

Planning, Scheduling and Allocation of Resources for Multi-Storied Structure using Oracle's Primavera P6 software

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Abstract - Attributable to an augmenting context of environment, Construction industry is ever upfront for the development and advancement in tools and equipment features, tools of communication, techniques of efficient management, educating the human resources about it. This unique specialization necessitates highly focused whose construction was planned to start at Pune, Maharashtra, India. Project Planning and Controlling tools or techniques. In the current study we implemented the computer based Project Management software/tool Primavera P6 for the Planning, Scheduling and Allocation of resources for a (G+8) residential apartment building. It helps to know the resemblance between the planned the planned progress of construction work and actual progress of the performed work. Thus the essentiality and the advantages of using Primavera will be outlined through the data results obtained. The acceptance of the software Primavera as a platform of scheduling is been on a boom in Multi National Construction Companies, but due to ignorance and lack of Project Management concepts and discourage towards the use of computer based programs, small and medium scale Indian construction companies confront various issues such as inefficient planning, project delays, inefficiency of resources and many other issues. Therefore, we also attempt to educate one such medium scale construction company about the advantages of Primavera in execution of any construction projects efficiently.

Key Words: Planning, Scheduling, Resources allocation, Primavera P6, Resource levelling.

1. INTRODUCTION

In today's world construction industry is one of the most widely used and rapidly booming industry of our nation and across the world. Hence, it is considered to be the second largest industry of India in terms of generating huge amount of revenue and employment. Though the construction and infrastructure industry being second largest industry of our nation (India), the identity and recognition of this industry has not been grown in all dimensions of the country. Especially, at the remote places like small villages, rural places and the large part our country is by these small villages and rural habitats. Therefore there is a requirement of certain tools and techniques for the

improvement of national economic upliftment, adequate land use and their environment planning to manage with the level of improvement in town and urban areas and the time required to tackle this goal can be shortened. There is an intense necessity for effective Project Management.

1.1 Project Management

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

Project Planning is a general and most common term in construction management which refers to attain the expected goals and destinations. Planning is the key to bring the expected projects into reality or in existence. Therefore, the term 'Project Planning' has been used at various platforms to get the close meaning of different things. Generally planning involves the breakdown of the undertaken whole project works into small definable, identifiable and quantifiable tasks or activities or works and then constitutes the logical interdependencies between them. Basically, the process of Planning refers to 3 dominant questions, they are as below

- i) What is to be done..?
- ii) Who does it..?
- iii) How to do it..?

Scheduling refers to slotting out the time duration by the thorough and explicit analysis of the planning team to each and every activity to know the final project duration and the project delivery date. In other words it governs the timing of each work activities recognised by the planning process before or during project execution. Typically it shows and signifies the sequential order or phasing various individual project activities in a systematic way to complete the project. The schedule is a tool or a technique of every project management team which is used and practiced to predict most probable project completion time and thus enabling the in/ on time resources conception which are budgeted on the particular work.

The general steps to develop a proper schedule are as follows

1. Proper time estimation of every activities.
2. Project planner should know the obligations of time for the project completion and delivery.
3. The activities such as must start and must finish should be establish well recessed.
4. Sorting out of activities which are crucial to timely completion of project should be recognised and kept in mind.

1.2 About Primavera

Oracle's Primavera P6 is the globally accessible and world's fastest, powerful, user friendly, easy to use robust and software application which is used to manage projects, programmes and port folios. Prioritizing, Managing, Scheduling, Planning can be done in favour of the globally located projects. It provides single solution to manage alter and update the project of any scale. Recently there is P6 released 8.2 as an upgrade in the last version. And it is fully web based solution and there is up gradation of handling projects of large scale is been implemented to according to the users' needs and P6 release 8.2 can be accessed through web from anywhere at any time across the globe.

In simple words it is 100% browser based solution including roles-specific functionality to satisfy each and every associated person with the project, stake holders' needs their responsibilities and the skills.

It is being invented as a desktop project scheduling system in the year of 1980 primavera has unpacked into one of the thorough and fully featured enterprise project portfolio management (EPPM) solution by offering world class tool for various project based organizations.

P6 EPPM also encompasses:

1. Planning and scheduling
2. Optimizing organizational capacities and prioritizing projects
3. Portfolio management
4. Resource allocation, levelling and its management
5. Mitigating the risks and issues
6. Reporting and tracking the projects progress
7. Sound decision making and team collaborations
8. Reports on earned value performances and etc.

If it is predominantly aimed at an individual users where compulsion is not there to share the project related data with the other members of the planning team or if it is aimed at the multiple user based then where there is no facility of internet connection, for high performance of Project Management Oracle's Primavera Project Management P6 is being renowned to standard. "The main wonder struck functionality of primavera is it has a capability to organize

up to 100000 of activities. Along with that it is able to offer infinite resources and enormous of target plans"

1.2.1 Benefits of Primavera P6

- 1) It is very helpful in planning and scheduling of the projects quickly and conveniently.
- 2) It recognises the available floats and determine the all possible critical paths by the project.
- 3) In this software there is facility to get the attractive customized colourful Gantt charts, network diagrams, histograms and time based logic diagrams.
- 4) It creates principal program schedule by integrating the schedules from owners, engineers, architects, planners and subcontractors.
- 5) It controls budgets, estimates even after changes at finishing point to relic successful delivery of the project.
- 6) It enables spot and instant planning for the forthcoming days, weeks, months, years and so on and activities.
- 7) Application of works to allocate the resources for the activities can be done precisely to haunt how the work is carried.
- 8) Improves relationship and alliance by timely E-mailing to the concerned entire project.
- 9) To understand the development in the changed versions "claim digger" is to be searched.
- 10) It expedites the communication related to project status to the stakeholders, contractors, owners and other project management team members by customized reports of industry standards.
- 11) If creates good co-ordination among the Labours, Material, Equipment and subcontractors to make sure on-schedule and on budget completion. It records actual cost, earned value, units and planned value by once customizing the financial year period which aids in comparison of future and current trends.
- 12) In this comparison between actual costs and work performed can be customized to baseline budgets by maintaining autonomous versions of cost complete estimation.
- 13) It creates infinite number of "what if" scenarios to determine the alternatives ways.
- 14) Any activities can be crushed to smaller defined steps to enable us tracking the accomplishment of the broken steps assess the activity percent complete.
- 15) It calculates risk and displays risk exposure values and these risks probable impacts on the projects schedule, duration and the budgetary cost.
- 16) It gives project performance these holds and shows notifications of performance if it is deviated beyond minimum or permissible performance window of acceptable.
- 17) Issues related to plan of project which references attention or some corrective activities could be logged by mailing issues details along with the attachments of notes, history of related issues.

18) To build any kind of new projects lowering of templates is the best practice to follow up and it is even helpful for the complete project as well

19) By using earlier performance of activities in the project earned value analysis can be done to see the future more accurate cost to completion.

2. LITERATURE REVIEW

After going through certain journals and review papers published which are related to this study, it is enabled me to explore much ideas and logical thinking about the topic and how to use the Primavera P6 software in efficient way. There are many such papers and journals which are published on the use and practice of primavera P6 across various industries but here in this study I have considered a few papers which are most relevant to this study which are especially published on the use of Primavera in Construction Projects.

3. METHODOLOGY

3.1 Working Principle of Primavera P6-8.2.

Generally Primavera P6 do works on the methodology of dynamic scheduling. Which indeed provides the Project Management office with a clear route map, which is intended to establish the best possible optimized plan of the project by using 'what-if' scenarios risk extenuation methods. Despite, the fact that it exhibit the Project Manager's capability to produce management change possibilities for the Project Management team to select from the when variances by the proposed project Baseline are being noticed. The method of dynamic scheduling frames the base or the platforms for the project scheduling which is designed to support the team of Project Management with certain official philosophies, policy, guidelines, terminology, templates and procedures which could include the coaching and training tool or platform through which a particular timeline of events, steps, and the project milestones are accomplished. Dynamic scheduling methodology is based on the below mentioned some indirect activities which are executed by the various Project Management team and its stakeholders.

1. Work/Budget Scope – Project Management Team/office
2. Strategic Planning -- Project Management Team/office
3. Project Work Breakdown Structure – Scheduler of the project
4. Focussed of the geographical and the physical breakdown of the past completed,

3.2 Procedure to begin the Project in Primavera Construction Schedule relevance in Primavera

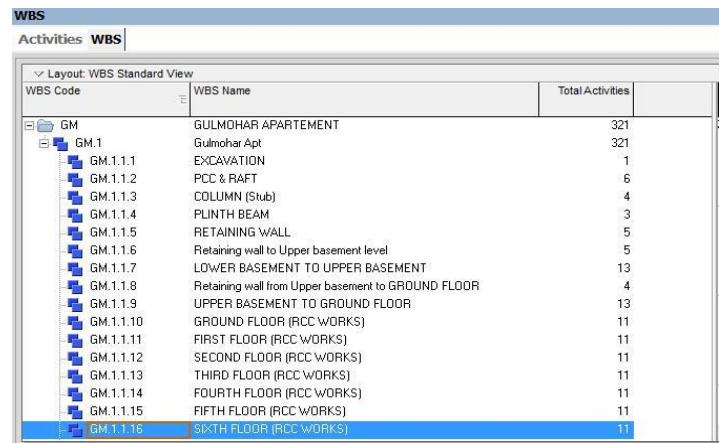
Other than the general objectives of assigning the dates to project activities, the project Schedule is anticipated to meet the requirement of matching resources such as labor, material and equipment with respect to the project activities

over the time span. An efficient and sound schedule of construction avoids the bugs' aroused due to blockage of production facilitates right time procurement of necessary materials and thus ensures the project completion date as early as possible.

Following is the brief procedure how to begin with a project in Primavera P6 with actual screenshots.

3.2.1 The project Work Break-down Structure

The term Work Breakdown Structure is in short commonly called as WBS. It is a process of grouping different elements of the project with concerned to specific product and it organizes or impinges to define the overall intent of the project.

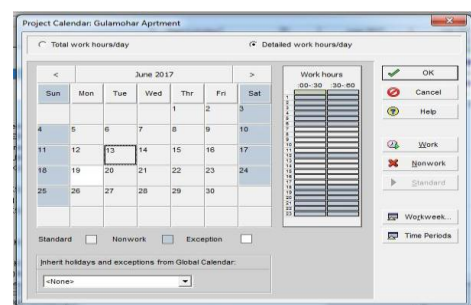


WBS Code	WBS Name	Total Activities
GM	GULMOHAR APARTEMENT	321
GM.1	Gulmohar Apt	321
GM.1.1.1	EXCAVATION	1
GM.1.1.2	PCC & RAFT	6
GM.1.1.3	COLUMN (Stub)	4
GM.1.1.4	PLINTH BEAM	3
GM.1.1.5	RETAINING WALL	5
GM.1.1.6	Retaining wall to Upper basement level	5
GM.1.1.7	LOWER BASEMENT TO UPPER BASEMENT	13
GM.1.1.8	Retaining wall from Upper basement to GROUND FLOOR	4
GM.1.1.9	UPPER BASEMENT TO GROUND FLOOR	13
GM.1.1.10	GROUND FLOOR (RCC WORKS)	11
GM.1.1.11	FIRST FLOOR (RCC WORKS)	11
GM.1.1.12	SECOND FLOOR (RCC WORKS)	11
GM.1.1.13	THIRD FLOOR (RCC WORKS)	11
GM.1.1.14	FOURTH FLOOR (RCC WORKS)	11
GM.1.1.15	FIFTH FLOOR (RCC WORKS)	11
GM.1.1.16	SIXTH FLOOR (RCC WORKS)	11

Figure-1: WBS layout of Project

3.3 Creation of Project Calendar

Project calendars are the insignificant part of the project schedules. The project calendars exhibit the working days, exceptions, suspensions, non-working days, holidays any other days corresponding to that project when used it properly. Even though, the calendars are categorized depending upon the need, the type of organizations, country/state/region of the proposed project and other parameters.



Project Calendar: Gulmohar Apartment

Total work hours/day: June 2017

Detailed work hours/day: Work hours 09:00 - 18:00

Standard Nonwork Exception

Inherit holidays and exceptions from Global Calendar: (None)

Figure-2: The Actual Project Calendar

3.4 Listing the Project Activities

An activity is an element of every project and its schedule, the number of such various activities together forms a complete Project or its Schedule. The activity can be considered as the task or an event which contributes to accomplish the undertaken project. Every particular activity has its specific descriptions about activity duration, start date, finish date and one or multiple logic relationships/ties.

Activity ID	Activity Name	Start	Finish	Original Duration	Remaining Duration	Schedule %	Total Float
Gulmohar Apt							
1	Complete Mobilization	09-Jun-17	09-Jun-17	0	0	0%	0
321	Completion of all super structure		28-Aug-18	0	0	0%	0
349	Completion of all activities		07-Dec-18	0	0	0%	0
EXCAVATION							
3	Excavation	09-Jun-17	11-Jul-17	28	28	0%	0
PCC & RAFT							
5	PCC marking	11-Jul-17	12-Jul-17	1	1	0%	0
6	PCC for Raft	12-Jul-17	13-Jul-17	1	1	0%	0
7	Raft & Column marking	13-Jul-17	14-Jul-17	1	1	0%	0
8	Reinforcement for raft and column	14-Jul-17	24-Jul-17	7	8	0%	1
9	Form work for raft	24-Jul-17	26-Jul-17	2	2	0%	1
10	Raft concrete	26-Jul-17	27-Jul-17	1	0	0%	1
COLUMN (Stub)							
		27-Jul-17	03-Aug-17	7	7	0%	3
PLINTH BEAM							
		04-Aug-17	08-Aug-17	4	4	0%	3
RETAINING WALL							
		08-Aug-17	24-Aug-17	14	14	0%	4

Figure-3: WBS and Activities Layout of the Project

3.5 Milestones of the Project

The project Milestones are the key/dominant events which symbolises the important and immediate destination/goals under the framed schedule..!

An activity which has the duration of zero days is generally known as Milestones of the projects. It is popularly used to represent the main hurdles of the projects as shown in the windows screenshot. Some of the important Milestones are identified and sorted out for the purpose of tracking and reporting by the concerned Project Manager.

Activity ID	Activity Name	Start	Finish	Original Duration	Remaining Duration
GULMOHAR APARTEMENT					
Gulmohar Apt					
A1	Complete Mobilization		09-Jun-17	0	0
A321	Completion of all super structure		28-Aug-18	0	0
A349	Completion of all activities		07-Dec-18	0	0
A173	Terrace floor RCC concrete work		09-Jun-17	0	0

Figure-4: Screenshot showing Milestones

3.6 Assigning of Activity Relationships

Basically there are four types of relationships to tie the activities while scheduling of the projects, they are as listed and shown below.

Finish to Start (FS): Here, until the predecessor activity finishes the start of the successor activity should not be made and it is one the often used relationship.

Start-to-Start (SS): Here, until the predecessor activity starts the start of the successor activity will not be made.

Finish-to-Finish (FF): Here, the relationship is tied in such a way that the predecessor and successor activity should finish at the meantime.

Start-to-Finish (SF): Here, the till the start of predecessor activity the successor activity will finish.

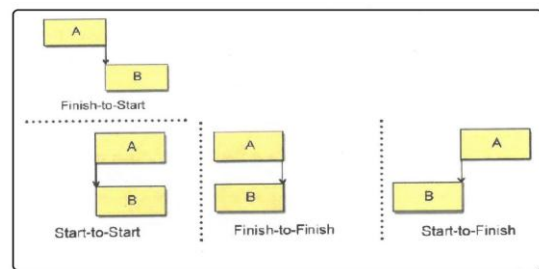


Figure-5: Types of Activities Relationships

3.7 Constraints

Constraints are artificial dates which aren't based on logic that are clearly stated. Shown onto activities or milestones, constraints can be the start or end dates and also they override the schedule relationships. Although constraints can be beneficial, project float and critical path can be interfered with constraints. Further, use of hard constraints will prevent the tasks from being disturbed by their dependencies and thus, prevent the schedule from being driven logically.

3.8 Float

The amount of time or working days a project can be delayed without any lag in the project completion date is called total float. Total float can also be called as slack time, only when the schedule network has a complete forward and backward pass the total float can be charted.

3.9 Resource Allocation for Activities

Resources are men, equipment's, materials needed to complete the activity. Most of the activities require multiple resources, however, not all activities require resources. For example, curing activity barely consumes any resource. Construction projects can be successful depending upon the proper utilization of resources which can be men, material and equipment.

The project resources are to be levelled once the resources are allocated to the activity to increase the work efficiency and thereby minimizing the cost. Resource levelling is the process of flattening the daily resource requirement by altering the time at which a particular activity is encountered without affecting the logic. In order to do so, resource constraints are used.

Resource ID	Resource Name	Resource Type	Unit of Measure	Standard Rate	Default Units / Time
M1	Bricks	Material	Each	Rs7,00/ea	0/d
M2	Sand	Material	Cubic Meters	Rs1,200.00/m3	0/d
M4	Reinforcement steel	Material	Tons	Rs38,000.00/tons	0/d
CM	Structural Engineer	Labor		Rs500.00/h	8/d
M6	Pest control	Material	Cubic Meters	Rs1,000.00/m3	0/d
M7	Water tanks	Material	Each	Rs10,000.00/ea	0/d
M3	Structural steel	Material	Tons	Rs42,000.00/tons	0/d
M9	Tiles	Material	Square feet	Rs35.00/FT2	0/d
M5	Cement	Material	Each	Rs320.00/ea	0/d
M11	Switches, boards	Material	Each	Rs25,000.00/ea	0/d
M12	Wires	Material	Linear meter	Rs10.00/LM	0/d
M8	PVC pipes and units	Material	Linear meter	Rs500.00/LM	0/d
M14	Windows	Material	Square feet	Rs550.00/FT2	0/d
M10	Wall putli	Material	Square feet	Rs300.00/FT2	0/d
M16	Emulsion Paints	Material	Square meter	Rs120.00/M2	0/d
M17	Exterior Emulsion paints	Material	Square meter	Rs140.00/M2	0/d
M13	Doors	Material	Square feet	Rs800.00/FT2	0/d
M15	Sinks & commodes	Material	Each	Rs8,000.00/ea	0/d

Figure-6: Typical screenshot of project resources sheet

3.10 Assigning responsibility and measuring project progress

Activities consume time and resources therefore, their assigning and measurement are to be done precisely. Assigning activities to liable parties is dominant as it considerably help in breaking the project into controllable pieces, assigning them to the parties that are efficient to complete the task. In addition to defining the activity behavior, the assignment expresses the responsible party. In order to control the activity of the project, the progress of each activity must be evaluated and the one responsible for its satisfactory progress must be held. Generally, activities are measured by the resources allocated, percent complete. Progress must be measured depending on resources used rather than planned, this is found to be the most effective method even though it requires tracking of the resources.

Activity ID	Activity Name	Resource ID Name	Start	Finish
2	3rd floor linel	48er Machine Operator	15-May-18	24-May-18
2	4th floor linel	48er Machine Operator	26-May-18	31-Jan-18
2	5th floor linel	48er Machine Operator	05-Jun-18	29-Jun-18
2	6th floor linel	48er Machine Operator	13-Jun-18	18-Jan-18
2	7th floor linel	48er Machine Operator	21-Jun-18	26-Jan-18
2	8th floor linel	48er Machine Operator	25-Jun-18	24-Jul-18
2	3x3 F flooring #4 basement	48er Machine Operator	31-Jul-18	29-Aug-18
3	Excavator operator	3 Excavator operator	05-Jun-17	30-Oct-17
3	Excavation	3 Excavator operator	05-Jun-17	30-Jul-17
3	Back filling	3 Excavator operator	25-Sep-17	30-Oct-17
3	Dumper driver	10 Dumper driver	05-Oct-17	30-Oct-17
3	Excavation	10 Dumper driver	05-Jun-17	30-Jul-17
3	Back filling	10 Dumper driver	25-Sep-17	30-Oct-17
44	Electrical conduit at 1B	R-4 Electrical conduit	30-Oct-17	30-Aug-18
62	Electrical conduit at 0B	R-4 Electrical conduit	22-Dec-17	22-Dec-17
75	Electrical conduit at Ground floor	R-4 Electrical conduit	17-Jan-18	17-Jan-18
87	Electrical conduit at 1st floor	R-4 Electrical conduit	13-Feb-18	13-Feb-18
95	Electrical conduit at 2nd floor	R-4 Electrical conduit	12-Mar-18	12-Mar-18
111	Electrical conduit at 3rd floor	R-4 Electrical conduit	05-Apr-18	29-Apr-18
123	Electrical conduit at 4th floor	R-4 Electrical conduit	04-May-18	24-May-18
135	Electrical conduit at 5th floor	R-4 Electrical conduit	31-May-18	31-May-18
147	Electrical conduit at 6th floor	R-4 Electrical conduit	27-Jun-18	27-Jun-18
159	Electrical conduit at 7th floor	R-4 Electrical conduit	24-Jul-18	24-Jul-18

Figure-7: A typical sheet of Resource Assignment

3.11 Presenting Project Schedules

For a successful project management, communication between the project schedules is essential. The activities and their inter-relationships can be made easy to be understood by the manager by means of better presentation of schedule. Graphical presentation is one of the important forms of presenting the schedule as it easier to understand the various fragments of information than the

large number of tables. Earlier the computers would schedule the program with large number of pages without any support to the managers in understanding them.

3.12 Bar Charts

Henry Gantt developed bar charts in 1917, bar charts displays as to when the activities are scheduled. Bar charts are the most commonly used visual tool in the construction industry due to their simple and visual clarity. Planners with no experience can read and prepare them therefore it is simple. However, the arrival of critical path method and advancement of computers have resuscitated the importance and dependence on bar charts. Used less as standard tool, the modern bar charts have a CPM calculated schedule or update supporting them even if it's not shown on the chart.

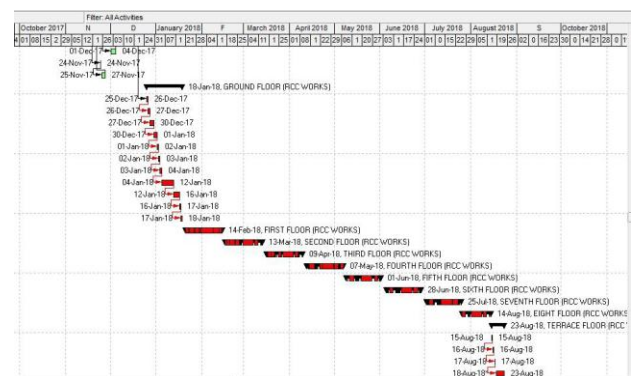


Figure-8: The Gantt Chart Showing Activities to be completed till 2018 of October

3.13 Network Diagram

A network diagram represents a project plan in detail graphically; it displays the job logic and basic activity succession. In broad the network diagram displays the 'big picture' like what next and what is the order of occurrence. This feature makes the network diagram accurate, efficient and dependable review method to prevent any bad logic from getting lost in the scheduling software tool and therefore it is important that the parties involved know to read the network diagram and evaluate them. The precedence diagramming method PDM is most powerful, popular, flexible and effective programming method used in the construction industry. Due to the ease of generation and use and also due to its incorporation of four major activity relationships the network diagram is used in most of the scheduling software.

Projects are introduced to network diagrams. These diagrams provide powerful visualization of the status of position and relationship among numerous project activities. These are the basic resource of communicating among planners and observers in the project.

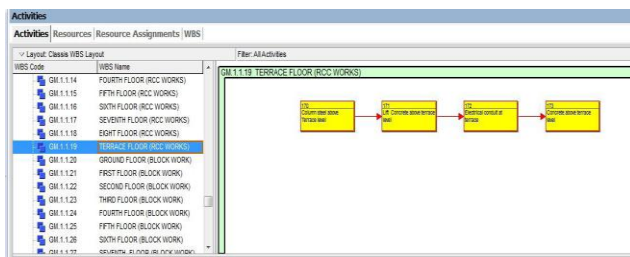


Figure-9: Network diagram of the project Activities

4. RESULTS AND DISCUSSIONS

Brief summary over the results obtained by the current study leads to the below conclusions:

- 1) The project completion date according to the planned schedule is 7 Dec-2018.
- 2) The progress of the project and the estimated total duration is to be reported and updated.
- 3) Total of 348 activities are involved with this project from its initiation to delivery of the project with various steps.
- 4) Planned float at some activities starting or finish is been observed to execute the activity works smoothly without overshooting the budget and resources.
- 5) The variance issues with respect to the start date or finish date of the project could not be reported, if the threshold variance of start date and finish date are properly monitored.
- 6) It helps in comparison of baseline schedule with the revised schedule which notifies about the added activities or deleted activities from the project schedule.
- 7) The report of allocation of resources helps in cost and time saving which results in increase of economy.
- 8) It provides an idea of arranging the required resources for the upcoming activity.

5. CONCLUSION AND FUTURE SCOPE

5.1 Conclusion of the Study

The main goal and the mission of the study was to know the role of planning, Scheduling, Monitoring and Control of the project progress with timely accomplishment of any construction project. This terminus was accomplished with the aid of literature references and the unique methodologies interlaced in Monitoring and Control with the help of Primavera project management software. In this thesis the study proved as a cicerone in interpreting the progress of Gulmohar Residential Apartment building, which helps to recognise the various problems aroused during or prior the execution process. The output results of the current case study defies the vitality of efficient planning, Scheduling, Monitoring and Controlling. Along with that the essential need and the influence of the project management software like Primavera P6 in any type of medium to large scaled Construction Projects.

The estimated completion time for the same project was earlier was framed to 640 days by the contractor, which is almost equals to 21.5 months. But the same project with precise and punctual planning, controlling, implementation and monitoring of the every activity using Primavera tool the expected time of the project completion is being planned to 434 days. The in charge Project Manager should be well aware about the schedule with respect to the activities, which are to be started or finished according to the schedule. Thus, with this study it could be concluded that...

- 1) For the current project the planned schedule activities are productive
- 2) The implementation of immense monitoring policies could be well observed.
- 3) On the various tasks of schedule completion the very high and systematic priority is been provided.
- 4) The usages of various resources throughout the project run would be optimum.
- 5) The software Primavera P6 proved like a perfect and efficient tool for the purpose of monitoring and controlling of the various construction project. The time for updating effort will be highly decreased by the specific layout.

5.2 Future Scope and Enhancements

1. Earned Value Management/Analysis: It is a sort of cost value management tool used to measure the performance and progress of the project or its activities. Which encompass cost, schedule and scope dimensions to assist the team of project management.
2. There is a scope for cost analysis, forecasting and cost variances.
3. There is scope for measuring Cost Performance Index (CPI), this is one of the peculiar indicators of the project's cumulative cost efficiency.
4. S-curve: The purpose of S-curve in project management is to graphically showcase the financial cash flow of a project. The S-curve could be generated from activity usage sheet and it shows an "S" like curve structure or shape, which seems to be flat at the beginning and sharp at the terminal and middle as well. Which indeed represents that the costs associated with the project is small in the beginning as well as at the end of the curve whereas, it increases with swift rate while the project lies in its mid stage.

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