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Research Paper

"Environmental Impact Of Construction Materials & Practices To Save Planet Earth On Lean Technique- Case Study

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ABSTRACT— *In rapid, construction projects, it is not possible to manage the project through the conventional ways. It has been observed many times that the productivity of the construction depleting and leads to rework and produces many wastages such as over production, inventory, unnecessary transportation, workers displacements, over processing, defect, waiting of materials, unused employee creativity, work accident, etc. Therefore practical ideas and techniques need to be used in construction that will help projects teams to deal with wastages in construction with the use of optimum resources and this can be achieved by using lean construction principles and techniques So this paper aims to overview and discuss the applicability of lean principles and its techniques used in construction project which helps to reduce wastages in construction and brings the quality of work in product developing process with raising the profit level and also which factors affects to adopt lean management in construction has discussed with the current construction practices and past studies In India, the implementation of lean management in construction industry is a major task. This project mainly focuses on to identify the possibilities of implementation of lean management in construction industry. It will be achieved by preparing the questionnaire and also conducting the interview with the project personals like top management, engineers and site supervisors etc. The questionnaires were evaluated to adopt the techniques through statistical methods. This paper presents the possibilities of effective utilization of lean management principle in construction industry, which can surely increase the quality of work and profit rate by eliminating the wastage of materials.*

KEYWORDS— *E-Construction, lean, construction, management, and implementation, Lean Management, Disputes, Lean Leadership, Labour Productivity,*

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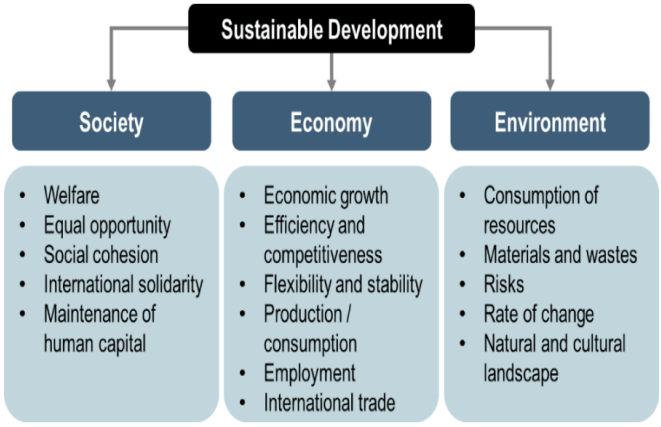
I. INTRODUCTION

Lean construction has been introduced as a new management approach to improve the productivity in construction industry. Lot of researches is going on towards the lean concepts and principles to get results of the successful adaption of lean ideas from car manufacturing industry to the construction industry. The construction companies struggling to transform their current forms of project management into the lean management approach.

In India, the construction industry is second largest industry after agriculture .it is diversified and involved in all spheres of construction like as following: Roads, Railways, Urban infrastructure, Ports, Airport.

Projects have been considered as temporary based production systems which need to be designed, planned, produced and delivered within a specified time. Fast track projects with long, complicated supply chains involving many players and subject to multiple, extensive process design changes have complex flow management that has failed miserably. As a result, the industry is characterized by delays and often has suffered cost and time overruns. In general, a very high level of wastes/non-value added activities is confirmed to exist in the construction industry. Several studies from various countries have confirmed that, wastes in construction industry represent a relatively large percentage of production cost. The existences of significant number of wastes in the construction have depleted overall performance and productivity of the industry, and certain serious measures have to be taken to rectify the current situation. It has been contended by the Lean Construction Institute that about 57% of productive time waste can be found in the construction industry.



The conventional project management approaches have inadequacies in resolving the problems in the industry. In the United States, meticulous studies have been carried out by CII (Construction Industry Institute), which estimate that between 25% and 50% of the cost of construction corresponds to waste due to the inefficiency of the traditional management system. According to (LCI) Lean Construction Institute, The construction industry is characterized by a ratio production/waste higher than that of the manufacturing industry. Nevertheless, lean manufacturing principles and techniques provide the foundations for minimization or total elimination of the waste faced by the industry. Lean construction has change the traditional view of labor flow and work flow reliability and gives the value added construction.

History

Infrastructure is the second largest sector after agriculture in India and is the integral part of country's development. It includes hospitals, townships, schools, offices, houses and other buildings and urban infrastructure. Construction is the basic input for socio economic development. In the past years many researchers stated there are number of waste can occur at any stage of the construction project. Since construction has directly or indirectly impact on many other industries so reducing the waste in the construction industry and saves the great cost of employer. Waste can be classified as natural waste which is unavoidable and avoidable waste. And the main root cause of waste comes from construction processes such as Planning, Design , Material procurement, Material handling, Material supply and Material manufacturing as well as construction stages, lack of work knowledge in labours, casual approach towards work, improper concrete mix design, faulty shuttering. Accidents due to negligence, choice of wrong construction process, cement/ mortar, timber, blocks, steel as the major material wasted on construction projects.

. The construction industry facing various problems as a result of the uncertainties of the global economic climate, environmental hazards, including labor delayed projects and zero margin contract bids, greenhouse gas emissions etc. So there is need for waste minimization and enhancement of productivity in construction activity. Productivity is critical determinant of cost efficiency. The conventional system of construction is not sustainable. In one of the research it is estimated that current system of construction had around 50% of non-value added efforts or waste. Most of The present construction practices run with traditional work flow methods and uses conceptual models of construction management because there are some barriers to adopt lean management in present construction practices those are mentioned further.

WHAT IS LEAN

In all industries have used Lean principles to streamline their workflows, reduce costs, and improve quality–most notably in software development, where Lean concepts (presented as Agile or Scrum) have significantly accelerated the pace of innovation. Software development teams have used Lean to improve workflow reliability — which is also a critical part of Lean construction, as we'll demonstrate in this article later.

While The Cost Of Steel And Cement Are Making Headlines, The Less Publicized Failures In The Management Of Construction Projects Can Be Disastrous. We Are Not Talking About Just Materials, Methods, Equipment, Or Contract Documents. We Are Talking About How We Work To Deliver Successful Capital Projects And How We Manage The Costs Of Inefficiency."

Everyone involved in the construction process has incentive to get projects done faster and at a lower cost. And yet, 70% of construction projects today are completed late and over budget. Construction labor efficiency has decreased in past decades, while all other non-farming labor efficiency has doubled or more since

the 1960s. Safety standards are also lagging behind, with the industry averaging 800 or more work-related deaths per year.

The lack of improvement in the industry can be contributed to a number of factors, including industry fragmentation, lack of trust between key participants, the traditional contracting environment, craft-oriented culture, increased regulations, safety issues, and lack of process innovation. Forward-thinking organizations are turning to Lean principles to improve efficiency, reduce costs, and boost morale. Applying Lean principles to construction is enabling:

- Improved safety
- Greater customer satisfaction
- Higher quality construction
- Reduced project schedule
- Greater productivity
- Greater profitability/reduced costs
- Better risk management

Research by the Lean Construction Institute (LCI) has found empirical evidence to support the idea that projects with high Lean intensity are three times more likely to be completed ahead of schedule, and two times more likely to be completed under budget. In this article, we'll discuss the basics of Lean construction, and how it can help alleviate the major pain points of the industry.

What Is Lean Construction?

The Lean Construction Institute defines Lean Construction as, "A collaboration-based system that is founded on commitments and accountability. It requires a significant shift in the trust that each stakeholder places on another. The adversarial relationship that has existed in the industry between contractors and design teams over many centuries is challenged, with all stakeholders having to align with goals and objectives. In projects where Lean construction management principles are applied, teams integrate through collaborative tools and search for ways to eliminate waste. Teams seek to continuously improve through reflection. Lean processes are designed to remove variation and create a continuous workflow to drive significant improvement in predictability and strongly encourages respect for all people involved."

As expected, as Lean management becomes more widely adopted in the construction industry, some of the benefits that the manufacturing industry experienced are now making their way into how construction teams operate and projects are executed.

HOW DOES LEAN APPLY TO CONSTRUCTION?

Researchers and Lean construction pioneers Ballard and Howell found in an analysis of project plan failures that, "normally only about 50% of the tasks on weekly work plans are completed by the end of the plan week," and that the industry could mitigate most of its problems through "active management of variability, starting with the structuring of the project (temporary production system) and continuing through its operation and improvement."

The goals and priorities for all construction projects are generally the same: To improve workflow reliability (to keep progress moving); reduce inventory of material and tools; and reduce costs by staying on schedule. Variability will always be a part of construction; inclement weather, inventory issues, unreliable suppliers, inaccurate plans, and changing requirements can all impact the progress of a project.

So the goal of Lean construction isn't to completely eliminate variability, because this is not a realistic or attainable goal. But in every project, there is an abundance of opportunity for mitigating the disruption caused by variables both internal and external to the project. Lean construction helps crews recognize opportunities for improvement and act upon them in a way that is measurable, valuable, and constructive.

LEAN THINKING IN CONSTRUCTION

Why lean? Traditional thinking of construction focuses on conversion activities and ignores flow and value considerations. Lean construction is the application of lean thinking to the design and construction process creating improved project delivery to meet client needs and improve profitability for constructors. It places _optimizing the total value instead of _minimizing the cost as the main goal. Within lean, cost cutting has to be seen in perspective of eliminating non value adding activities (Womack and Jones, 2003). Eriksson (2010) carried out a study on how to increase the understanding of how various aspects of lean thinking can be implemented in a construction project and how they affect supply chain actors and their performance. The core elements of lean construction are investigated reflecting how the various aspects of lean construction can be grouped into six core elements: waste reduction, process focus in production planning and control, end customer focus, continuous improvements, cooperative relationships, systems perspective.

The Lean Principles
- Eliminate the waste.
- Precisely specify value from the perspective of the ultimate customer.
- Clearly identify the process that delivers what the customer values
- Eliminate all non-value adding steps.
- Make the remaining value adding steps flow without interruption
- Manage the interfaces between different steps Let the customer pull don't make anything until it is needed.
- Make it quickly.
- Pursue perfection by continuous improvement.
- Do not push your projects on customers.

LEAN CONSTRUCTION IMPLEMENTATION
The Lean Construction institute saw there was a better way to deliver projects and drive productivity. The LCI has developed a Lean project delivery system that brings the lessons found in the manufacturing process to life in the architectural and construction industry.

Creating a culture of collaboration, transparency and systems integration is essential to the success of any Lean project. The key driver is to select trade partners, designers and engineers based on value added to a team rather than overall cost. Business owners can require contractors, architects and designers to design and construct a space that meets their established values without compromise to the projected target costs. These two goals work in tandem with a lean team to drive innovation and by seeking out and eliminating waste, resulting in timely project delivery and profitability.

Some differences you will find in Lean design vs. the traditional construction model include the following:

Redefining control: The partners focus less on overseeing outcomes and more on creating the outcome. Driving out waste while maximizing value Designing a facility in tandem with the production of the facility – do work only once. Each trade works closely and in tandem. Trade partners are brought on early in the design process, not last in the construction process. Coordinating processes and outcomes with a continuous flow pattern a pull‖ rather than the ―push‖ of traditional construction methodology. Empowering partners through transparency, and eliminating a central decision authority: Arm participants with ongoing information sharing and allow them to take action.

In actual practice construction is very much different from manufacturing, in construction the tools and techniques has to be applied on job site, it is very difficult for standardization of activities in case of construction. At the same time management of human resource is also challenging. And the repetition or rework is necessary in case of construction. With these hurdles it may not be difficult to implement lean construction in India.

1.1 BACKGROUND
(Refer paper no. 30)
Lean construction is a management philosophy spun off from the principles of lean manufacturing. Lean is a philosophy that focuses on value instead of cost, and seeks to optimize productivity by removing all non-value adding processes. Specified the following concepts, which became the five governing principles of lean:
- Precisely specify value from the ultimate costumer's perspective
- Identify the value delivery process (Value stream) – Eliminate non-value adding steps
- Make the value adding steps flow without interruption
- Establish a pull from the costumer. Do not produce until it is needed.
- Pursue perfection

These principles all concerns the problem of waste. Activities or processes that take up resources without creating value, which should be eliminated in order to deliver things right at the right time - For the good of the producer and the costumer; the different types of waste that can occur in a production.
- Defects in products
- Overproduction of items no one wants;
- Inventory waiting to be processed;
- Unneeded processing;
- Unnecessary transport of goods;
- People waiting for input to work on;

❖ Design of goods and services that do not satisfy customer needs.

In order to achieve an optimal production without waste, the following concepts and ideas have been developed as management tools.

❖ The facility and its delivery process are designed together to better reveal and support customer requirements. Positive iterations within the process are supported and negative iterations are reduced.

❖ Work is structured throughout the process to maximize value and to reduce 'Waste' at the project delivery level.

❖ Efforts are made to improve total project performance.

❖ Control' is redefined from 'monitoring results' to 'making things happen'. Performance of planning and control systems is measured and improved.

❖ Coordination is improved since the release of work from one specialist in design, supply and assembly to the next is more reliable

1.2 Related Work

Using a Lean Health Check to Assess Performance

- **Lean Training.** Contractors that have not yet put their lean knowledge into action can benefit from a multiday training program. In addition to helping participants understand theoretical principles, an effective program will include simulations that allow attendees to actively experience how using a lean approach can improve the performance of projects.

- **Lean Project.** Contractors can apply the six lean levers discussed earlier to a specific project in order to achieve gains in productivity and profitability. Contractors can launch this effort when planning a project or to support the turnaround of a project that has encountered issues during construction.

Lean Team Contractors with lean experience that are highly motivated to capture the full lean advantage are ready to establish a lean team to move the effort forward, ideally in combination with launching a lean project. Establishing a permanent lean team is essential for all contractors that seek to anchor lean thinking in their operations sustainably over the long term.

STEPS OF LEAN MANUFACTURING IMPLEMENTATION

1. Identification of wastes in the system: Many organizations need to know that they have many hidden and unhidden wastes in their systems.

2. Wastes present in the organization can be of different types:

There is a need to recognize the types of waste and their causes. Lean manufacturing believes in treating the causes and curing the problems permanently. There are various tools and techniques that are quite helpful in reducing or eliminating these types of waste.

3. The next step is to find the solution for the root causes:

One must stick to basic lean concepts and identify the root causes. Looking at causes might not help properly, so there is a need to identify the effects of the solution on the entire system.

4. The final step in the lean implementation process is to find the solutions and test the solutions first:

Once solutions are tested then they should be implemented. Training and following up are important in each and every step explained above. One needs to be patient because the implementation process might take a long time.

1.3 PROBLEM DEFINATION

(Refer paper no.30)

1.4 NEED FOR LEAN IN CONSTRUCTION

(Refer paper no.30)

1.5 AIMS AND OBJECTIVES

- To statistically analyze the factors affecting labour productivity. To make recommendations to improve labour productivity in construction
- To find out the Disputes in construction industry.

II. LITERATURE REVIEW

Applying lean thinking in construction and performance improvement

Author: Remon Fayek Aziz, Sherif Mohamed Hafez in (2013)

Abstract: The productivity of the construction industry worldwide has been declining over the past 40 years. One approach for improving the situation is using lean construction. Lean construction results from the

application of a new form of production management to construction. Essential features of lean construction include a clear set of objectives for the delivery process, aimed at maximizing performance for the customer at the project level, concurrent design, construction, and the application of project control throughout the life cycle of the project from design to delivery.

Requirements for building information modelling based lean production management systems for construction

Author: Rafael Sacks, Milan Radosavljević, Ronen Barak

Abstract: Smooth flow of production in construction is hampered by disparity between individual trade teams' goals and the goals of stable production flow for the project as a whole. This is exacerbated by the difficulty of visualizing the flow of work in a construction project. While the addresses some of the issues in Building information modeling provides a powerful platform for visualizing work flow in control systems that also enable pull flow and deeper collaboration between teams on and off site. The requirements for implementation of a BIM-enabled pull flow construction management software system based on the Last Planner System™, called 'KanBIM', have been specified, and a set of functional mock-ups of the proposed system has been implemented and evaluated in a series of three focus group workshops. The requirements cover the areas of maintenance of work flow stability, enabling negotiation and commitment between teams, lean production planning with sophisticated pull flow control, and effective communication and visualization of flow. The evaluation results show that the system holds the potential to improve work flow and reduce waste by providing both process and product visualization at the work face.

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Lean Construction: An effective approach for project management

Author: Richard Hannis Ansah, ShahryarSorooshian, Mustafa Shariman (2015)

Abstract: Projects have been considered as temporary based production systems which need to be designed, produced and delivered within a specified time. It has been asserted by a number of researchers that fast, complex and uncertain projects cannot be managed through the conventional ways and that fast track projects with long, complicated supply chains involving many players and subject to multiple, extensive process design changes have complex flow management that have failed miserably. The conceptual models of construction management and the tools it utilizes (work breakdown structure, critical path method, and earned value management) have been criticized to be deficient in handling the present unique challenges of projects. As a result, the industry is characterized by a number of wastes including: overproduction, lead time, transportation, inappropriate processing, inventories, unnecessary movements, rework and making do wastes.

Lean Construction Techniques in Indian Construction Industry: Some Analysis

Author: Vinaya D. More, Dr. Shrikant Charhate and Madhulika Sinha,

Abstract: Lean construction is as an effective management tool to enhance the productivity in construction field. Large research is being done in recent past and is an ongoing process to adopt lean principles from manufacturing industry to the construction industry. In order to improve the efficiency, reduction of waste, the lean construction has been introduced as new management tool. There are many challenges in implementing the lean concept in construction industry in India. Due to lack of attention and illiteracy towards the lean management principle, stake holders associated to this like builder, contractor, and engineering and project management firms etc. are still in process of adopting this principle for construction project. In this paper efforts are made to find out main barriers towards the implementation of lean techniques in Indian construction industry with the help of questionnaire survey and actual site implementations are made to develop a process map for ongoing projects. **Lean Manufacturing: 3 Critical principles for improving productivity**

Author: Christine Wheeler, May 2014

Abstract: The "go green" movement may have seemed like a passing fad many years ago when it first entered mainstream consciousness. To some, it resembled something that brought to mind the free-spirited and anti-establishment countercultures of the late 1960s more than it did a modern step toward environmentally responsible living. Despite scepticism, sustainable living has become an integral part of our daily lives. Principles and standards that guide eco-friendly ways of living and doing business are often referred to as "lean" principles, and the term is used most frequently in the manufacturing industry

Name: Productivity Improvement by Implementing Lean Production Approach.

Author: Mahmood, K., ShevtShenko, E.

Abstract: This paper aims to provide a better understanding of lean production approach in order to enhance productivity, reduce cost and maximize customer value while minimizing waste during the production processes. Lean tools enabling a company to differentiate value from waste and facilitate to maximize customer value while minimize waste. Although there are many key factors for this methodology but here authors would be focusing on the Value Stream Mapping (VSM), Pull system and Dedicated Flow that are contribute to change the process by eliminating different kind of wastes (such as inventory) which slows down the process. A case

from metal manufacturing company will be taken into account that focus on lowering down the inventory (waste) levels with the help of lean tools.

General overview of Lean Management in Construction Industry
Author: Tejas Vidhate, Asst. prof Ashwini salunkhe
Abstract: In rapid, construction projects, it is not possible to manage the project through the conventional ways. It has been observed many times that the productivity of the construction depleting and leads to rework and produces many wastages such as over production, inventory, unnecessary transportation, workers displacements, over-processing, defect, waiting of materials, unused employee creativity, work accident, etc. Therefore practical ideas and techniques need to be used in construction that will help projects teams to deal with wastages in construction with the use of optimum resources and this can be achieved by using lean construction principles and techniques So this paper aims to overview and discuss the applicability of lean principles and its techniques used in construction project which helps to reduce wastages in construction and brings the quality of work in product developing process with raising the profit level and also which factors affects to adopt lean management in construction has discussed with the current construction practices and past studies.

Can Lean Manufacturing Principles improve Construction?
Author: Andy Haltmann
Abstract: If construction jobsites have one thing in common, it's that they're all different. This variation in project size, scope, type, materials, timelines, etc.; makes a philosophy like lean manufacturing seem unsuited to the construction industry. Lean, an approach to manufacturing first developed by Toyota, focuses on streamlining and standardizing processes by reducing waste, improving flow and designing what you do based on what's valuable to end customers. It aims to continually improve all facets of operations, including productivity, an area that has become a key performance indicator for contractors.
That sounds great, right? But what about that inevitable variation; Manufacturing is a controlled environment where companies can easily minimize variation. How can you standardize your processes when jobsites are all different and conditions constantly change?
Site Implementation and Assessment of Lean Construction Techniques
Authors: O. Salem, J. Solomon, A. Genaidy, and M. Luegring
Abstract: The goal of this paper is to test the effectiveness of some lean construction tools, in particular, those tools that can be applied in medium size construction firms. Due to the success of the lean production system in manufacturing, the construction industry has adapted lean techniques to eliminate waste and increase profit. A field study was conducted to evaluate the effectiveness of some lean construction techniques including last planner, increased visualization, daily huddle meetings, first run studies, the 5s process, and fail safe for quality. The data collection methods included direct observations, interviews, questionnaires, and documentary analysis. The effectiveness of the lean construction tools was evaluated through the lean implementation measurement standard and performance criteria
THE GUIDE TO IMPLEMENTING LEAN PRINCIPLES IN CONSTRUCT
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Abstract: The lean methodology is a modern approach to managing construction in a way that delivers successful projects in the most time-efficient and cost-effective manner. The lean approach emphasises on maximising customer value while minimising waste through the implementation of predefined holistic practices and so, it makes perfect sense in the construction industry where timeframe, cost and safety are crucial.
The lean principles were originally developed by the Japanese auto manufacturer Toyota to achieve a sustainable competitive advantage and this changed the industry's best practices forever. Later the lean principles were adopted by various manufacturing organizations to improve productivity, increase safety and enhance quality. The lean management approach has evolved considerably over the last few decades and today it is being widely practiced in different forms that include Six Sigma, Total Quality Management, Kaizen and Just-in-time

III. METHODOLOGY

❖ .

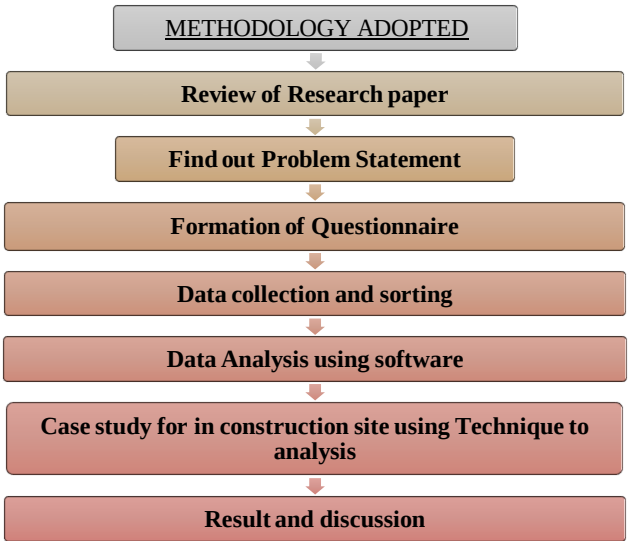


Figure: Proposed System Methodology Flow

To verify and re- evaluated the status of existing productivity and performances on construction activities and processes for construction industries

The cost of design is made up of costs of value-adding activities and waste. The waste in the design process is formed by.

Rework (due to design errors detected during design)

- Non value-adding activities in information and work flows
- Proper relation flow is made for heavy equipment and for critical situation.
- Minimize physical and process waste.

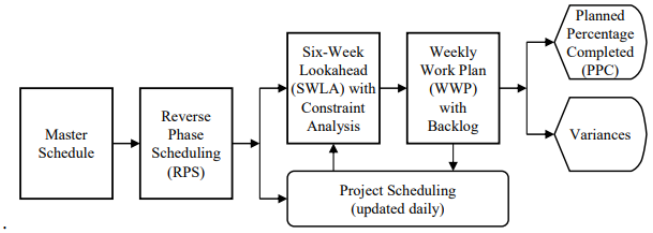
IV. LEAN PRINCIPLE

❖ **Last Planner System (LPS)**

One of the most effective ways to increase efficiency of construction industry is to improve planning and control process. In Lean Construction, planning and control are considered to be complementary and dynamic processes maintained during the course of the project. Planning defines the criteria and creates strategies required to reach project objectives, control makes sure that each event will occur following the planned sequence. Re-planning must be done when the previously established sequences are no longer applicable or convenient. Feedback facilitates learning when the events do not occur as planned. One of the best known Lean techniques is the Last Planner System which has been demonstrated to be a very useful tool for the management of construction process, and continuous monitoring of the planning efficiency, to assist in developing Foresight, smoothing workflow variations, and reducing/removing uncertainties plaguing construction processes.

It consists of work flow control and production unit control. Work flow control is accomplished primarily through the look-ahead process, while production unit control is accomplished primarily through weekly work planning. Mossman defined the last planner as a system for collaboratively managing the network of relationship and conversations required for program coordination, production planning and project delivery, by promoting conversations between trade foreman and site management at appropriate levels of detail before issue become critical.

Last Planner System aims to shift the focus of control from the workers to the flow of work that links them together. The two main objectives of LPS are to make better assignments to direct workers through continuous learning and corrective action and to cause the work to flow across production units in the best achievable sequence and rate.



The last planner integrated components are: master plan, phase planning, look-ahead planning, weekly work planning, Percentage of Promises Completed on time or Percent of Planned Completed measure key of the Last Planner System success and reasons for incompleteness, when systematically implemented can bring many advantages and add major benefits to construction management practice in general and planning practice in particular. PPC does not measure productivity or production, only planning.

❖ **Pull Planning**

A Phase Pull Plan is prepared by a project team in a collaborative fashion to display the activities necessary to complete a phase of work and identify the best sequence to complete those activities. The phase typically is defined by an "end" target or event – pouring slab on grade, ready to erect steel, or target cost agreed upon, permit package issued, etc. The team works backwards pulls from the end date to the start of the phase to identify the activities necessary to reach the end target. The team pays special attention to the handoffs what is necessary to be completed in one activity before the next one can begin. The actual time or duration of a phase is based on the master schedule or the team best estimate – phases can be measured in hours for shut-down, weeks for a typical construction Activity, or months if the team is developing an overall project plan.

In using the Last Planner System or traditional project management, it is important that the team understands and accepts the schedule to which they are committing their efforts. Pull Planning, with its requirement for discussion and collaborative development, allows the participants to have ownership of the schedule as well as providing the most realistic information as to the actual sequence and duration of the activities on the schedule.

❖ **Value Stream Mapping**

Value Stream Mapping is a more in-depth technique designed to set out each of the steps from the beginning to the end of a specific process (including how much inventory, rework and waiting there is within a process) and includes:

✓ Teaching the crew working in the area on the task about the 7 wastes
✓ Asking the Team Leader/Superintendent to Go & See the work site and spend some time mapping out each step of the process, engaging with the crew
✓ Using post-it notes to display these steps up on a wall, including data for each step:
a) number of people doing the work
b) how long it takes
c) any rework seen
d) any inventory seen between steps
e) any waiting between steps

❖ **Just-in-Time Resource Pull**

In a lean operation, resources and materials are pulled into the process just in time to satisfy project requirements. The just-in-time approach allows contractors to eliminate waiting times, avoid storing materials, and reduce costs for stock. This approach also promotes flexibility by allowing contractors to accommodate their clients' last-minute decisions. To avoid delays and higher costs, however, this approach must be carefully managed on the basis of lead times for each resource and the various materials. In supporting project management for the construction of a cruise ship, BCG worked with the shipbuilding company to demarcate "frozen zones" periods during which the ship owner could not change the type or specifications of materials to be ordered. The ship owner was required to communicate the specifications for the various materials to the shipbuilding company before the frozen zones, so that it could place orders with sufficient lead time to adhere to the agreed-upon schedule and budget.

❖ **Zero Defects**

Through continuous improvements fostered by control and feedback mechanisms, contractors can strive to come as close as possible to achieving the goal of zero defects and thereby standardize and stabilize processes. Short-cycle processes can be deployed throughout the project value chain to significantly reduce the number of defects. Such processes allow project managers to detect mistakes quickly, so that they can remediate the errors and prevent them from recurring in subsequent work at the site. Catching defects early is especially important with regard to repeated elements and processes, which may recur dozens or even hundreds of times in any given project.

V. DATA ANALYSIS

Lean Technique	Lean Technique description	Flow
Last planner System	Supports the timely realization of plans by reducing delays, getting the work done in the best constructability sequence, matching manpower to available work, coordinating multiple interdependent activities,	Manpower flow Equipment and tools flow Material flow Information flow Workflow
Providing operational Flexibility and Responsiveness	Allows reactions to problems that induce variable conditions by providing sufficient resources when necessary	Manpower flow, material flow
Providing visual control and inspections	Refers to equipment and structure inspection by workers using raw human senses and any non-specialized inspection equipment to immediately recognize deviations from standards	Workflow
Installing fail-safe (Poka-yoke) devices	Refers to automatic warning, identification and prevention of defects going to the next process	Workflow
Preventative maintenance	Intended to keep all equipment in excellent working condition through proactive and preventative maintenance	Equipment & Tool flow
Batching	Refers to creating package sets needed to accomplish tasks and reduce work-in-process inventories	Manpower flow, material flow, Equipment & Tool flow, Information flow
Involving "takt time" planning	Aimed at making task duration consistent for every trade	Manpower flow
Restructuring work	Refers to any work that should be performed ahead of its scheduled time	Workflow
Changing activities from sequential order to parallel order	The number of work teams that can work in parallel rather than in series	Manpower flow
Multiskilling	Performing large packages of continuous work	Manpower, work flow, equipment & tool flow
Optimizing components/structures and integrating more functionality into them	Reducing the part count of products through design changes or prefabricated parts	Workflow
Standardizing activities	Related to efficiently organizing the sequence of job tasks that are repeatedly followed by a team member	Manpower flow
Value Stream Mapping (VSM)	Decreasing activities that takes time, resources or space but does not add value	Workflow
Pull System	Refers to the signals that make a process transparent and allow timely production in the required quantity	Work flow, Manpower flow
Reducing interdependence of production unit	Allows correct timing and spacing between crews	Manpower flow
Increasing visualization	Refers to signs and labels around the construction site reminding workers about various issues	Manpower
Making the process directly observable	Related to providing an observable machine layout and materials that allow an understanding of possible problems	Material flow, Equipment & Tool flow
Using visual devices	Related to a management tool that emphasizes the visual status of operations (e.g., amount of machine operating), a quality or process problem via a signal alerting about abnormalities	Equipment & Tool flow
Incorporating information into the process	Related to inserting helpful workplace worker information	Manpower Flow & Information flow
Involving Five S's	Refers to organizing an efficient, effective work space by identifying and storing items used, maintaining the area and	Material flow, Equipment & Tool flow

	sustaining the new order	
Rendering invisible attributes visible through measurements	Reveals critical situations before they become problems	Workflow
Concurrent Engineering	Aimed at integrating all construction teams (e.g., general and specialty contractors, architects and design engineers) and integrating the construction and design stages	Information flow
Synchronizing and aligning	Aimed at synchronizing delivery rate and sequence with installation rate and sequence	Material flow
Supplier-managed inventories	Applies when suppliers have access to inventory data and are responsible for maintaining inventory levels	Material flow
Establishing interpersonal communication	Aimed at using verbal and nonverbal exchange of information	Manpower flow
Showing respect	Intended as a means of showing appreciation for good worker ideas or qualities	Manpower flow
Deploying policy	Aimed at encouraging employees and giving them a common go	Manpower flow
Involving creative thinking	Refers to reviewing problems or unorthodox solutions from a fresh perspective	Workflow
Developing problem-solving skills	Refers to a way of considering a problem in detail in order to prevent its recurrence	Workflow
First Run Studies/ "Plan-Do-Check-Adjust	Aimed at reviewing work methods by redesigning and streamlining the different functions involved	Manpower flow, Workflow
Brainstorming	Aimed at generating creative ideas and solutions through intensive group discussion	Workflow
Reengineering	Refers to the radical reconfiguration of processes and tasks to achieve dramatic improvements in performance measures such as cost, quality, service, and speed	Workflow
Designing key performance indicators	Designed to eliminate inefficiency and maximize cost effectiveness and productivity	Workflow

DEFINITION OF WASTE

(Refer paper no.32)

According to Koskela, waste can be defined as "any inefficiency that results in the use of equipment, materials, labour or capital in larger quantities than those considered as necessary in the construction of a building". Waste can be classified as unavoidable waste (or natural waste), in which the investment necessary for its reduction is higher than the economy produced, and avoidable waste, in which the cost of waste is higher than the cost to prevent it..

- Design
- Procurement
- Materials Handling
- Operation
- Residual

DIRECT WASTE

CATEGORIES	REASON	EXAMPLE
Delivery Waste	During the transportation of material to the site, unloading and placing in addition to the initial storage	Bricks, Blocks, Glass, Bulk Material
Cutting and Conventional waste	Cutting material into various size and uneconomical shapes	Formwork, tiles and reinforcement
Application and residue waste	Hardening of the excess material	Paint, mortar and plaster
Waste caused by	Damage occurred by	Painted surfaces
other trades	succeeding trade	
Criminal waste	Theft and vandalism	Tiles, cement bags, wires, metal parts
Management waste	Lack of supervision or incorrect decision of the management	Throwing away excess material
Waste due to wrong usage	Wrong selection of material	Rejection of inferior quality, marble, tiles bulk material

INDIRECT WASTE

Sr.No.	CATEGORY	REASON	EXAMPLE
1	**Substitution waste**	Substitution of material in work, which will incur losses to either contractor or client	Use of facing for common bricks, fixed blocks for brick mortar, ready mix concrete
2	**Execution waste**	Contractor does not receive any payment for the work done	Excess thickness of slab- concrete waste

3	**Negligence waste**	Site error because of the condemned work or use of additional material	Over excavation of foundation resulting in use of additional concrete, wrong drawing, handing over status of concrete
4	**Operational Waste**	Unavailability of proper quantity of material on site	Formwork, Reinforcement, Low Equipment utility, concrete order.

ELIMINATING WASTE

In order to help us see waste within our process, we split it down further into the 7 waste.

- **Waiting** – for materials or specifications for a job before it can start, waiting for others to finish their part of a job, waiting for sign off before moving on.
- **Over Production** – producing more than is required by the customer; in a construction environment this may be working on items which are not on the critical path instead of items which are
- **Rework** – any job which is not to the right specification or quality and has to be rectified is waste
- **Motion** – the movement around the site of the people themselves is not actually adding any value to the site
- **Processing** – doing too much to a job, producing too high a specification when it is not necessary, for example painting 3 times what only needs to be painted once
- **Inventory** – too much or too little inventory is waste, we need the right amount to enable us to do the job well
- **Transportatio**n – moving equipment, tools or materials around the site is waste as it does not add value to the construction work.

There are some factors affecting on lean Technology

1. Cost
2. Resources
3. Labour Productivity
4. Disputes

COST- Construction cost estimating is the process of forecasting the cost of building a physical structure. Of course, builders and clients both worry about the financial impact of cost overruns and failing to complete a project. That's why they devote time and effort to estimating how much a project will cost before deciding to move forward with it. Clients considering large projects often seek multiple cost estimates. Construction cost estimating is the process of forecasting the cost of building a physical structure. Builders and clients both worry about the financial impact of cost overruns and failing to complete a project. That's why they devote time and effort to estimating how much a project will cost before deciding to move forward with it. Clients considering large projects often seek multiple cost estimates, including those prepared by contractors and those calculated by independent estimators. Project owners use cost estimates to determine a project's scope and feasibility and to allocate budgets. Contractors use them when deciding whether to bid on a project. We usually prepare estimates with the input of architects and engineers to ensure that a project meets financial feasibility and scope requirements. A good cost estimate prevents the builder from losing money and helps the customer avoid overpaying. It's a core component of earned value management, a project management technique that tracks a project's performance against the total time and cost estimate.

There are many aspects which can impart poor value to the project.

- Proper information is not considered as there is time shortage.
- Whenever there is a problem some adjustments are done and the problems are tried to be solved which lacks the quality.
- Sometimes the requirements and needs of the customer are not taken into consideration and after the completion of the projects it lacks its functions for which it was meant to be.
- No proper communication is being done and few aspects are misunderstood.

Cost Engineering is always applied on a service or product for its analysis and design. In value engineering the people who are experts take into consideration of all the parameters based on their experience and knowledge with construction. During the review, the external factors are also taken into consideration so that to identify its impact on the projects and also the extent of the impact. Also it is necessary to keep in mind to check is these parameters are able to tackle all the challenges. Then the experts check for all the alternate possibilities and which can suit with the existing conditions. The alternatives should be able to resist all the influences.

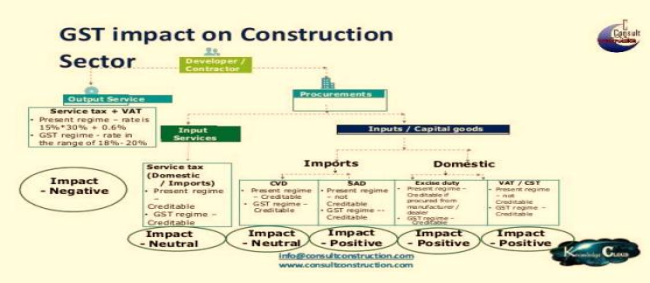
Because "costs" are measurable, "cost reduction" is often thought of as the sole criterion for a value improvement application and indeed it is primarily addressed in this document. However, the real objective of is "value improvement" and that may not result in an immediate cost reduction. Cost and Time Engineering is a systematic, low-cost approach to assessing the "value" of a project. Typically, VE on projects can be used to gain the following benefits:

- cost reductions;
- time savings (schedule & Planning)
- quality improvements
- isolation of design deficiencies

The costs of a constructed facility to the owner include both the initial capital cost and the subsequent operation and maintenance costs. Each of these major cost categories consists of a number of cost components. The capital cost for a construction project includes the expenses related to the initial establishment of the facility:

- ❖ Land acquisition, including assembly, holding and improvement
- ❖ Planning and feasibility studies
- ❖ Architectural and engineering design
- ❖ Construction, including materials, equipment and labor
- ❖ Field supervision of construction
- ❖ Construction financing
- ❖ Insurance and taxes during construction
- ❖ Owner's general office overhead
- ❖ Equipment and furnishings not included in construction
- ❖ Inspection and testing
- ❖ The operation and maintenance cost in subsequent years over the project life cycle includes the following expenses:
- ❖ Land rent, if applicable
- ❖ Operating staff
- ❖ Labor and material for maintenance and repairs
- ❖ Periodic renovations

GST –



It is often wondered that how does it concern for a Civil Engineer to study the GST impact, for the same following points can be stated for which a Civil Engineer needs to study GST & it's consequences in construction sector: -

- High Initial Investing Sector.
- Contractor's relied on Labor's.
- Service Charges.
- Machinery Cost.
- Material Cost.
- Man Power Cost.
- Rate of Interest on Borrowings.
- Labour Contracts Turn Dicey.
- Transparency of Tax Reforms.
- No Scope of Cheat.
- Organizing the Unorganized Sector.
- Project Planning, Scheduling & Budgeting.

A single tax structure is definitely a welcome move and the introduction of Goods and Services Tax (GST) seeks to do just that by way of amalgamating a large number of Central and State taxes into a single tax. GST will not only address the concerns of double taxation but will also help in reducing the overall tax burden on goods and services. Furthermore, it will also help in making Indian goods competitive internationally thus providing a much-needed boost to the economy.

The Construction industry is one of the most pivotal sectors in India and has seen a phenomenal growth, not just in cities, but even small towns. GST is another development that will have a significant impact on this sector. Let's take a look at the impact of GST on the construction industry and the construction sector.

RESOURCE- Resource management is therefore mainly concerned with non-consumable resources. Also, resources may be classified according to their importance to key resources, secondary resources and general resources. Key resources are the most important, Expensive and not available resources in the project such as skilled labors, or equipment. These types of resources will have a great attention in the resource scheduling process. Secondary resources are those resources which have no constraints on their availability, such as normal labour. General resources are defined as those resources that are used by all or most of the activities on the project such as site overheads. General resources will not be included in the resource management.

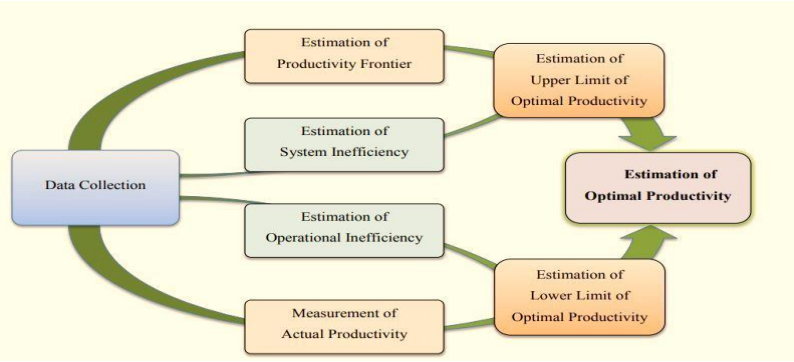
Resource management plans
A resource management plan can be used to:

- Ensure resource availability and resolve resource conflicts.
- Optimize time, effort and cost
- Ensure workers with the right skills are available.
- Identify limitations, such as site access, weather condition and so on.
- Resign resources in response to circumstances
- Track resources utilization to avoid excessive resourcing or under-utilization

Making a resource management plan work in construction
Successful resource management requires a good resource management plan

1. Access to the up-to-date project plan with clear definition of the different phases of work and activity scheduling
2. Understanding the types of resources that are needed.
3. Understanding the availability and optimum utilization of resources.
4. Understanding the potential for developing resources for new uses.
5. Understanding of the lead time require to ensure that resources for new uses.
6. The ability to redeploy resources if works need to be accelerated. Resource management system can improve overall efficiency; replacing less efficient data collection method such as paper forms, spreadsheets, and so on.

LABOUR:



Accurately Measuring Actual Productivity
This research uses three Canon XF professional camcorders to collect video data from three different locations, which capture the movements of workers. The camcorders provide the benefit of reviewing the video whenever required as well as to break down tasks and actions. One thing to note here is: whether the analysis is done at activity level or task level the events must be repetitive in nature.

Estimating System Inefficiencies
The identification of system inefficiencies necessitates a qualitative analysis. Different methods and models for assessing qualitative factors and their implementation can be found in papers such as Thomas and Inspired by these papers, this research developed a Qualitative Factor Model (QFM) to evaluate the productivity lost due to system inefficiencies—those factors that affect productivity but are outside the control influence of project managers. The QFM uses a severity score technique following a probabilistic approach. In this context, $\Delta' si$ is

the estimated productivity loss due to system inefficiencies rather than the actual productivity loss Δsi. Based on this QFM, system inefficiencies for the research is calculated as follows:

$$\Delta'_{si} = \Delta'_{(PF-OP_{LL})} * \sum_{z=1}^{n}[\sum_{i=1}^{m}\left(\frac{S_i P_i}{TS_i}\right)] W_z$$

Estimating Operational Inefficiencies

The process of estimating operational inefficiencies involved developing a DES to model the construction process. The purpose of this simulation was to emulate the processes observed in the video recordings as close as possible so as to later be able to differentiate contributory from non-contributory actions. Contributory actions include those actions that are necessary to accomplish the task. For example, if one considers the bulb replacement task, then basic actions and movements required to replace bulb are contributory actions.

Estimating Optimal Productivity

The estimate of upper boundary and lower boundary determines the range over which optimal productivity can fluctuate. Once the upper and lower limits are estimated the average of these limits provides the best estimate for optimal productivity. The project managers can then use the result to determine the efficiency of their labour-intensive construction operations by comparing actual vs. optimal rather than actual vs. historical productivity.

Guidelines for Improving the Labour Productivity

- Properly training to the labourers
- Motivation to workers towards project completion
- Properly and in advance material procurement and management
- On time payment to the workers
- Systematic flow of work
- Properly, clearly & in time supervision
- Advance site layout
- Maintain work discipline
- Facilities to the labourers
- Clearance of legal documents before starting of work
- Systematic planning of funds in advance
- Pre-mansoon plan to avoid work stop
- Maximum use of machinery and automation system
- Advance equipment planning.

1	**Lack of labor surveillance**
2	Misunderstanding between labours and superintendent
3	Opposition by local due to inadequate conceptual design
4	Addition in scope of work
5	Deletion in scope of work
6	Drawing and specification alteration during execution
7	Skill and experience
8	Planning and Management
9	Material availability
10	Lag of material
11	Delay in arrival of materials
12	Unclear instruction of labour
13	Labour strikes
14	Financial difficulties of the owner
15	Construction technology and method
16	Supervision
17	Improper Project planning
18	Delay In approval of design and drawing
19	Scarcity of manpower/skilled labour
20	Shortage of experienced labour
21	Communication between site manager and labour force
22	Incentive programs
23	Availability of the material and ease of handling
24	Leadership and competency of construction management
25	Competency of labour supervision
26	Absenteeism of worker
27	Labour skill and experience
28	Financial Shortage
29	Inspection and instruction delay

30	Incomplete drawings
31	Accident due to construction equipment / machinery
32	Accident due to moving traffic adjacent to project site
33	Disputes due to discrepancy in contract document
34	Poor Performance of sub-Contractors
35	Adverse Weather Conditions
36	Disease and Epidemic
37	Shortage of Personal protective equipment
38	Availability of health and safety training
39	Delay in salary, poor wages, Lack of Financial motivations
40	Lack of training sessions, lack of labour recognitions programs, lack of place for eating & relaxation, Lack of team spirit

DISPUTES-
DISPUTE PREVENTION TECHNIQUES
The best dispute management skill is the ability to stay out of dispute not as an avoidance technique but rather, as specific prevention strategy. Three key areas to manage are:

Clear specifications
Writing a specification that will be interpreted the same way by different people is a skill that takes years to acquire. In a dispute, it does not matter what was meant, only what is in the contract.
An independent specification review should find and correct material ambiguities. Unfortunately, most organizations do not conduct such reviews and find out later, after the contract has been put into operation, that the specification should have been much, much clearer.

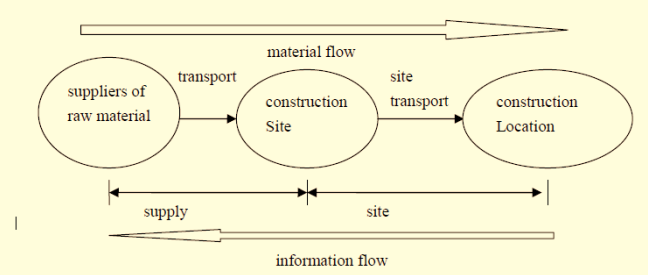
Clear communication protocols
Internal policies and procedures regarding communication, approvals, signoffs and the like, have no bearing in a dispute unless incorporated into the contract and made an obligation of the parties. Consider the number of people who might have a discussion, some form of correspondence, or even just contact with anyone in the other party – there will be quite a few people acting with presumed authority and inadvertently committing your organization. Have clear internal processes, authorities, forms and the like, incorporate them into the contract and make them binding on both parties.

Proactive issue management
It is not unusual, in a contract of reasonable size and complexity, to have up to 300 unresolved issues at any given time; they can quickly grow into disputes if the environment is right. Before declaring something a dispute, consider managing it as an issue, at least to begin with.
Defining a problem an 'issue' rather than a 'dispute' has a big impact. You can apply normal project management techniques to issue management. Have a mechanism for anyone to raise an issue track and assign all issues, and have regular issue resolution meetings.

1	Lack of surveillance
2	Failure of contributors to instantly handle changes
3	variations in legislation and guidelines
4	Lack of understanding
5	Incompetent designer
6	Poor communications among project contributors
7	Lack of cooperation among contributors
8	Indistinct contract documents
9	Impracticable expectations by the parties
10	The impact of local culture.
11	Misinterpretation of contracts
12	Lack of resources
13	Poor communication and documentation
14	Late involvement of lawyers in the construction projects
15	Tendency of lower price offer
16	Working relations and Supervision
17	Circumstances produces a model based on project uncertainty
18	Dispute in construction contracts: Alterations
19	Lack of effective communication among project contributors
20	Delayed payments
21	Design insufficiency
22	Lack of necessary proficiency and experience
23	Poor site management
24	Poor planning and programming

25	Project hampers health of people and damage the natural setting of flora and fauna
26	Disputes with subcontractors
27	Late imbursement to subcontractors
28	Harmonization of subcontractors
29	Alterations to standard conditions of contract
30	People seeking more benefit from the project
31	Inappropriate contract type
32	Accident due to moving traffic adjacent to project site
33	Disputes due to discrepancy in contract document
34	Lack of professionalism of participants
35	Weather Conditions
36	Availability of health and safety training
37	Inappropriate in salary, poor wages, Lack of Financial motivations
38	Inaccurate design information and incomplete tender Information
39	Inappropriate Contractor Selection
40	Lack of training sessions, lack of labour recognitions programs, lack of place for eating & relaxation, Lack of team spirit
41	Decisiveness of the agreement
42	The location and implementation of work
43	Minimized costs in attaining settlement
44	Sustained business relations
45	Control of the result and procedure

LOGISTICS –



The engineering construction project physical distribution management is the plan, the organization, coordinated and the control carries on to the physical distribution activity. It is for the purpose of making the project process to be easier and quickly, simultaneously obviously and controllable. In view of the fact that the engineering construction project physical distribution constructs scene the physical distribution cost to account for the entire project physical distribution cost the very major part, says from the function angle, may divide into the engineering construction project physical distribution the supply physical distribution and the scene physical distribution.

The supply physical distribution and in the production process circulates the work activity related, the basic activity includes: Definite resources (material, equipment and man-power) specification, supply plan, resources purchase, storage control, ex works. Scene physical distribution and in scene production process material plan, organization, direction with control related, including: The scene transportation and the delivery, the field processing, the scene operating system management, the safety equipment, the site layout, the work order's arrangement, as well as between various engineer brigades conflicts solution measure

The Construction Logistics Plan:
Define The Most Efficient Method Of Managing The Logistics Function…It Seems Astonishing–Given The Impact That Logistics Has–That A Document Defining Its Function Is Not Commonplace.

A brief outline of the content of a typical CLP, as specified by current policy documents:

Overview of the Project- A brief description of the development and general site location, as well as proposed site layouts and basic maps of surrounding roads and transport routes

Introduction to the Supply Chain-A brief description of primary products required for the development and their source, as well as the method by which they will be transported. A brief investigation of expected material waste, its removal and recovery

Planning the Supply Chain-This section contains the policies and procedures to be utilized by trade contractors and suppliers for reducing road traffic before and during the construction process. Some examples include:

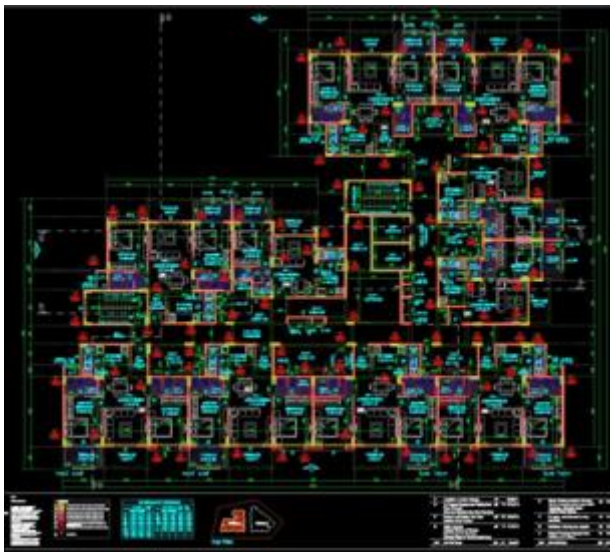
- Materials–A record of all the materials expected to be delivered to and removed from the site and their predicted mode of transport;
- Consolidation Centre and Pre-fabrication (aka. Off-site Manufacture);
- Integration with neighboring sites–Details of any potential delivery consolidation available through
- Combining loads for separate sites situated close to each other. Outlines the processes to be shared and which sites will be collaborating with each other;

Project phase	Guidelines and tools
Design	Logistic guidelines for the conception Analysis of technological alternatives Definition of the plan of attack for on-site work Production design, site design As-built design
Planning	Gantt physical chart Gantt materials consumption chart Gantt equipment chart Histogram of own labour Gantt subcontractor chart Gantt chart of implementation of work safety-related preventive measures
Supplies	Materials specification plans for materials delivery to the site Gantt chart of the start-up of the purchasing process Materials/supplies purchasing rules Materials and services suppliers qualification Guidelines for equipment purchasing or leasing Use of indices of material losses and wastage
Execution	Plan for the execution of work Documentation, implementation and maintenance of the information system Use of labour and equipment productivity indices Work safety and health rules

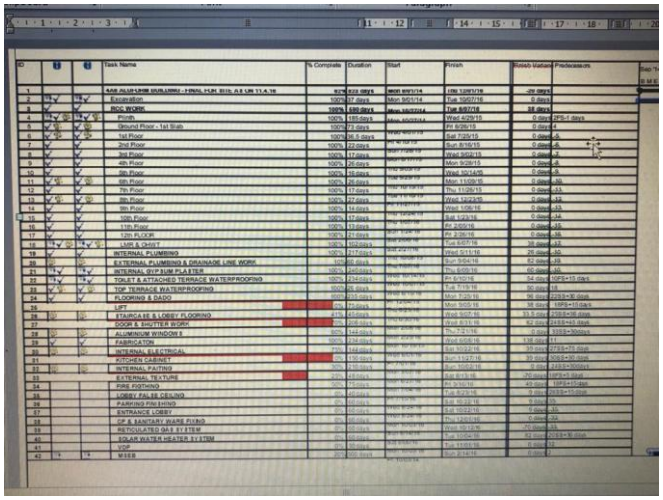
VI. CASE STUDY

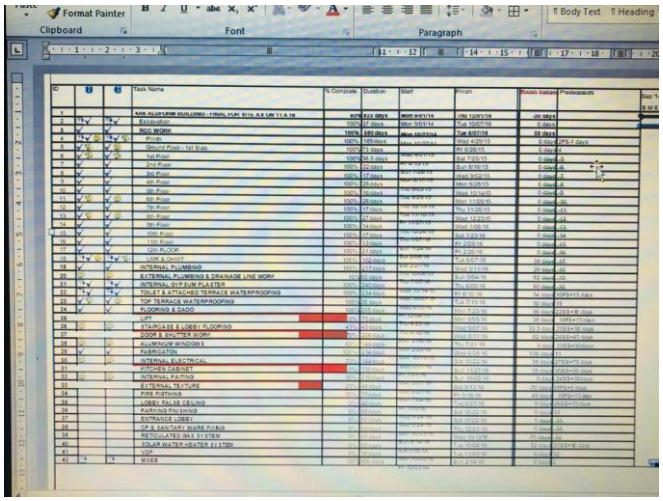
- **Name of the project:** Green Republic Samrat Buildcon
- **Location:** Wagholi, Pune
- **Total project Cost:** 50.30 Crores
- **Total Length:** 39.75/34.825 m
- **Date of Commencement:** October 2014
- **Completion period:** 27 Months
- **Construction Type:** RCC Frame Structure.
- **No. of Floor:** G+11 Floor
- **Total Area of Building:** 1, 15000 Sq. Ft.
- **Plinth Area:** 8500 Sq. Ft.
- **RCC Contractor Name**: Mr. Rohit Patel
- **Authority Engineer:** Tejas Shingvi
- **Local Authority:** GP, Pune
- **Walls:** 230 mm thick brick masonry walls only at periphery.
- **RCC Design Consultant**: VastuStruct

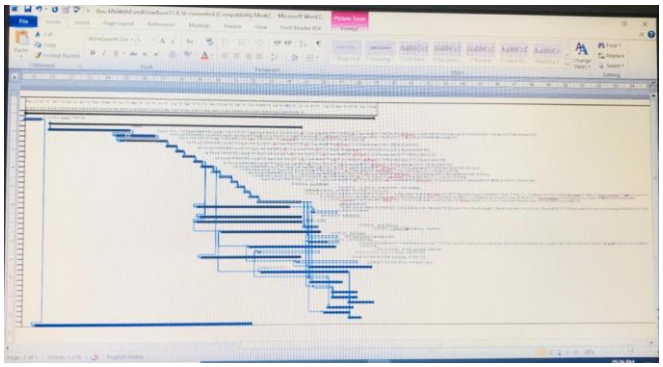
DESIGN PHOTOS



MSP RESULTS:







VII. RESULTS & DISCUSSION

Do you think using Lean management on site it will increase Quality of work at lower cost?

Valid	Frequency	Percent	Valid %	Cumulative %
2	1	2.5	2.5	2.5
3	1	2.5	2.5	5.0
4	4	10	10	15.0
5	34	85.0	85.0	100.0
Total	40	100.0	100.0	

Waste minimization enhances the productivity in Construction activity?

Valid	**Frequency**	**%**	**Valid %**	**Cumulative %**
1	1	2.5	2.5	2.5
3	1	2.5	2.5	5.0
4	29	72.5	72.5	77.5
5	9	22.5	22.5	100.0
Total	40	100.0	100.0	

Do you think complexity of detailing in drawing causes wastage in construction?

Valid	**Frequency**	**Percent**	**Valid%**	**Cumulative %**
3	**1**	**2.5**	**2.5**	**2.5**
4	**32**	**80.0**	**80.5**	**82.5**
5	**7**	**17.5**	**17.5**	**100.0**
Total	**40**	**100.0**	**100.0**	

Due to Inappropriate placement of the material it will increase wastages of material?

Valid	Frequency	Percent	Valid%	Cumulative %
3	1	2.5	2.5	2.5
4	11	27.5	27.5	30.0
5	28	70.0	70.0	100.0
Total	40	100.0	100.0	

Improve safety at work place increase labour productivity?

Valid	Frequency	Percent	Valid %	Cumulative %
2	1	2.5	2.5	2.5
3	2	5.0	5.0	7.5
4	7	17.5	17.5	25.0
5	30	75.0	75.0	100.00
Total	40	100.0	100.0	

Labors Errors affects the construction productivity?

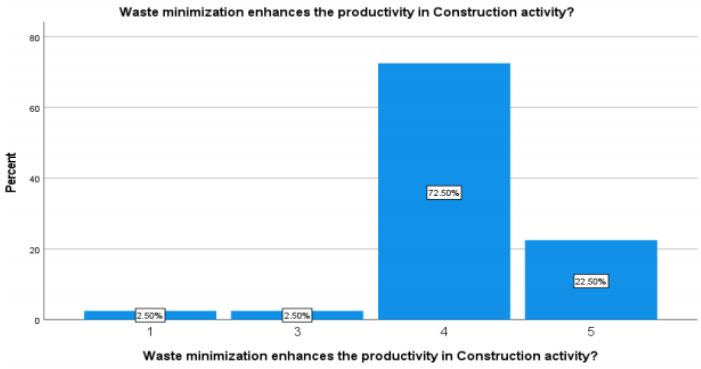
Valid	Frequency	Percent	Valid %	Cumulative %
2	2	5.0	5.0	5.0
3	2	5.0	5.0	10.0
4	10	25.0	25.0	35.0
5	26	65.0	65.0	100.0
Total	40	100.0	100.0	

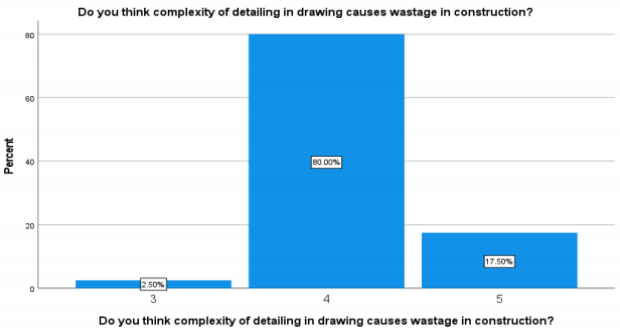
Is it part of lean management that procurement of materials just before the requirement during process to decrease the volume of inventory on site?

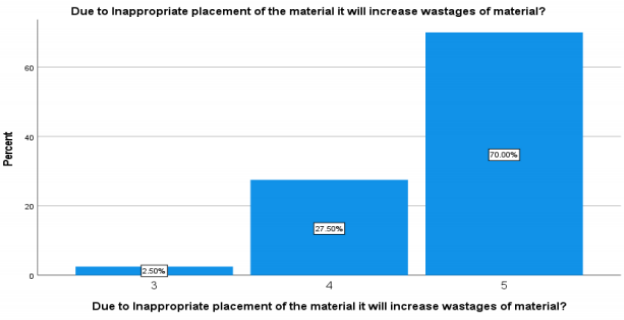
Valid	Frequency	Percent	Valid %	Cumulative %
1	26	65.0	65.0	65.0
2	6	15.0	15.0	80.0
3	6	15.0	15.0	95.0
4	1	2.5	2.5	97.5
5	1	2.5	2.5	100.0
Total	40	100.0	100.0	

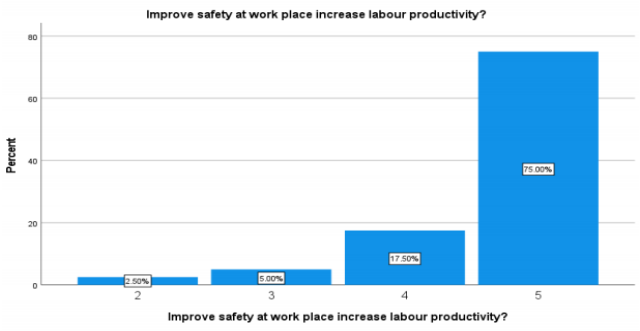
Is there any need of training for different levels of management to improve overall efficiency

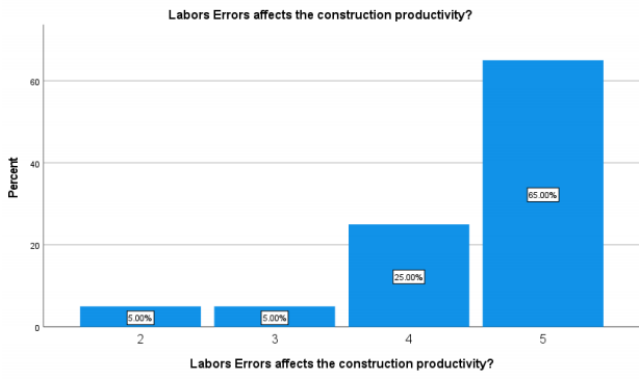
Valid	Frequency	Percent	Valid %	Cumulative %
3	1	2.5	2.5	2.5
4	8	20.0	20.0	22.5
5	31	77.5	77.5	100.0
Total	40	100.0	100.0	

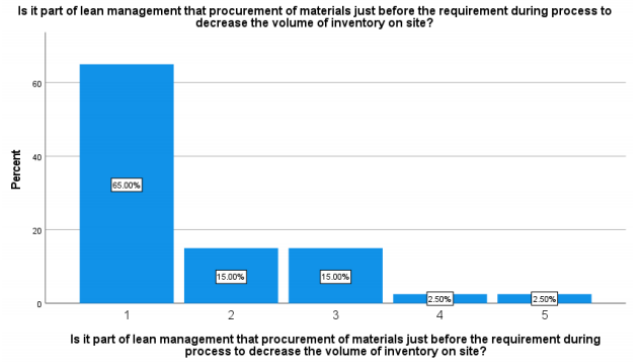


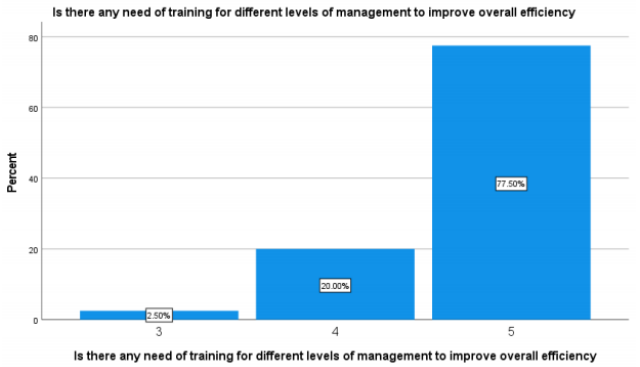





Improve safety at work place increase labour productivity?
Percent
80
60
40
20
0
2.50%
5.00%
17.50%
75.00%
2
3
4
5
Improve safety at work place increase labour productivity?


Labors Errors affects the construction productivity?
Percent
60
40
20
0
5.00%
5.00%
25.00%
65.00%
2
3
4
5
Labors Errors affects the construction productivity?


Is it part of lean management that procurement of materials just before the requirement during process to decrease the volume of inventory on site?
Percent
60
40
20
0
65.00%
15.00%
15.00%
2.50%
2.50%
1
2
3
4
5
Is it part of lean management that procurement of materials just before the requirement during process to decrease the volume of inventory on site?


Is there any need of training for different levels of management to improve overall efficiency
Percent
80
60
40
20
0
2.50%
20.00%
77.50%
3
4
5
Is there any need of training for different levels of management to improve overall efficiency

SITE PHOTOS

VIII. CONCLUSION

1. It is conclude that for any medium to large scale construction site applying lean technology or the principles of the lean techniques we will increase the productivity of the construction.
2. Using eco-friendly products will not temper with your use or productivity but make it more efficient and effective
3. The Environment Management Plan would consist of all mitigation measures for each item wise activity to be undertaken during the construction, operation and the entire life cycle to minimize adverse environmental impacts as a result of the activities of the project.
4. The aim is to integrate an architecturally sustainable design with the natural environment with least damage to the nature and at best improving it by restoring its balance.

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