



, Planning, scheduling and allocation of resources of commercial building using Primavera software

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Abstract : Proper planning and scheduling are very important part of construction projects for reducing and controlling delays of the project. Substantial amounts of time, money and resources are wasted each year in a construction industry due to improper management of construction activities. With globalization the construction projects have become vast and very complex. Planning of such projects requires huge amount of paperwork and time, which can be reduced with the help of project planning software. Providing good planning, proper organization, sufficient flow of resources to a project cannot automatically achieve the desired result. A warning mechanism must be present, which can alert the organization about its possible success and failures throughout the project. The main objectives of this study are to plan, schedule, and track an industrial project with the help of primavera P6 software and study the results generated. Also to recommend measures to the organization for enhancing their project planning skills for similar projects in future.

INTRODUCTION:

The construction industry is an integral component of a nation's infrastructure and industrial growth. Many problems and issues are being faced by the construction industry, the majority of them are cost overruns and time overruns due to inadequate project formulation, poor planning for implementation and improper management during execution. Observations show that proper skilful management is essential for a project to complete within time, estimated budget and with allocated resources. Providing good planning, proper organization, sufficient flow of resources to the project can automatically achieve the desired result. A warning mechanism must be present, which can alert the organization about its possible success and failures throughout the project.

Project Monitoring acts like a warning mechanism; it is the process of recording, collecting and reporting information regarding project performance that the project manager and others wish to know. Monitoring includes watching the progress of the project against time, performance schedule and resources during actual execution of the project and it identified the lagging areas which require timely attention and actions. Large projects become more complex and the ability to exchange information on paper within the organization on a timely basis gets difficult.

The traditional project management system cannot meet the demands of today's projects, as a countless amount of information and data on a project is always changing. The main objectives of this study are to plan, schedule, and track an industrial project with the help of

primavera software, also to recommend measures to the organization for enhancing their project planning for similar projects in future.

STEPS INVOLVED IN OPERATION OF PRIMAVERA P6:

1. **Creating an ideal schedule:** The first step is to collect all the data and summarize it together in order to undertake schedule preparation.
2. **Enterprise Project Structure (EPS):** Create a new structure of the company with the branches which is undertaking the execution of the project.
3. **Organizational Breakdown Structure (OBS):** After the generation of EPS, OBS is created which directly reflects the persons responsible for the respective project carried out in in the enterprise. All the new and upcoming projects related to the person are directly added under the same OBS.
4. **Assigning Calendar:** As per the requirement of the work, a suitable calendar is generated and assigned in the OBS. Specific working hours are determined and the breaks are allotted as specified.
5. **Create a New Project:** A new project is created in the respective division of the EPS and is respectively assigned to the person under the OBS. Expected start and finish dates may be given and assigned a calendar which can be global, resource or project oriented.
6. **Work breakdown structure (WBS):** WBS is a hierarchy of the total work that must be accomplished to undertake completion of the project. Each project. Each WBS contains different activities associated with it.
7. **Define Activities under WBS:** Activities are the fundamental elements of a project and from the lowest level of a WBS as well as the smallest subdivision of a project. An activity is associated with characteristics such as activity ID, activity name, start and finish dates of the activity, activity calendar, activity type and codes as well as constrains, expenses, successor and predecessor relationships, resources, roles etc. associated with the activity.
8. **Determination of Activity Duration:** While planning is undertaken, the duration of every activity is entered in the original duration field. It could be in days, weeks or months. The actual duration can only be entered for those activities, which are completed.
9. **Activity Dates:** The activity dates available in Primavera P6 for various activities can be categorized as follows;
 - Actual Start.
 - Actual Finish.
 - Planned Start.
 - Planned Finish.

10. Activity Relationship: All the activities must be inter-connected to each other to for a structured work flow. This is achieved by assigning relationships i.e. successors and/or predecessors to every activity. The relationships may further be defined under the following categories;

- Start to Start (SS) Relationship.
- Start to Finish (SF) Relationship.
- Finish to Start (FS) Relationship.
- Finish to Finish (FF) Relationship.

11. Run Schedule: After defining all activities, assigning duration and relationships to them, the project activities are scheduled and the grant chart is obtained along with the network diagram of the project.

12. Resource and Role Allocation: Different roles of people working in the project can be created and different resources can be assigned to the created roles. The resources are specified certain value per unit and allotted maximum units. These resources fall under the category of labour, non-labour and material.

13. Activity cost: The cost of all the activities obtained after resource allocation is summoned up as the overall activity cost.

14. Baseline creation: A baseline plan is a perfect copy of the original schedule which provides a target against which a project's performance is tracked and the project activities are updated as per their performance.

15. Updating the Schedule: If the project is progressing exactly as planned, updating may not be necessary. However, if the project falls behind and many activities undergo out of sequence or actual resource usage exceeds the planed usage, then the activities must be updated to enable on-time completion of the project. Activities may be updated as per their completion percentage, existing lags or leads and the project may be rescheduled as necessary after a given span of time.

16. Tracking: The tracking window is used for monitoring a project's progress by using different layouts such as labour costs, project cost, resource forecasting as well as resource allocation both unit wise and cost wise.

17. Earned value: Primavera P6 allows the manager to track the project performance in terms of Earned value is a technique for measuring project performance according to both, project cost and schedule. This technique compares the planned budgeted cost of the project to the actual cost and obtains the following essential parameters, Planned Value, Actual Cost, Earned Value, Budgeted at Completion, Cost Variance, Schedule Variance and Performance Indexes.

18. Claim digger: The claim digger is a schedule analysis tool which enables any company to create a report that undertakes comparison of the selected data fields in a revised project for the corresponding baseline of the project.

19. Project issues: Project Issues are known problems within a project plan that require attention or corrective action. Issues can either be manually created or automatically generated. Issues can also be associated with Work Breakdown Structure (WBS) elements, activities or resources.

20. Project thresholds: Thresholds are created by selecting a parameter, such as start date and setting end values for the threshold. The can be applied to a specific element of WBS or an activity of the project plan. Project thresholds are helpful in monitoring the projects and create issues.

21. Risk Analysis: Project risk demonstrates uncertainty to any event or condition and may has both positive as well as negative effects on the objectives of the project such as its scope, quality, schedule and cost. The risks are termed as opportunities and threats. The project may be accepted if the risk value is under the threshold value as specified. Positive risks may also be undertaken with threshold limits to create enhanced values.

22. Report Generation and Portfolio access: Finally, the project report can be generated indicating all applicable parameters as required and the ultimate summary of the project can be viewed in the portfolio section.



Fig. 1 – Primavera P6 steps Involved and application

CRITICAL LITERATURE REVIEW:

The following are the previous research reviews based on Effective Scheduling and Control of Construction Project Using Primavera P6:

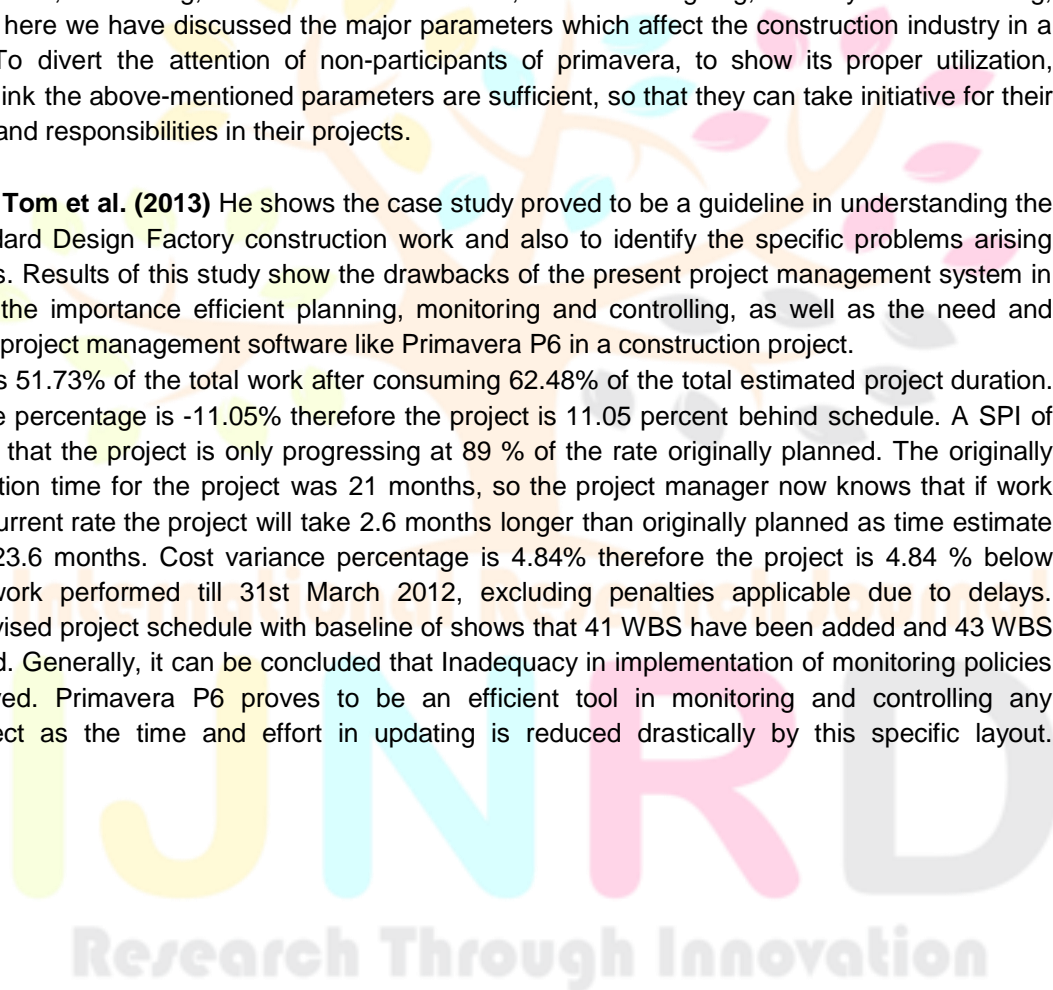
Matthew J. Liberatore et al. (2001) this study confirm that construction professionals are heavy users of PM software. The software package of choice among most construction respondents is Primavera, which contrasts with the total respondents' heavy use of Microsoft Project. Not surprisingly, professionals in the construction industry, are using PM software

more now than ever before. An influential factor for construction professionals when deciding when to use and not to use PM software is the complexity of the project. The results also indicate that those construction professionals who use more analytical techniques tend to choose the full-featured software package Primavera over other packages, while those who use fewer techniques chose the more basic Microsoft Project package. Some interesting results were found concerning both technique usage and the types of information that are entered and updated in a typical project. Construction respondents are heavy users of critical path analysis for planning and control, resource scheduling for planning, and earned value analysis for control. In terms of the types of information that are entered and updated in a typical project, the results show that more than half of the construction respondents who entered specific types of PM information also updated that information. The number of activities in a typical project and the use of software for all active projects were the key determinants of the usage of specific analytical techniques. These factors are also significant determinants of the types of information entered and updated in the software.

Pethe Sarang S et al. (2012) Said that project management concepts are no longer theoretical but have got converted to technology driven means. There are some more parameters of Primavera such as primavera architecture, calendars, scheduling, work breakdown structure, resource assigning, its analysis and levelling, updating, etc. But here we have discussed the major parameters which affect the construction industry in a far bigger way. To divert the attention of non-participants of primavera, to show its proper utilization, applicability, we think the above-mentioned parameters are sufficient, so that they can take initiative for their business or roles and responsibilities in their projects.

Andrew Fernans Tom et al. (2013) He shows the case study proved to be a guideline in understanding the progress of Standard Design Factory construction work and also to identify the specific problems arising during the process. Results of this study show the drawbacks of the present project management system in SDF project and the importance efficient planning, monitoring and controlling, as well as the need and effectiveness of a project management software like Primavera P6 in a construction project.

Project progress is 51.73% of the total work after consuming 62.48% of the total estimated project duration. Schedule variance percentage is -11.05% therefore the project is 11.05 percent behind schedule. A SPI of 0.89 would tell us that the project is only progressing at 89 % of the rate originally planned. The originally estimated completion time for the project was 21 months, so the project manager now knows that if work continues at the current rate the project will take 2.6 months longer than originally planned as time estimate at completion is 23.6 months. Cost variance percentage is 4.84% therefore the project is 4.84 % below budget for the work performed till 31st March 2012, excluding penalties applicable due to delays. Comparison of revised project schedule with baseline of shows that 41 WBS have been added and 43 WBS have been deleted. Generally, it can be concluded that Inadequacy in implementation of monitoring policies has been observed. Primavera P6 proves to be an efficient tool in monitoring and controlling any construction project as the time and effort in updating is reduced drastically by this specific layout.



T. Subramani et al. (2014) found although EVA (Earned Value Analysis) may be most easily associated with the monitoring and evaluation of project cost that are undertaken within an organization, it can also be readily applied, with some adjustment, to the control of project cost that are performed by contractors and vendors. In those circumstances, however, it must be recognized that the client and contractor will have differing perspectives on actual and budgeted costs. This study also indicated that EVA has significant value and presents unique features that can benefit clients, consultants and industries. The two Projects were analysed using the developed software (in C#, .Net & SQL server) and MS Project 2007 and Primavera P6 based on Earned Value Analysis Method. CPI, PD, AD, CV, PV, AC, EV variable were selected. The result shows a strong relation between each software. The final result gives more than 99.5% accuracy. A new parameter SV (t) (Schedule Variances respect to time) is identified and incorporated in developed software which is not in MS Project 2007 and Primavera 6. The final result gives almost 100% accuracy.

Kyong Ju Kim et al. (2016) this study investigated measures to improve the efficiency of initial scheduling by developing a database of various scheduling models and automating the initial schedule preparation process. Even novice schedule engineers can develop an initial schedule plan by referring to the standard schedule and project database built by schedule management professionals, and technical information on schedule management can be organized for future use through this system. The system also minimizes the time needed to prepare the initial schedule through automation, helping companies meet the tight deadlines mandated by Korean law. The system automatically generates activities and logic networks using a standard schedule and project database. Major activities are connected to a proper CBS, which is used to automatically calculate quantities each activity. This study defined a code system for work classification, calendar types, and activities required for initial scheduling, and developed a field-friendly initial scheduling system that can automatically generate activities and calculate quantities. The system was designed to be connected to the Primavera commercial schedule management software to improve its schedule management efficiency. Based on the three measures suggested above, the study compared the existing and automated methods for initial scheduling. A survey of sites that had prepared an initial schedule showed that activity generation, logic network connection, and quantity calculation were the most time-consuming.

Ming-Fung Francis Siu et al. (2016) carried out in current practice, the assessment of budget sufficiency and resource utilization for a formulated resource-constrained project schedule is critical to the successful delivery of a construction project. This paper also contrasts the application of a practical scheduling approach (PrimaveraP6) and the resource supply-demand matching problem (RSDMP) optimization approach recently developed from in-house research to generate multiple alternative resource-constrained project schedules in terms of budget sufficiency and resource utilization for case study projects. The two project schedules have thus proven the academic and practical values of the proposed research. The results of the case studies show that budget sufficiency and resource utilization for resource-constrained project schedules can be quantified, analysed, and compared using the proposed schedule assessment metrics in a straightforward yet objective manner. the practical approach (Primavera P6) and the optimization approach (RSDMP approach) are capable of producing the project schedules subject to constant resource supply limits throughout the project or periodic resource supply limits that vary for particular time periods. However, Primavera P6 relies on heuristics rules in resource levelling. As such, RSDMP outperforms Primavera P6 with regard to higher budget sufficiency and higher resource utilization, such that more contingency can be reserved in the control budget against unexpected works. Primavera P6 schedule is shifted to add to the contingency in the optimized schedule as a result of improved resource utilization in the optimized schedules.

Abuzar Aftab Shaikh et al. (2016) Studied on the Schedule Variance (SV) obtained is a negative value, hence Primavera P6 gives a warning that the project is behind the planned Schedule at the rate of 17.80%. The Schedule Performance Index (SPI) of 0.822 indicates that the project is working or progressing at an efficiency of 82.2% of originally planned.

Cost Variance (CV) and Cost Variance % (CV%) obtained is ₹11,33,836.8 and 3.656% respectively and both the values are positive hence it indicates that the project is under budget. Cost Performance Index (CPI) obtained is 1.03 hence it shows that the project is within budget. The project is updated in the 11th month from the starting date. According to the planned schedule 64.70% of total was to be completed, but the actual work completed is 46.9%. the project is thus delayed by 3.026 months. The project requires 3.026 months more for its completion i.e. total project duration will be 20.026 months, if project is to be completed within the planned duration it should be levelled and smoothed by increasing the number of labors and providing the materials on time. From the study it is clear that Primavera P6 is an effective tool for tracking the project progress, cost associated with progress and managing to avoid delays. Primavera P6 eliminates lots of paper work unlike in the conventional method of planning and scheduling. [2]

Mrs. Sangeetha H M et al. (2017) Worked on project of residential building inland edilon (G+4) is concluded as per planning, scheduling and tracking using earned value analysis with the statement as per planned. According to results obtained the project is still progressing and delays with around four months as per plan. Schedule variance = Rs 6035015.42 since it is a negative number this states that project is behind the schedule. Cost variance = Rs 935,822.00 since it is negative number; this states that project is over budgeted. Schedule performance index = 0.98 Hence it is less than 1, the project is behind the schedule. Cost performance index =1 Hence it is equal to 1, the project is going within budgeted cost. From all this statement they concluded planning is a very important key function in any sector. [12]

Chiranjeevi D. S. et al. (2017) said that the Earn value management is a program evaluation approach which is evaluated and tracks a project in better manner. This project report indicates significance, execution and particular components of earned value management that advantages extend director & eventually brings about project achievement. The project is tracked on 3 durations. As on third tracking 138days are remaining to complete the activities, the schedule performing 98% (SPI 0.98) as planned value under 1 show the project is under running from planned schedule value. And cost performing 88% (CPI 0.88) as budgeted cost, it shows the project cost is overrunning. Cost variance of project is -2,07,83,000 the negative

CONCLUSION

From first iteration it is found that the project requires 3 years' time to complete after second iteration it is found that the project requires only 1 year to complete which is possible by preparing the labour schedule, material schedule and gantt chart. The completion time of the project is reduced from 1 to 3 years the project in such a way that some of the activities can be started at the same time for example curing of the columns and bar bending schedule for the staircase or slabs can be prepared at the same time and increasing the number of labours required per day similarly increasing the numbers of machineries and equipment's etc.

We can conclude that by using primavera software the project can be managed properly and we can complete the project either the expected time and estimated cost. The management is necessary to reduce the wastage and losses over materials and machinery and to use the available resources effectively and efficiently. Primavera software is most useful for managing a commercial, industrial or any type of high-rise building. Estimation of quantities of material like concrete, steel, bricks, paints, tiling, and sanitary fixtures can be determined according to the given plan. Estimation of the required manpower and machinery can be carried out for further ease in scheduling. Keeping the resource as time as a constraint, manpower, machinery, and money can be optimized so as to achieve a quality product that is also economical. Through Primavera, Resource Allocation and Resource leveling techniques can be applied for calculating the total budget of the project.

Primavera P6 in a construction project helps us to understand the role of scheduling before execution of the project and monitoring and control of the progress of a construction project. This objective was achieved through careful planning, proper scheduling and effective resource utilization and project management skills. Results of this study highlights the present construction project delays. An efficient and proper planning is necessary to minimize unnecessary delays.

RESULT

In our project "Scheduling of Building Using Primavera P6" we finally save 3.5 months from estimated duration of the project. So, the final result is summarized below: