Reducing Construction Constraints using Primavera

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Abstract

Objectives/Background: Every successful construction project has to be completed within the budgeted cost and the scheduled time. Constraints affect the project success. Therefore, proper management is required to reduce the constraints. Methods: This study deals with the methods that reduce time and cost constraints and resource management. A construction of residential apartment is taken for this study which is undergoing a time and cost overrun. The constraints are reduced by using techniques interconnecting activities properly and increasing the resources, schedules are prepared by means of Primavera software. The cost constraints can also be reduced by managing labour resources of different categories. Results: The actual schedule of the project is considered as base schedule. The base schedule is compared with the modified schedule using techniques which helps to reduce constraints. Schedule made by the technique interconnecting activities properly gives a time difference for the completion of the project of about 5 months from the base schedule of the project. Schedule made by the combination of the both techniques shows the result of 7 months prior completion from the base schedule of the project. Further, with the management on the labour resource of skilled, unskilled male worker and unskilled female worker in the construction activities, the cost spent on the labour resources reduces by 5%. Conclusion: This study supports project manager to guide himself to control the constraints in the planning, execution process and shows the importance of proper allocation of labours of different categories.

Keywords: Constraints, Cost Overrun, Labour Resource Management, Primavera, Scheduling, Time Overrun

1. Introduction

Construction constraints are restrictions for the project flow. These constraints will lead to time overrun, cost overruns due to delay in the construction process and to inadequate quality because of the rushing up of work for making the project completed within time. For making the project as a successful one, the constraints have to be reduced. In construction industry, time and cost are the two major factors to say a project becomes a successful or not. A successful project should be completed on time and within budget. The time and cost are interdependent factors. The time delay of a project is also leads to the cost increase in the project. The more delays in the construction activities will cause cost overrun in the project which finally leads to the failure of the project. Therefore, the delays and cost has to be monitored and controlled during the progress of the project. For these, the constraint affecting the project has to study and identified.

The constraints affecting the time of a project has to be carefully noticed. There are several constraints which are responsible for the time delay of the projects. The constraints involved in the construction may differ according to the type of construction and the situation in which the construction progress is going to take place. Resources are also responsible for the project success and failure. Therefore resource management also to be taken into account.

There are several reasons for the construction constraints. Some of the studies are included which gives clear idea about the reasons of the constraints. Hamzah N, et al.1 gives a theoretical framework on the causes of delay in construction. In this, the construction delay causes were classified into excusable, non-excusable and concurrent. The excusable delays are compensable and it is caused by owner/consultant. Non-excusable delays are caused by contractor. Concurrent delays are non-compensable and they are caused by act of god and by third parties. Soren

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L. et al.\(^2\) explores the reasons for delays in construction to reduce it and improves the construction process. This research was done by qualitative and quantitative analysis. For this research, three case studies are studied. Their weekly plans are scheduled by means of last planner system. All the case studies are studied and the delays were noted. This paper shows that the reason for the delays in the construction is related to the connecting activities and the reworking activities due to improper quality. This will lead to the delay of the activities and this delay will be carried to the subsequent activities. Gardezia et al.\(^3\) study focused on the time extension factors in the construction. This study reviewed the causes of delay stated by other authors in their paper and investigates the factors contributing in time extensions in construction project according to key participants of the projects i.e. contractors, consultants and the clients.

SK. Nagaraju et al.\(^4\) shows a comprehensive framework for resource management particularly related to manpower as resource element in construction domain. Aftab H. M., et al.\(^5\) presented a problem solving method in controlling the chronic problem of time and cost overrun faced by construction industry. WRATTCO approach will enable practitioners in identifying and assessing relative risk of various factors affecting project time and control. This gives the idea of resolving the problem by means of a web based techniques for resolving problems of time and cost. Shu-Shun L., et al.\(^6\) study shows the importance of resources in the profit maximization of a project. Shu-Shun Liu et al.\(^9\) presented an optimization model using constraint programming (CP) for project selection and scheduling problems with time-dependent resource constraints. The proposed model allows planners to determine an optimal portfolio with specified resource constraints according to various time intervals, and benefits decision-making for project selection and scheduling.

Murali Sambasivan et al.\(^7\) identified the delay factors and their impact (effect) on project completion and also established an empirical relationship between each cause and effect.

Maryam Molani\(^8\) presented a software model based on radial basis function neural network and generic algorithm for the cost estimation of a project.

Andrew Fernans Tom et al.\(^10\) stated the importance of project formulation, planning and proper management in the execution of project and the performance of the project were effectively measured by using EVM technique in primavera.

### 2. Methodology

The scope of work was divided into the following steps:

- Study area characteristics.
- Preparing actual schedule for the project in primavera.
- Identifying the constraints in that project.
- Reducing the constraints which causes delay and prepare new schedule.
- Optimize the labour resources to reduce the cost of the project.

#### 2.1 Study Area Characteristics

A real time residential apartment which is in ongoing status has taken as a case study for the project. The construction is for a residential purpose having stilt + G+3 and the area of the construction is 2632 sq. ft. The number of dwellings at each floor is three numbers. The area of each dwelling in the project is 722 sq. ft., 638 sq. ft. and 649 sq. ft.

#### 2.2 Preparing Actual Schedule for the Project in Primavera

Actual schedule preparation process starts with the collection of data like project start date, activities involved in the construction of a G+3 apartment with stilt, activities sequences, duration taken for each and every activities, resources needed for each and every activities and its amount, cost spent for each and every activities. The collected data are entered in the software and the relations between the activities are given as per its sequence of activities collected. The process of scheduling in primavera for the actual progress of work is shown in Figure 1, 2, 3, 4, 5 and the report obtained for the actual

![Figure 1. Actual Schedule Part (i).](image-url)
schedule from the primavera software is shown in Figure 6. This actual schedule and report is considered as a base schedule for this project.

2.3 Identifying the Constraints

The project was started on the month of January-2013 and will be finished on the month of April-2015. This construction of the residential apartment takes a long duration of two years and three months for the completion of the project. The long duration of a single project will lead to a considerable increase in the cost of the project. Therefore reducing the project completion time is necessary for completing the project within the budgeted cost. This on time project completion and on budget completion of project is the two factors which state the project is a successfully completed. Reason for taking a long duration of this project is identified by means of the primavera schedule report.
The root causes for the long duration are,

- No parallel activities were done.
- Longest critical path.
- Lack of resources.

These three are the reasons for the delay of the project and due to the interdependencies of time and cost; these causes are also responsible for the cost overrun of the project.

2.4 Measures Taken to Reduce the Time Constraints

Constraints causing the time delay have to be reduced. The techniques used to reduce these constraints are,

- Interconnecting activities properly.
- Increasing the resources.

3. Results and Discussions

3.1 Modified Schedule 1 - Interconnecting Activities Properly

The connection of the activities plays a major role in the time controlling of the project. Connecting activities should be carefully done which is considerably resulting in the project success. The constraints of having longest critical path can be reduced by means of doing activities parallel. These parallel activities can be done in the primavera software by differentiating relationship between the activities. Figure 7, 8, 9, 10 and 11 represents the modified schedule process and Figure 12 shows the report for the interconnecting activities properly schedule.

Report obtained from the modified schedule 1 gives the result of interconnecting activities properly. This interconnecting activity shows a considerable result in the time taken for completion of the project. The time difference taken for the completion of the project between the original schedule and modified schedule 1 is five months.

3.2 Modified Schedule 2 - Increasing Resources

For doing every activity in the construction process, sufficient amount of resources is required. Resources play a vital role in the project for the successful completion of all the activities on time. Time delay caused in a single activity will be carried over to the subsequent activities. This
delay of each activity is due to the insufficient resources. Therefore, it is necessary to provide sufficient amount of resources like men, material and equipment to reduce the time taken for the construction of the project.

In this residential apartment, the shuttering material and workmen are insufficient. Therefore the activities of constructing structural elements of columns in each floor take four sets of activities. Single set of activities consists of reinforcing, shuttering, concreting and de-shuttering. Therefore increasing the resources will result in reducing the repetition of that sets of activities, which results in reducing the delay in the project. In this, the resources have been increased twice and the schedule was prepared in the primavera.

These two measures can be done by means of proper planning and scheduling of the project. The corrective measures of proper interconnecting activities and increasing the resources is incorporated in the new schedule of that residential project. Figure 13, 14, 15 and 16 represents the modified schedule-2 process and Figure 17 shows the report of the interconnecting activities properly with increased resources schedule.

The schedule made by increasing the resources twice with the interconnection of activities properly completes two months before from the project completion time of the modified schedule 1 and it completes seven months before from the original schedule of the residential apartment project.

3.3 Optimize the Labour Resources
The cost constraints in a construction may lead a project to the failure. The cost constraints have to be controlled in
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For completing the project within budgeted cost, careful allocation of labours of different categories will also helpful. Every activity in construction requires labours of different categories having different skills and with different prices. Allocating labours of higher price where it's not necessary, it heavily affects the cost of the project. Therefore allocating suitable labours with suitable skills and prices gains importance in a project's success.

The labour resources of this project were studied and their cost spent on the labour resources of different categories were noted. The labour resources of this project were optimized by allocating suitable categories of labours and with sufficient amount for activities. After optimizing the allocation of labour resources of the project, it shows a difference of 1,99,650 rupees from the actual cost spent on the labour resource of 39,07,950 rupees. The percentage difference between the improper managing of labour and proper managing of labour resources is by 5% of the actual cost spent for the labour resource in the project.

4. Conclusion

Schedule made by using techniques that reduce the constraints helps for the project to complete earlier of five to seven months from the actual base schedule of the project and thereby increase the profit outcome from the project. Further, with the management on the labour resource of skilled, unskilled male worker and unskilled female worker in the construction activities, the cost spent on the labour resources reduces by 5% of the actual cost spent on the labour resources. Using a software helps to manage the work easily and it reduces the
information constraints between the management and the site members which greatly contribute to the project success.

5. Acknowledgement

The authors would like to thank the Vice Chancellor of SASTRA UNIVERSITY for providing facilities to do this work and for the continuous support and encouragement given throughout this research work.

6. References