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Analysis of Lean Construction by Using Last Planner System

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***Abstract* — Lean construction is a relatively new construction management philosophy which has evolved from Lean manufacturing principles. Lean construction along with its various tools like the Pull Approach, Just in Time, Total Quality Management, Continuous Improvement, Last Planner System, etc. has gathered a lot of momentum in the developed nations. The challenge now lies in implementing it in the developing countries. The Last Planner system is a production planning system designed to produce predictable work flow and rapid learning in programming, design, construction and commission of projects The essence of Lean Construction is to increase in efficiency by elimination of non value adding activities.**

***Keywords*—Master schedule, Look-ahead schedule, Weekly workplan,Percent planned complete, Make work ready planning.**

1. INTRODUCTION

The objective of the present study is to analyze the Last Planner System in reducing the construction complexities involved in the project and to analyze the last planner system to complete the project within the stipulated time and cost and to study the concept of lean construction and how it is being implied in the local construction industry Lean construction project is very different compared to traditional construction project management where Lean approach aims to maximize performance for the customer at the project level, set well-defined objective clearly for delivery process, design concurrent product and process and applies production control throughout the life of project. Generally, lean approach breaks the construction project to smaller parts of activities which will be defined clearly the start and end date for completion of each activity with an appointed person to keep on monitoring the all the activities to be completed according schedule.

2. NECESSITY OF THE STUDY

Planning defining criteria for success and producing strategies for achieving objectives. Control causing events to conform to plan and promoting, learning and re-planning. Better planning results from overcoming several obstacles common in the construction industry, including

- Management focus is on control, which prevents bad changes and neglects breakthrough, which causes good changes.
- Planning is not conceived as a system, but is rather understood in terms of the skills and talents of the individuals who are in charge of planning.
- 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 the construction process, and continuous monitoring of the planning efficiency.
- The Last Planner integrated components are master plan, phase planning, look- ahead and weekly planning.

3. THE RESOURCE-CONSTRAINED SCHEDULING PROBLEM

Planning is the construction of the project/process model and definition of constraints/objectives. Scheduling refers to the assignment of resources to activities (or activities to resources) at specific points in, or durations of, time. The definition of the problem is thus primarily a planning issue, whereas the execution of the plan is a scheduling issue. Yet planning and scheduling are coupled; the performance of the scheduling algorithm depends on the problem formulation, and the problem formulation may benefit from information obtained during scheduling

4. GENERAL FORMULATION

In its most general form, the resource-constrained scheduling problem is defined as follows:

- Set of activities that must be executed
- A set of resources with which to perform the activities
- Set of constraints which must be satisfied, and
- A set of objectives with which to judge a schedule's performance.
- Minimization of project duration
- Minimization of cost
- Maximization of the net present value of the project
- Optimum resource utilization efficiency
- Involvement of designers in joint solutions.
- Direct interactions between designers and customers.
- Explicit and healthy client supplier relations.
- Always working with a set of design alternatives

5. IMPLEMENTATION OF LAST PLANNER SYSTEM

This tool in simple words can be taken to be an assimilation of the above mentioned tools. It also has a number of other features which are explained below. The main objectives of a production control system like the Last Planner System are as follows

- Manage and mitigate the variability.
- Assignments and schedules should be sound regarding their prerequisites.
- The completed assignments should be monitored.
- Causes for failure to complete the planned work should be investigated and removed.
- The prerequisites of upcoming assignments should be made ready.
- The traditional push based construction process model should be incorporated with pull techniques.
- Traditional project control focuses on hierarchical decision making and thus the decision making process lies in the hands of few and often decision makers are unaware of the ground realities. Decision making powers should be well distributed among the project team.

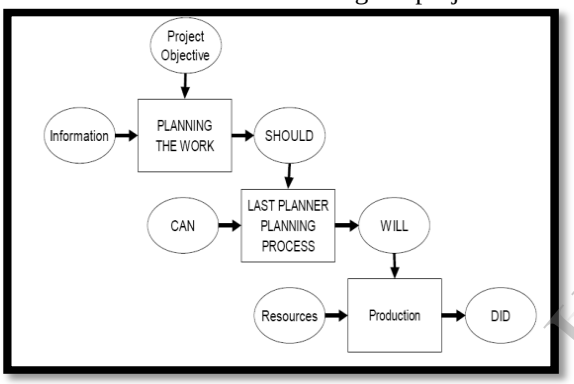

Figure.1 Last Planner system

In CPM there is strict adherence to the master schedule even when great obstacles lie in its path. Supervisors keep on pressurizing the subordinates to produce despite obstacles. Many a time these obstacles result in poor quality output which remain in the project supply chain throughout. Last Planner System (LPS) 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 Figure shows the processes of Last planner system.

6. APPLICATION OF LEAN CONSTRUCTION PRINCIPLES TO THE CONSTRUCTION PROCESS

The application of lean construction tools to the construction process will be explained in this section. The construction process is considered as a three phase process:

- Design
- Planning
- Scheduling
- Execution
- Monitoring a
- Controlling

6.1 Application of lean construction principles to design management

- Having some degree of flexibility in the sequence of design activities. Not defining activities in a very fine level of detail and encouraging team work.
- Involvement of designers in joint solutions.
- Direct interactions between designers and customers.
- Explicit and healthy client supplier relations.
- Always working with a set of design alternatives.

By making use of the integrated models, the share of wasteful activities can be reduced, output value can be increased by more emphasis on customer's requirement, and variability can be reduced by reducing the number of steps involved in the design process; cycle times and most importantly continuous improvement can be built into the process.

6.1.1. Application of lean construction principles in construction planning

They have highlighted the fact that the construction planning process most prevalent today is that of developing a single plan and adhering to it for the entire duration. Those plans are seldom reviewed during the execution stage and the corrective actions only include adjusting the original schedules to actual performance. To improve the planning process they have suggested a shift towards contingency planning which includes preparation of several detailed plans prior to execution for different project environments. Hence the need to review the original plan for problems very seldom arises. To implement the contingency planning substantial amount of time and resources need to be expended during the construction planning prior to the execution and also in project control during construction work on site.

6.1.2. Application of lean construction principles in construction execution

This stage involves utilization of the last planner tool (described earlier) of lean construction for execution of the project. In this section the meaning of the "pull process" for building up of the schedules and the workable backlog is described.

6.1.3. Phase scheduling

Lean construction uses the pull technique for development of project schedules. Thereby only those tasks are scheduled and executed whose completion releases work to other tasks. This way, only the work that is required is done and thereby prevents any over production .The phase schedules serve as a basis for the development of look-ahead schedules. In the phase scheduling process, representatives of all organizations involved in the phase sit down to decide on the work that must be performed to release work to other phases. The people responsible for the work write their requirements on a sheet of paper and stick them on a wall in their expected sequence of performance. After all sheets are on the walls, the network diagram is prepared by moving and shifting of sheets. Thus new techniques and methodologies for doing the work are found out. After the finalization of the sequence of the activities, durations (without any float) are applied to them. The network diagram is then reexamined to look for processes which can be shortened. The earliest practical start date (calculated) for the phase is then determined by working

backwards from the schedule. If there is any positive difference between the possible and the calculated start date that time can be allocates to critical processes in the phase to protect them from uncertainties. In case the difference is negative then the phase will have to be delayed and the time lost will have to be made up in other phases.

7. Look ahead process and Last Planner System

The look ahead process involves the following processes: explosion; screening and make ready.

7.1.1 Explosion

This involves exploding the activities mentioned in the master schedule to great details to identify all the pre requisites for the activity before it enters the look a-head window.

7.1.2 Screening

This process is used for determining the status of tasks that are present in the look a-head window based on their pre requisites (constraints). Here we can choose whether to advance or postpone the tasks based on their status.

7.1.2 Make ready

In this process the lead time (time for order to delivery) is estimated, the pre requisites are pulled and the work is executed. This process requires great caution as the ordering times have to be estimated reliably to prevent any inventory from building up at site. The status of the consuming activity should be matched with the ordering times of resources with great detail and caution. The make ready work then enters the workable backlog so that the scheduled work can begin. The work is monitored by using PPC (Percent of Planned Complete) and the inability to achieve a high PPC is investigated for process improvement and to prevent the problems from re occurring.

7.1.3 Percent planned complete

PPC or Percent of planned complete is the method used for monitoring of the project. Unlike the techniques of earned value estimate which is traditionally used for monitoring of projects, the PPC measurement has the following advantages:

- Work is selected by the workers themselves and hence there is less chance of time over run.
- The causes for the non completion of work are mentioned explicitly while analyzing PPC.
- PPC helps in continuous improvement of the construction project as
- Efforts are made to prevent the re occurrence of problems.

8. LEAN CONSTRUCTION PRINCIPLE

The traditional project management practices treats all the activities in construction as value adding activities and accordingly the construction process is a conversion based process in which one value adding activity leads to another. This model pressurizes the available resources to act fast thereby resulting in a compromise in the quality of the construction. On the other hand lean construction is a flow and conversion based model where a construction process is a collection of conversion processes involving flows of information and materials from one process to the other as depicted in Fig. (Lean Construction process)

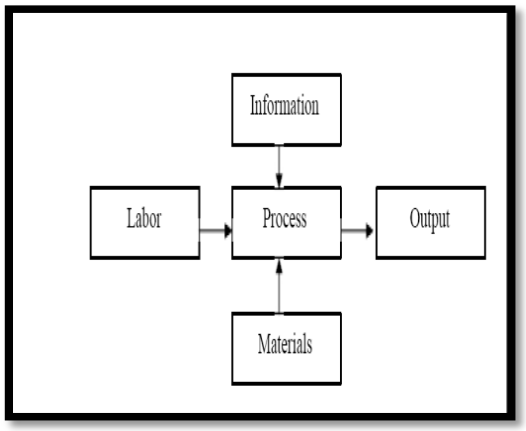

Figure.2 Lean Construction principle

Planning for the project cannot be performed in detail much before the events being planned. Consequently, deciding what and how much work is to be done by a design squad or a construction crew is rarely a matter of simply following a master schedule established at the beginning of the project.

9. MODEL DEVELOPMENT

The following are the basic step which is involved in the development of a model. The Flow chart of Last planner system is shown in the figure.

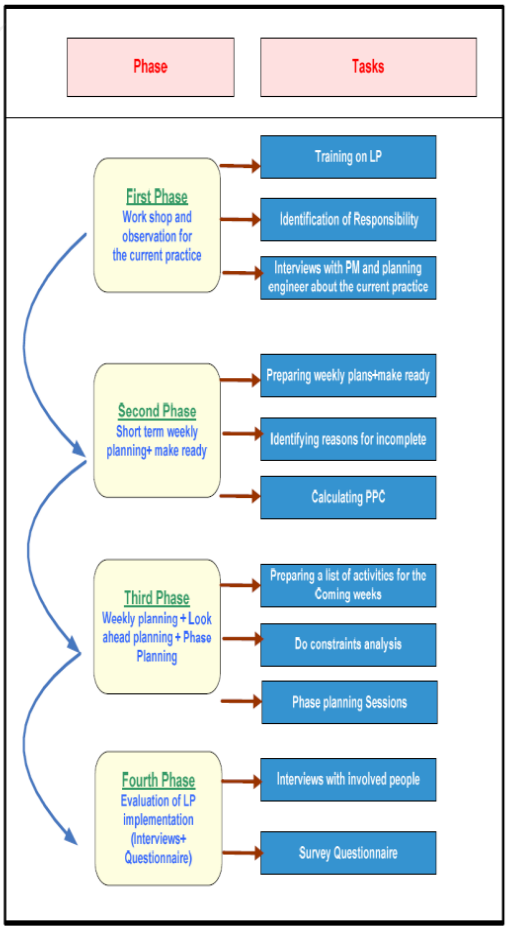

Figure.3 Model Development of Last Planner System

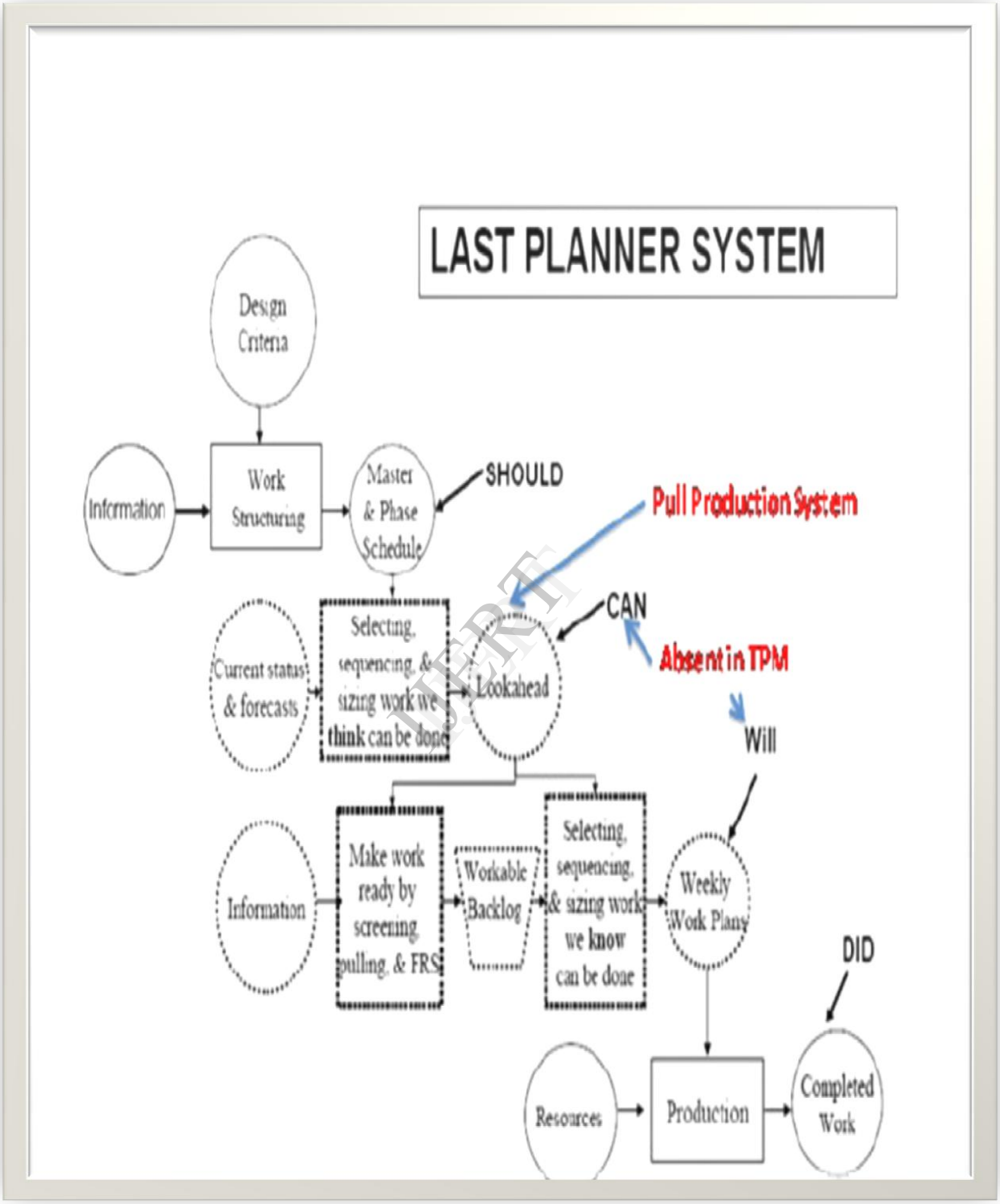

Figure.4 Processs of Lean Construction vs Last Planner System

10. MASTER SCHEDULE OF THE PROJECT

Master Schedule is the overall project schedule. It contains major milestones only. Milestones dates are determined by using the pull process from successor milestones, beginning with the project starting date and working forward to project completion date.

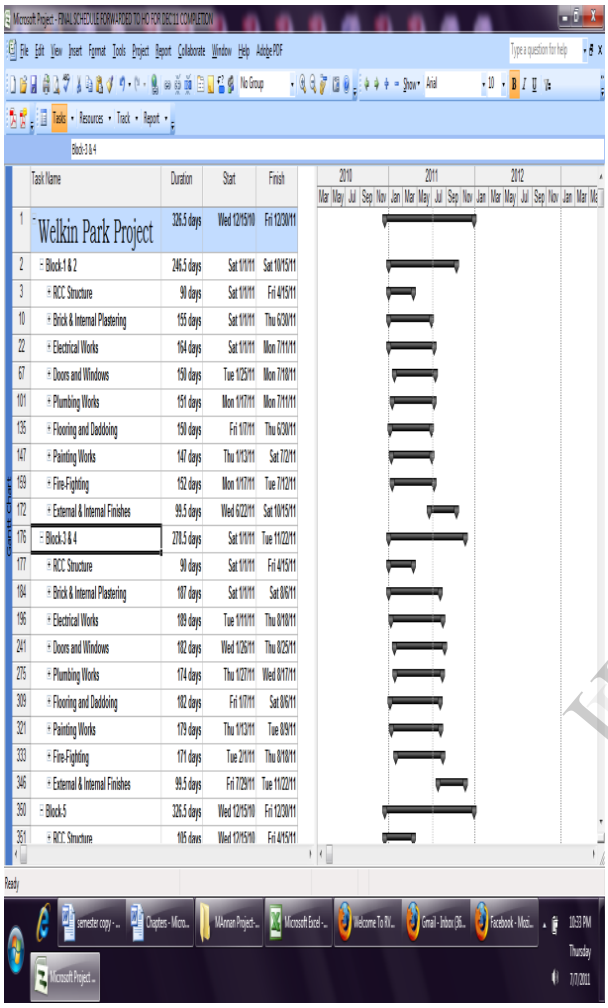

Table.1 Master Schedule

10.1 Look-ahead Schedule

Look-ahead schedule represents an intermediate level of planning. This schedule contains major work items that must be completed in order to meet the milestone dates in the master pull schedule. Major activities and their completion dates are pulled from the master schedule, broken into detail and screened prior to entry in the look-ahead schedule. Screening essentially means that all the constraints preventing the execution of the activity has been identified.Lookahead schedule comes after the master schedule of project.

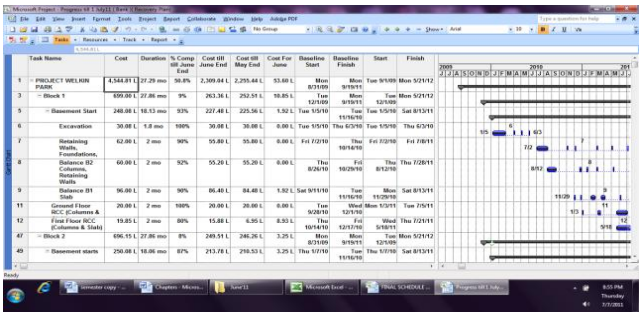

Table.2 Look ahead Schedule

10.2 Weekly Work Plan

Look ahead schedule is prepared based on the information that is made ready by Screening and pulling which is a workable backlog of selecting, sequencing and sizing the work that can be done through weekly work plan. The Weekly planner is an assignment level schedule, one week in duration. This schedule includes all assignments or work activities that are required to be started that week in order to maintain the completion dates in the look-ahead schedule. Work assignments are pulled from the look-ahead schedule onto the weekly work plan.

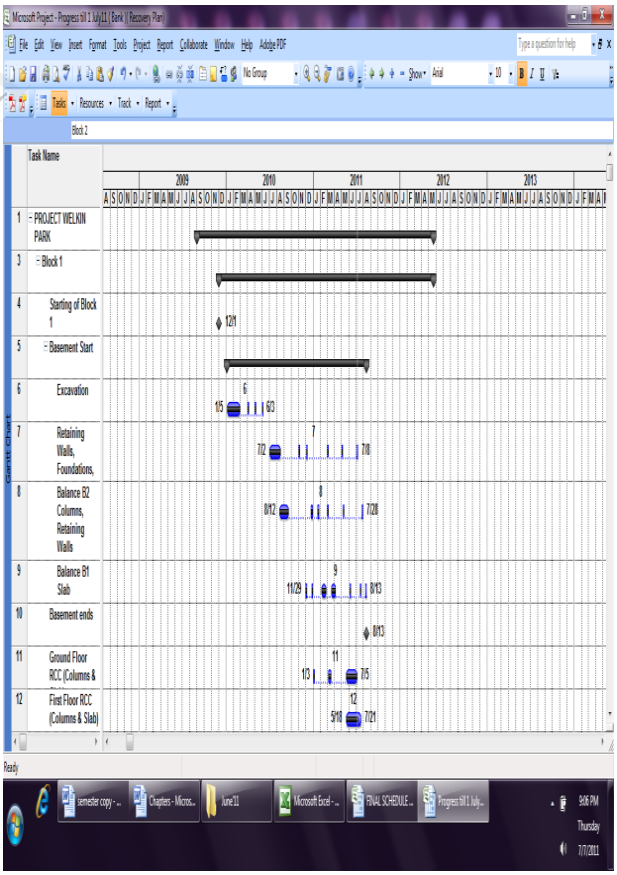

Table.3 Weekly work plan

11. DISCUSSIONS OF RESULTS

Based on the present case study the following results are determined. The various factors are tabulated as follows which

indicate the data representation to achieve the following results.

S.no	Name of the Blocks	Planned		Actual	
		Cost in Lakhs	Duration in months	Cost in Lakhs	Duration in months
1	Block-1	699	27.86	526.4	26
2	Block-2	696	27.86	499	25.86
3	Block-3	825	26.87	658	25
4	Block-4	896.73	28.87	825	30
5	Block-5	1427.54	28.03	1427	30

Table 4. Master schedule of the project

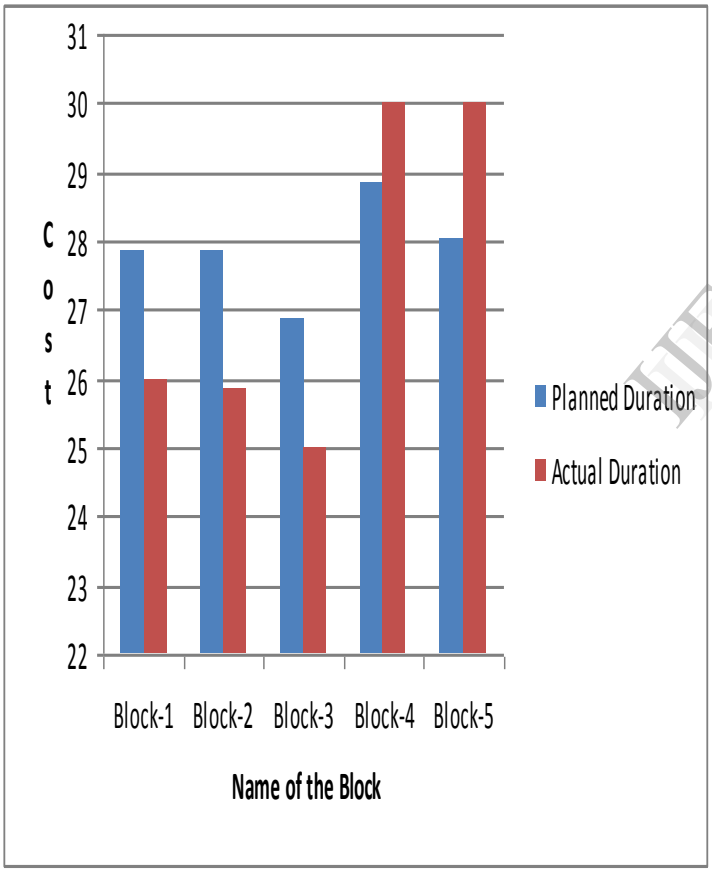

Fig.5 Planned duration Vs Actual duration for all the blocks

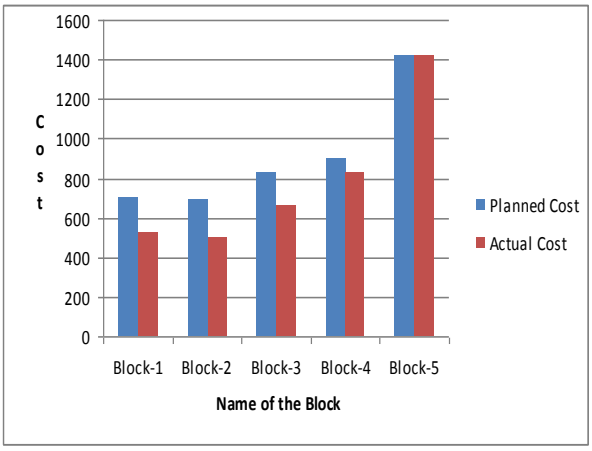

Fig 6.Planned cost Vs Actual cost for all the blocks :

12. CONCLUSIONS

The last planners system could be an appropriate tool to help solve problems which arise at site during execution, minimizes delays, optimize the resources, and reduced the project cost. Present study describes how a Last planner system is prepared and the case study demonstrates an application in which the Last planner system enabled the user to validate proposed construction estimation.

The purpose of using Last planner system for construction simulation is to assist project planners to better understand the construction process and predict the accurate future costs.. This shows that the Last planner system can be used for this purpose and site is a key to implement the Last planner method. The specific conclusions derived from the following study are as follows:

- After analyzing the Last Planner system it is observed that there is a saving of Rs.1,15,5800.00 for the total project. There are 5 blocks which are to be completed by 2014, The amount saved by using last planners system is 1,15,5800.00 for 5 blocks.
- It has been seen that the Last planner system was successful in reducing the construction complexities during execution of the project.
- In conclusion, the developed Last planner system is more accurate and simple to use most with significant time and cost saving

13. Scope of Future Work

An accurate planning can increase the productivity of construction activities, improve the utilization of resources. A comprehensive forecast of costs, planning are the main preliminary factors for successful construction management. The Last planner system can be successively use by planning engineers to make the project schedules more predictable and increases the chances that work will flow and projects will be completed on time.

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