegid and Vicente A. González (2019) [13] Observed that Simulation technique needs to be updated as par trending era in construction management. To close the gap in the construction industry's lack of simulation adoption, computer simulation is being used to replace traditional construction methods. To facilitate the deployment of the LPS in the construction sector, researchers attempted to develop a bond between the LPS and simulation modelling. Because of its well-established construction planning methodology, LPS was chosen for integration which stabilizes construction production & increases plan reality. The integrated framework makes use of the LPS and a simulated conceptual framework's synergy (CM). It develops a simulation conceptual model based on the information provided in the LPS. The study aided in the development of virtual decision-support tools using simulation modelling, This aided LPS research by offering an integrated framework for improving LPS performance and compliance. Furthermore, the framework tries to reduce effort duplication by constructing the model using existing data rather than starting from scratch. As a result, it adds to the mark in construction simulation research by allowing for the quick construction of simulation models.

Bassam A. Tayeh and Khalid Al Hallaq (2019) [14] It was discovered that projects are frequently delayed during the creation phase due to a variety of uncertainties such as conflicting contract sequences, a lack of coordination, a

project domain problem, and poor quality. They also offered in detail research to identify 16 key tools that helped the Gaza Strip industry adopt LPS Visual displays are used to communicate information about the construction site, as well as the presence of main stakeholders and a look ahead plan, which are all important tools/techniques for the LPS application. Using visual devices to transmit information on the construction site, according to the findings would significantly decrease needless movement and save time. The following are some of the advantages that may be obtained with LPS implementation: allowing for a more effective knowledge of pro-control, maximizing team member cooperation, confidence & accepting the management to make the work constraints more visible. Knowing program control and keeping track of activities regularly will assist the project go forward with the greatest possible results while minimizing project time and cost overrun. Contractors should be aware of their responsibilities in terms of timely supply and storage of required materials to ensure project continuity and avoid material shortages; preparing material samples and shop drawings ready for supervisor approval to avoid project time waste; and collaborating with all the members of the staff to achieve the best project schedule, according to the study. To some extent, these guidelines may also be applied to other nations with similar work environments and economic situations.

Tarcisio A. Saurin and John Rooke (2020) [15] It has been noticed that as the complexity of a construction project grows, so does the time and cost of the project, and it necessitates more sophisticated planning, coordination, and control. The complexity of the project can be amplified by managerial choices like a large number of sub-contractors or neglecting the control of basic wastes. The author discussed how LPS addressed complexity. The research also proved that lean management (LPS) in general is better suited to complex projects than traditional methods. The need was founded for developing the means of projects. This held support decision making regarding the necessity of Lean in project management. The application of LPS involves several decisions on production control, either with small or large implications for site operations. LPS allowed early identification of unintended consequences of decisions before it scales to greater damage. LPS constantly monitors the conditions & significant changes were immediately been delt in point of production. They provided six guidelines for coping with complexity that can be used to understand the LP System of production control. The conclusion was drawn that LPS is theoretically consistent with complexity thinking and offers practical ways of operationalizing the guidelines for coping with complexity, and LPS was considered as a subsystem of a complex socio-technical system.

Sakshi Gupta, Mujib Ahmad Ahmadi and Lalit Kumar (2020) [16] Observed that in the construction industry beneficiary margins are lowering every year because of the increasing cost of Resources and Economic issues such as

fees & taxes. This is why a managerial tool was required to gain a sufficient level of efficiency and productivity. According to them, Lean construction is an approach to planning a production system to cut down on waste of materials, time, and Efforts to generate a high proportion of value. The main goal of lean construction was to reduce the duration of the project, labour & wastages of materials so that value can be increased. As per them, "MUDA" or waste is everything that consumes the resources but generates no value. There was a total of 7 wastes were founded out of which the first 5 i.e., Overproduction, Waiting, Transportation, Overprocessing & Inventory refers to the flow of materials and last 2 i.e., Movements and Defects are reduced to work of labours. There were some major barriers faced by civil engineers in applying the lean principles are Lack of Training and awareness, Inadequacy technical skills, Drawback of Government support, Fault of lean work.

Conrad BOTON, Yaya PITTI and Daniel FORGUES (2021) [17] Observed that the construction industry is underperformed industry as compared to other industries, it's reflected in Low productivity and frequent cost and schedule overruns They tried to sync Lean Construction & Building Information Modelling (BIM) as a means of enhancing the practices in the industry. The traditional planning model is been used in the system. The industry was having difficulties due to the limitations of traditional planning and control systems. By combining BIM & LPS productivity of planning and controlling can be increased. Preliminary planning, planning with the LPS, and using the BIM 360 plan are the three phases of the planning process. Only 30% of people on-site accepted this system while the rest of 70% of people opposed it because of lack of software knowledge. On the other hand, planners accepted the LPS technique as it simplifies the planning work. The findings reveal a difference in viewpoints between higher management which is more optimistic & the less optimistic site team. In its infectious enthusiasm, senior management appears to dismiss the critical role it must play in the implementation's success, which must be developed on a strong alignment of business operations & information technologies. Over the last few decades, the alignment of information technology (IT) with business processes has been "a major priority" in the Information Technology community. Hence, to incorporate BIM and LPS balance between management should be maintained.

Alan Mossman & Shobha Ramalingam (2021) [18] It has been noticed that "rework" is a key source of delay and cost inflation in construction projects. According to research, rework accounts for 5-10% of the total project cost. On typical construction projects, workers are expected to follow the directions given to them. The same problems were observed in countries like the UK, US, EU, India, and elsewhere, as a result, language and cultural barriers were formed and psychological distance was formed between crew members and project team members. On a lean project, crew leaders use the Last Planner System (LPS) to decide

how they will allocate work, what tasks they will accomplish, when they will do them, and how they will execute them. The study investigates the links between learning, criteria understanding, and project-based production rework to see how we may lower project rework caused by performers' misinterpretation of client requirements for each job. The Major outcomes are as follows: a) rework will be reduced if performers and customers can acquire a common understanding of the criteria for each work job; b) When the criteria are explicit, shared understanding is more likely; c) learning every day can assist the process of clarifying the unwanted information.

Patricia del Solar, Mercedes del Rio and Raúl Fuente (2021) [19] explained the Spanish construction industry with Collaborative work tools. They found that in Spain, the level of LPS application is still quite less; just 37.5% of professionals asked claimed they are aware of the approach, but only 9.52% utilize it regularly. Technical Architects and Construction Engineers are the most common agents, most likely because they were the specialists that conduct the monitoring and control activities associated with project planning. It's been established that the agents in construction industry view LPS and BIM to be complementary technologies. Furthermore, experts known with the LPS approach believe that using BIM in conjunction with LPS during the building phase can increase quality and minimize construction time. It has also been verified that experts believe it could take 3 to 5 years for LPS to be implemented in the majority of development projects.

Selin Ortenburger and Timo Hartmann (2021) [20] Observed that construction projects fail to deliver the products on time, which shows that there is still room for improvement in the efficiency of the schedule. They used BIM as a solution by collaborating with the Last Planner System, where Lean construction focuses on reliable and predictable workflow on construction sites through aligning the entire supply chain for creating a project structure that maximizes value and minimizes waste. Building Information Modelling (BIM) and Lean Construction may both improve project scheduling efficiency by utilizing a BIM 4D model or the LPS, a Lean Construction scheduling tool. The research was conducted in Berlin, Germany, and only the LPS was used to design the building work. They also found that while planning process most of the planners omitted several important tasks which needs to be revised after construction started which is resulted in a delay in the project. According to the findings, if planners had merged their LPS efforts with a 4D BIM deployment, they would have been able to avoid the majority of the project's challenges. As a result, they create a detailed 4D model of the project and then assess how the model may have helped in the resolution of some of the project's issues. The findings give the first empirical proof that BIM can help support LPS. The findings can assist planners in making judgments on whether or not to use 4D and LPS on their projects, as well as communicating the reasons for it.

2.1 Major Findings from Literature review

1. The high rate of waste creation is one of the most common unsolved & difficult concerns in the construction industry. The Wastages Impacts the Productivity of Construction Industry and Overall, Economy.
2. In the Traditional Method, the key cause of Process waste is the adoption of a Push schedule, while in the Last planner system Process waste is considered as one of the serious issues.
3. Process waste is a Global issue that still needs to be mitigated, by adapting the LPS Process waste can be reduced.
4. Last planner system is a Pull strategy that helps to overcome limitations of the Traditional construction system which works on the Push strategy.
5. LPS method is a key to mitigating traditional construction's weaknesses like Time delay, Cost overrun, and Quality improvement. By using suitable lean methodologies, non-value-adding tasks can be decreased, and Process waste can be minimized.
6. Contractors' failure of Cost & Time overrun is a Major attribute in Traditional construction, Monitoring contractors' work is feasible, and the effort required to maintain a continuous procedure can be Reduced, which is also time-saving.
7. With the help of Last planner tools, it Becomes easy to Facilitate Better Communication between Teams and it also Participates to understand the Constraints of Stakeholders.
8. A Complex project can be Handled better than the Traditional method of Construction in the Last planner system.
9. Unlike traditional building methods, the LPS has a clear set of objectives and provides superior project planning and monitoring management.
10. It could be difficult to accept the Last planner for Contractors on the Other hand for the Planner's planning work becomes easier.
11. In Traditional Construction Instructions were Passed to workers to complete tasks while using LPS leaders themselves distribute work and take ownership.

Table -1: Factors affecting Outcomes of LPS

Factors	Papers
Reduced Process waste	[8][9][10][11][2][12][14][15][16][18][19]
Increase in value to Customers	[8][9][10][11][2][12][14][15][16][17][18][19]
Reduction in Cost	[8][9][10][11][2][14][16][18][19]
Higher Sustainability of the project	[10][14][16]
More Clarity between teams (Less Misunderstanding)	[10][11][12][14][16]
Better Communication in team	[9][10][2][14]
Higher Rate of Percent Plan Complete (PPC)	[9][11][2][12][13][14][15][16][17][18][19][20]
Reduction in project delivery time	[8][10][11][2][12][13][14][15][16][18][19][20]
Enhanced quality work	[2][13][14][16][19]
Reduced Uncertainty in Process	[10][11][2][14][20]
Regularity in Schedule (monthly, weekly, Daily) work plan	[14]
Use of Collaborative planning	[2][14][16][17]
Higher Efficiency in Planning	[2][13][14][19]
Work Flow Improved	[2][13][19]
Stabilization in Production	[13][14]
Higher Cooperation & Confidence among Team Members	[10][2][14][15]
Higher Rate of Trained workers	[16][17][19]
Removing Non-value adding Activities	[8][9][11][2][12][16][18]
Allows Manager to better Visualize Work Progress.	[14][15][16]
Improving Learning Process	[14][15][19]
Improvement in Planning, Controlling Practice & Tracking program Commitments.	[14][15]

3. Last Planner System

There are several lean construction techniques available in the market among which LPS is the most effective among all the methods available. This strategy involves to make programmes more expected by the use of planning, reducing waste & non-valuating assignments for work. It was established to increase the feasibility of completing a project on time by making programmes more predictable by boosting the accuracy of planning and control. LPS is based on a panoptic collaboration amongst a variety of consultants, contractors, and subcontractors who commit to more comprehensive coordination of the activities in order to generate the more practical utilizing strategies. In LPS "last planners" is the man or group that creates program to direct workers. Last planners are those who are associated in the actual application of the job; they are also actively involved in designing the work schedule and ensuring that tasks are completed prior to the start of the activity. The last planner's responsibilities include ensuring that the workflow in the building process is efficient and that the job is completed at an ideal level.

3.1 Principles of Last Planner System [21]:

1. Throughout the project, keep all plans, at every level of detail, visible to the public at all times.
2. Maintain milestone-level detail in master schedules.
3. As the start date for planned work approaches, plan in greater detail.
4. Create plans in collaboration with those who will be responsible for carrying out the job.
5. Re-plan as needed to align plans with the realities of the future.
6. As a group, decide to reveal and remove limits on scheduled tasks.
7. Improve workflow consistency to boost operational efficiency.
8. Don't begin things that you know you won't be able to finish. Commit to completing only those tasks that are clearly defined, thoroughly executed, and appropriately scaled.
9. Make and keep reasonable promises, and speak out immediately if you lose confidence in your ability to keep commitments (as opposed to waiting as long as possible and hoping someone else speaks up first).
10. Take lessons from setbacks (unintended consequences of actions taken).
11. Underload (Preload) resources to improve work release reliability.
12. Maintain a workable backlog of ready work (tasks that are ready to be completed) to protect against capacity and schedule constraints.

3.2 Components of Last Planner System

There is total 5 Last planner system components:

1. Master planning
2. Phase scheduling
3. Look-ahead planning
4. Weekly work plan
5. Percentage plan complete

The objective of a master plan is to develop planning and execution methods, as well as to assess the feasibility of existing resources in completing the plan within the allotted time frame and to identify key milestones for stakeholders and owners. Phase scheduling is an aspect of the LPS process that involves to use a pull mechanism to create each phase schedule of the project. These phases are based on the master schedule's milestones and offer a framework for the schedule's appearance. Look ahead planning's major goal is to identify and eliminate constraints that must be addressed ahead of the start of an activity. Contract design, material procurement, labor needs, and precursor work are all examples of constraints. After the mentioned limits are erased, tasks are considered ready to work and may be placed in workable place. The drafting of a look ahead program is usually done over a period of 4-6 weeks. Increased communication is a main objective of weekly plan, understand the status of before plans, make plans for the future week, and look at task interdependency. Only quality assignments that are work ready are included in WWP, which includes activities that have all limitations eliminated, adequate resource availability, necessary work performed, and so on. In the last planner system, PPC is the learning phase. The PPC approach is used to keep project on track. PPC is obtained by dividing the total no. of tasks accomplished by the total no. of planned tasks for a specific period 1 week. LPS may be pushed as a useful planning technique that targets the source of uncertainty and improves the plan's dependability by improving performance. A more dependable design will naturally lower the amount of variance, which will lessen the requirement for huge time buffers during the construction phase. LPS has proven to be a very effective technique in terms of planning, improved participant coordination, collaborative management, and information flow. [2]

3. Process Waste

The Process waste means that any activity or stage in a process that do not bring value to the consumer, which is considered waste. Transportation, inventory, motion, waiting, overproduction, overprocessing, and defects are the basic seven wastes. The phrase 'TIMWOOD' is frequently used to refer to them. The 'Skills' of employees are the eighth waste which is utilized as per circumstances. As a result, the eight wastes have become known as TIMWOODS.

Table -2: TIMWOOD

T	Transportation
I	Inventory (stock on hand)
M	Movement
W	Waiting (Time on hand)
O	Over processing (Processing itself)
O	Overproduction
D	Defects (Making defective products)

3. CONCLUSIONS

One of the most effective Lean construction techniques is the Last Planner System, and its proper application can decrease construction wastes such as defects, delays, inventory loss, motion, transportation, overprocessing, overproduction, and underutilised potential of manpower. Some other advantages of LPS include reducing the risk of time and cost overruns and increasing efficiency in project management. The Weekly Work Plan, Six Week Look Ahead Plan, Phase Schedule, Master Schedule and PPC all are components of the LPS. Overall project scheduling, including project milestones and deadlines, is covered by master scheduling. Phase scheduling is intermediate work structure after master scheduling possessing duration of 3 months. Look Ahead Scheduling allows the LPS team and higher authorities to plan for any pending actions so that they can be mitigated. Weekly Work Plans are prepared with a focus on the activities of the current week/coming week alone. Benefits such as a smooth flow of work and a higher production rate can be improved with the usage of LPS. PPC can be defined as the proportion of Planned Work vs. Actual Work Done. By following the concept of LPS the process waste can be reduced. The lean principles can be adopted; non-value-adding items can be removed; monitoring and control systems can be improved; and subcontractor billing can also be tracked. As a result, by adopting lean concepts a network may be created that helps to reduce process waste while also minimising time and cost overrun.

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