On-Site Performance Improvement Program- A Case Study

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Abstract— On site performance improvement program by planning scheduling implementing new construction techniques have become an essential part of any project for the timely and economical completion of the project. A proper construction schedule can be used for different purposes. By using construction schedule to predict project completion, contractors can adjust crew size, shifts or equipment to speed or slow the progress. All the construction projects will vary from each other in size. All the projects have time constraint. Delay in completion of project will increase the overall cost of the project. Small projects can be managed efficiently manually; whereas large projects are not so large projects can be better handled by the use of computers. Many types of software are available with the help of which project management can be done easily. Large quantities of different kinds of resources are also required for execution and the risk is more in the case of projects. So planning scheduling and implementing new construction techniques of activities for construction of big projects is essential. In this study, an effort is made in on site performance program, which is done by using MS Project, Primavera and MS Excel software. Labor requirement for each activity is calculated from standards obtained from site. An updated schedule, which helps to finish the project well in time with optimum resources and update helps in improving on site performance, is under the scope of this study.

Keywords— Planning, Scheduling Delay analysis, MS Project, Primavera Project management.

I. INTRODUCTION

A project is defined as a collaborative enterprise frequently involving research or design that is carefully planned to achieve a particular aim. A project involves lots of interwoven processes which have to be carried out by making use of inputs like money, material, manpower, machinery, information and energy.

Project management, according to British Standard BS 6079: 2000, defines it as the planning, monitoring and controlling of all aspects of project and motivation of all those involved in it to achieve the projective objectives on time and to the specified cost, quality and performance.

The primary challenge of project management is to achieve all of the project goals and objectives while honouring the preconceived constraints. The typical constraints are scope, time, and budget. The secondary and more ambitious challenge is to optimize the allocation of necessary inputs and integrate them to meet pre-defined objectives.

Some of the common software used for project management for managing a variety of tasks around the world is Microsoft Project (MSP), Primavera, Genius project, Intuit Quick Base, etask-it, Liquid Planner etc.

A project environment comprises various interrelated constituents such as resources, tasks, and technology along with the people working against time under stress and strain, all of these combine together to achieve the common project objectives. The problems of management are so complex that they defy simple solutions. Some of these are beyond the management's control but some can be avoided. The following causes of project failure can be attributed to management failure: Planning failure, Organizational failure, Resource failure, Directional failure, Controlling failure, Coordination failure, and other failures.

On Site Performance Improvement Programs (OSPIP) of a construction project which includes: data collection; measuring the project time progress, analysis the deviation of project from time schedule, planning the change content to achieve project time objectives, and provides a guideline for necessary steps required to improve construction project performance with respect to time. The study provides the measurement techniques to measure the project performance to find out where the project stands in terms of performance.

The key Performance Indicator is the measure of a process that is critical to the success of a project. The key performance Indicators are essential to find the area which need Improvement in a project.

The Key Performance Indicators are now widely used within the construction Industry to Measure Performance

and drive the improvement. The KPIs are explained in more detail in next section.

II. PROBLEM STATEMENT

The duration of contract performance has a direct effect on the profitability of construction projects from the perspective of all stakeholders. From a scheduling standpoint, the goal of every project is to be delivered on time and within budget, with desired functionality and acceptable quality level. A small delay in a critical activity can affect many schedules. Delay can alter the planned level of resources and their mobilization. Time over runs increase overheads, reduce planned revenue from sales and create cash inflow problems. Delay in contracted projects can result in penalties, and adversely affect the reputation of the company.

In this thesis work studied how to finish the project on scheduled time by more improved techniques so that the project finishes in a scheduled time to overcome the above mentioned problems.

III. OBJECTIVE OF THE PRESENT STUDY

- The objective of this study is to explore the ways in which construction project can manage the performance of the project during field operations.
- To find weather the project is overrunning and missing the milestones.
- To find the main disruption sources from where the project is being delayed and where the main concentration of the project should be to minimise the delay of the project.
- The objective of this study is to complete the delayed project in scheduled time by introducing innovative construction techniques.
- To provide guidelines for necessary steps required to improve construction project performance to complete the project on time.

IV. LITERATURE REVIEW

Work by **Anu V. Thomas et.al. 2013** compares the productivity of subcontract labor and directly employed labor engaged in masonry works on a project were made to determine the variability in productivity among the labor force and the causes of the inefficiencies. Productivity plots and statistical tests revealed the productivity of the subcontract labor to be significantly higher than the productivity of the directly employed labor. Subcontract labor achieved on an average 33% higher productivity than the directly employed labor. Benchmarking measures of performance ratio, waste index and coefficient of productivity variability were also applied to illustrate the productivity differences between the two types of labor.

Variability in productivity among different types of labor was studied on a construction project in the state of Kerala in India. Significant difference in productivity was observed between the subcontract labor and the directly employed labor with the subcontract labor performing better than the directly employed labor on the project. Investigation on the reasons for the loss of productivity revealed that the directly employed labor experienced higher percentages of overtime and time losses due to disruptions, when compared to the subcontract labor.

Another work done by **TeGao et.al.** the assumptions considered during the planning and execution of construction projects. In planning stage the decisions made based on invalid assumptions can negatively impact the outcomes of construction projects, such as rework, activity delays, and extra material cost. To address the problems caused by invalid assumptions, it proposed to develop a formal approach to capture and represent assumptions andproactively verify assumptions to reduce the uncertainties associated with construction projects.

In order to avoid the negative consequences caused by invalid assumptions, there is a need to proactively verify assumptions. The first step toward proactive assumption verification is to identify the general characteristics of assumptions so as to develop a formal approach to capture and represent assumptions made in construction projects. A formal approach to capture and represent assumptions would help project planners to better understand the uncertainties associated with upcoming activities and verify assumptions associated with plans.

Another work done by **SalehAlsulamy et.al, 2012.** to evaluate the main project and organizational performance metrics including financial and nonfinancial measures that have been developed in recent years. In this work, the fundamental requirements for suitable performance metrics are identified.

The author uses key performance indicators to identify the performance of the projects. The author states that the major issue in using the KPIs is that they are concerned with past events. That is to say, that the performance is not affected by the results of KPIs. On the contrary, the leading measures deal with the current activities which are being performed. As a result, these measures offer chance to the change in future.

Another research work by **Mostafa E. Shehata et.al.2012**. on labor productivity in the construction industry. It covers the construction labor productivity definitions, aspects, measurements, factors affecting it, different techniques used for measuring it and modeling techniques. This study provides a guide for necessary steps required to improve construction labor productivity and consequently, the project performance. Also, it gives an up to date concept of loss of productivity measurement for

construction productivity claims. Two major case studies are presented in this paper to show construction labor productivity rates, factors affecting construction labor productivity and how to improve it.

Reaearch work done by **James T. O'Connor 1998.** The constructability is enhanced when innovative construction methods are utilized. The focus is on the development and effective utilization of innovative field construction methods that simplify construction effort and reduce project costs.

Insight into the advancement of field operations constructability may be gained from analyses of innovation in construction and of construction technology. Prompters of construction innovation include self-motivation, performance incentives, and programs such as value engineering, performance improvement councils, quality circles, and constructability teams. Circumstantial natural prompters of construction innovation include needs for adhoc focused studies, needs for work-around solutions to actual problems, and risk-management solutions to potential field problems.

The relationship between technology and field operations constructability is strong and, in the opinion of the authors, the average construction organization should be more eager to advance and implement new technologies. The importance of adaptations of innovative construction technologies should not be overlooked and deserves more attention from the industry.

V. DATA COLLECTION

A. Brief description of project

1. Residential towers -3 no's Namely A, B & C.
2. Total land area - 6.5acre
3. Floors – 1B+S+G+12Floors

Table 1: Shows Each Block with number of Flats and Super Built-up area

Phase	Block	No. of Flats	Super Built-up Area(Sft)
Phase - I	Block - B	312	3,12,185
Phase - II	Block - C	310	4,07,560
Phase - III	Block - A	52	91,270
Total		674	8,11,015

Above table shows which block was constructed in which phase along with number of flats each blocks consists and super built-up area.

B. Material Description of Project

a) Steel: All Reinforcing steel shall be High Yield Strength Deformed bars of grade Fe-415 & 500.

b) Concrete: Grade of concrete is as follows.

1. Columns: Grade of concrete for all columns is as per schedule. Minimum concrete grade is M20 & maximum concrete grade is M50.
2. Foundations, Retaining walls & other concreting below ground level: For above structural elements with concrete grade M20 with minimum cube strength 20 N/mm2 at 28 days with minimum cement content of 310kg / cum.
3. Roof Slabs from Ground floor level to Terrace floor level: Concrete grade M20 with minimum cube strength of 20 N/mm2 at 28 days with minimum cement content of 310 kg /cum. As per the trail mix and approved by structural consultant minimum cement content is 290 kg/cum.

C. Specifications

a) Flooring:

1. Master Bed Room: Laminated wooden flooring.
2. Bedrooms, Living Dining & Kitchen: Vitrified Tiles (600mmx600mm) of reputed make.
3. Toilets & Utility flooring: Anti-Skid Ceramic tiles.
4. Lobby & Common area Flooring: Natural Stone or tile.
5. Staircase Flooring: Natural Stone.

D. Kitchen: Granite platform with stainless steel sink of single bowl with drain board.

E. Painting: Oil Bound Distemper over a coat of plastofix (putty).

F. Joinery:

a) Main Door: Teak wood door frames with HDF molded Paneled Shutter with French polish and reputed make hardware.

b) Bed Room, utility & Toilet doors: Hard wood frames with HDF molded Paneled door with enamel painting with reputed make hardware.

c) Balcony Door: UPVC sliding door.

d) Windows: UPVC glazed windows.

e) Ventilators: UPVC glazed ventilators.

f) Balcony & staircase Railing: MS Railing.

g) Elevation – Projected Balconies: SS railing with Glass.

G. Innovative Construction Techniques

a) Self Consolidating concrete(SCC).

b) Doka Shuttering for Slab.

c) Automated Bar bending machine.

d) Gypsum Plaster instead of Cement Sand Plaster.

VI. DATA ANALYSIS AND RESULT

A. Planning and Scheduling

Planning and Scheduling done using the Microsoft project software. The first step is the preparation of the schedule was to break down the total project work into individual work activities. The next objective was to determine the number and size of activities. The objective for determining the number and size of the activities was to divide the project into sufficient small activities, by which the work can be controlled. Using the construction procedure, the project was divided into milestones, which were further divided into activities and their sub activities. The size of activity depends upon the type of work involved and importance of activity to the project completion.

The Schedule of the project is prepared by the data obtained from the BOQ and Drawings. During planning of construction project various assumptions were made with respect to execution of construction activities, availability of resources, suitability of construction methods, and status of preceding activities.

a) Calculation of Required resource (Manpower) team. The required manpower team for each sub-event is calculated by the formula given below;

Required Resources = {Total Quantity/ (Productivity X Duration)}

Example: Ground Floor (Beams and Slabs)

- Shuttering = 883.33Sqm
- Reinforcement = 11.86 MT
- Concreting = 95.7 Cum

1. For Beam and slab Shuttering:

Manpower team required = 888.33Sqm/(15sqm/days * 4days) = 4

That is 4 carpenters and 4 carpenter helpers required in the ratio of 1:1

2. For Beam and slab Reinforcement:

Manpower team required = 11.83Mt/(0.3MT/days * 3days) = 13

That is 13 barbenders and 13 barbenders helper required in the ratio of 1:1

3. For Beam and Slab Concreting:

Manpower team required = 95.7Cum/ (30Cum/days * 1days) = 3

That is 3 mason and 12 mason helpers are required in the ratio of 1:6.

Similarly for all the activity the manpower team required is calculated and feed in the resource sheet in M S Project.

b) Baseline schedule (plan)

The baseline is set after the preparation of schedule model. The baseline is used as the benchmark to compare the dates, resources and costs to the current schedule. This method is used to measure project status as well as performance. Using baseline plan enables us to review delayed activities related to the original plan. Baseline schedule provides us the duration, i.e; the estimated time period in which each event or sub event has to be completed. This schedule also provides us with the sequence or the order in which the various events and the sub-events have to be carried out.

1. Setting Baseline in M S Project

a) Go to project tab > Schedule Group > Set Baseline.
b) From the drop down menu that appears, click set baseline > set baseline dialog Box.
c) Open the set Baseline > select the Baseline that want to set.
d) Click ok.

2. Tracking

a) After setting baseline schedule (plan), add the columns to the sheet; baseline duration, baseline start, baseline finish, actual duration, actual start, actual finish, % complete and finish variance.
b) Collect the actual start and actual finish of all the tasks which are completed and go on adding to the respective column and row.
c) The duration, % complete and finish variance software will take on its own.
d) The data is collected from site visit and site engineers, supervisors.
e) The project is tracked till the 24th may 2014.

3. Performance Measurement

Many methods of measuring project performance have been established, one of them is project key performance indicators. The key Performance Indicator is the measure of a process that is critical to the success of a project. The KPIs which are used in this thesis work are calculated below:

a) Programme

This KPI is a measure of how well we can meet the schedules agreed in the contract. This is determined by adding the sum of all current actual and forecast durations, and dividing by the contract project duration. Thus if the KPI is more than 100% the project is overrunning and missing the milestones.

The data collected from the scheduling n planning prepared using the M S Project. The contract project

duration is 658 days and start date of the project is 15-01-2014, and finish date is 17-03-2016. The tracking of the project is done up to 24-05-2015, the current actual duration is 427 days and forecast duration is 436 days

Formula:

Programme = {(Current Actual Duration + Forecast duration) / Contract Project Duration} X 100

$$programme = \frac{427 + 436}{658} \times 100$$

Programme =131.2%

More than 100% shows the project is overrunning and missing milestones

b) Disruption

In construction there are many disrupting parameters occurs. To measure the effect of disruption in construction industry the disruption index is calculated. The Disruption Index is the ratio of the number of disrupted (abnormal) workdays divided by the total number of observed workdays.

Formula:

Disruption Index = (Number of Abnormal Days / Total Number working Days)

Table 2: Showing the disruption index of different parameters

Total Number Of Working Days-427		
Delay Responsible	**No, of abnormal Days**	**Disruption Index**
Manpower	47	11
Material	142.46	33
Equipment	14.75	3
Rework	23	5
Consultants	14	3
Force Majure	24	6
Work Order	7.5	2

Above table shows detail of delay reasons along with disruption index values for different parameters as tabulated in table.

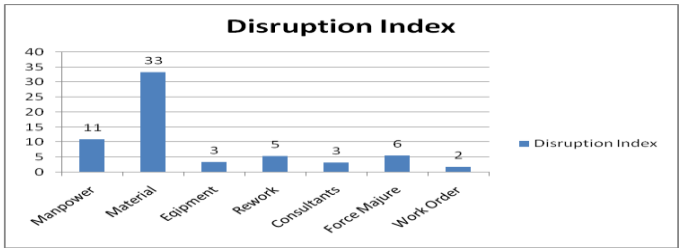

Fig 1. showing the graph DI of different parameters

Figure shows different parameter along with Di (Disruption Index) , above figure material has highest Di value.

c) Performance

Performance is the comparison technique used to identify the workflow obstacles in construction industry. Performance is calculated as the ratio of quantity achieved to the quantity planned of respected activity where the planned quantity is the benchmark for the activity which needs to be achieved.

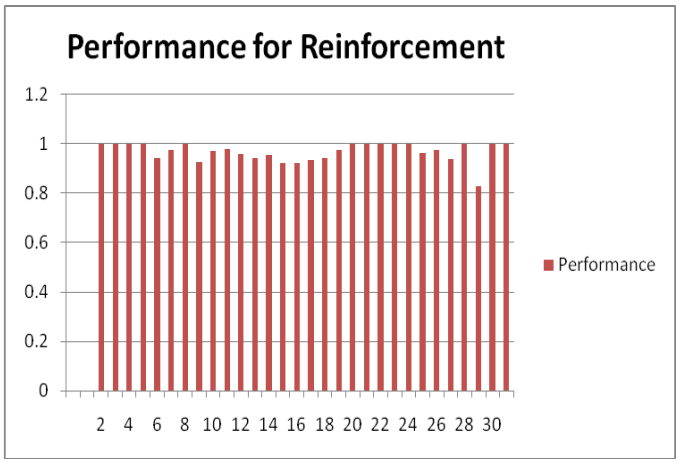

Fig 2. Showing the Weekly Performance of Reinforcement activity

Above figure shows performance of reinforcement weekly bases, with the help of above figure performance of bar bender can be measured.

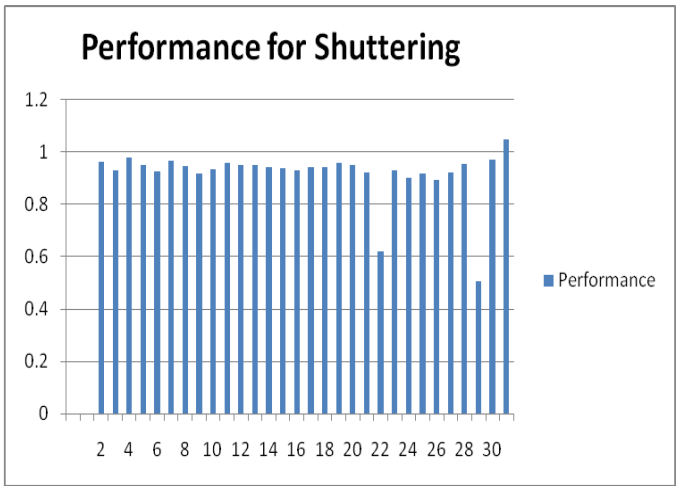

Fig 3.Showing The Weekly Performance Of Shuttering Activity

Above figure shows performance of shutter weekly bases, with the help of above figure performance of carpenter can be measured.

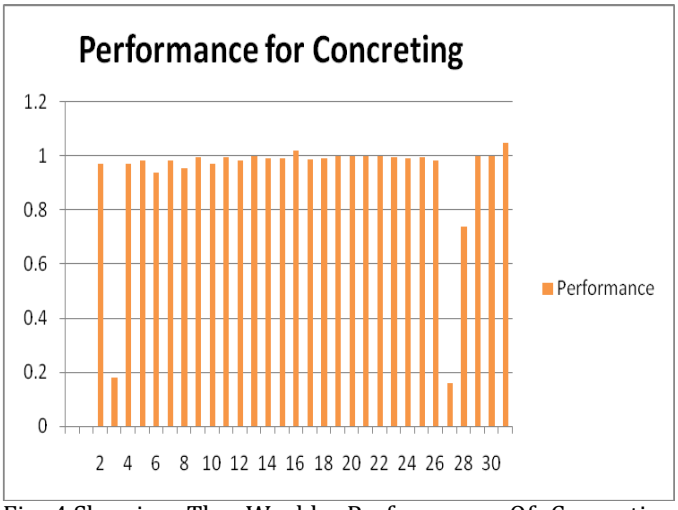

Fig 4.Showing The Weekly Performance Of Concreting Activity

Above figure shows performance of weekly bases, with the help of above figure performance of concrete mixer /RMC plant can be measured.

d) Productivity

Productivity is the ratio of the output quantities to the input work hours. The source of the data is weekly progress report which is prepared. Productivity requires a continuous effort to track and manage productivity at the project level. The calculation of the productivity for different activity is done weekly basis for 30 weeks and the graph is plotted for identifying the variation in productivity.

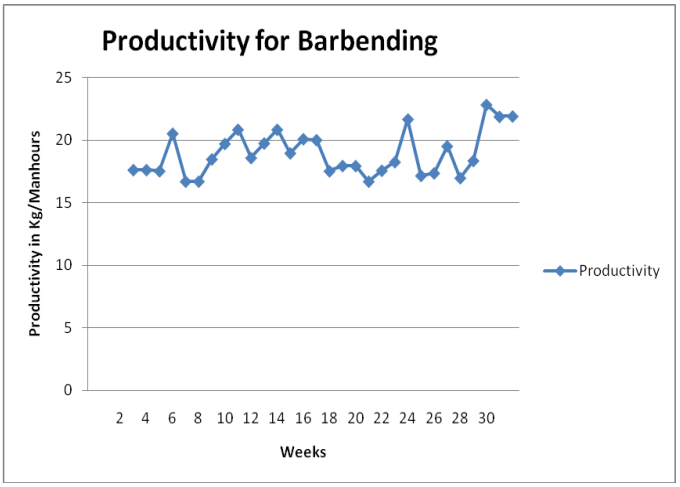

Fig 5.Showing The Weekly Productivity Of Bar bending Activity

Above figure shows productivity of weekly bases, with the help of above figure productivity of bar bender can be measured.

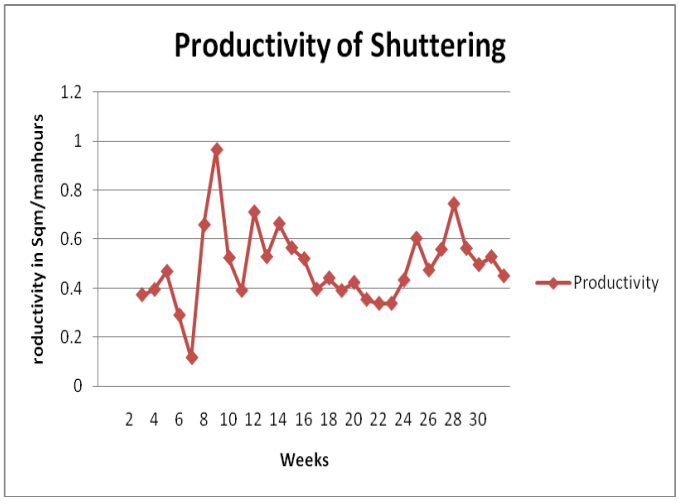

Fig 6.Showing The Weekly Productivity Of Shuttering Activity

Above figure shows productivity of weekly bases, with the help of above figure productivity of bar carpenter can be measured.

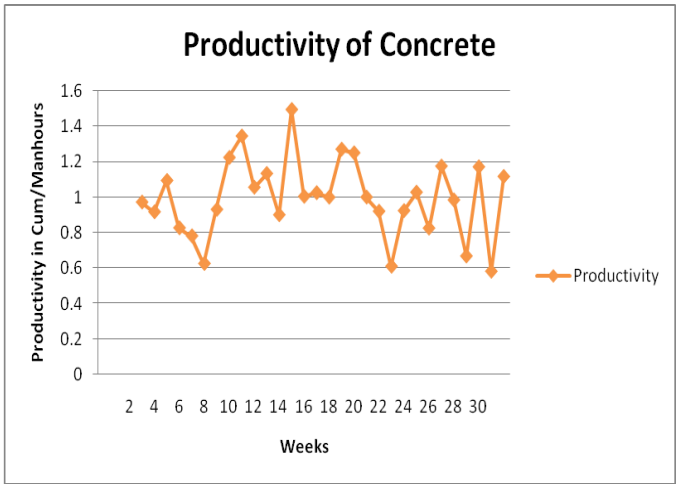

Fig 7.Showing The Weekly Productivity Of Concreting Activity

Above figure shows productivity of weekly bases, with the help of above figure productivity of bar concrete mixer/ RMc plant can be measured.

VII. CONCLUSION

1. From Key Performance Indicators we can conclude that;
   a. The project is behind the schedule by 273 days and missing mile stones.
   b. The main disruptive parameter of the project is material and manpower
   c. The performance of the project with respect to quantity of work is fluctuating not in constant and equal to one. Need improvement in achieving the set target.
   d. The productivity of all the labours is below the expected baseline productivity so need more efficient worker or should train the worker to achieve the required productivity.
   e. Safety in site is good but still need improvement because the minor and major accident cases are more and rules of safety should be made strict.

2. The project is delayed by 273 days, to overcome these many days and to complete the project in given schedule time of completion the we used the innovative techniques and around 135 days recovery obtained and by improving labour productivity we may reach the scheduled completion time.

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