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Multiple Project Management using CCPM Methodology–A Case Study

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Abstract—*Project managers are often given the responsibility to manage more than one project at a time due to resource scarcity and increase in number of projects. This situation has led to the practice of Multiple Project Management (MPM).Critical chain project management is a suitable method for multi-project management which is already being implemented in countries like Japan. In Indian scenario, multi-projects are still being managed using traditional project management techniques like CPM. This paper presents a case study conducted in India which mainly focuses on the CCPM method of project duration calculation and concludes with the advantages and disadvantages of using CCPM methodology in the Indian scenario.*

1. INTRODUCTION

In the present world, the simultaneous management of multiple projects is an everyday situation. Because of resource limitation as well as the nature of the projects that are being implemented, project managers in many organizations are tasked to lead more than one project at a time.

Multiple project management (MPM) is defined as "a management practice in which a project manager is assigned to simultaneously lead multiple projects". With resource limitation, this practice has been popular in many organizations, since it helps improve efficiency in managing projects. MPM involves planning and monitoring of several projects. While considering a multiple project scenario, the projects have interfaces with other projects in addition to their internal interfaces.

Critical chain project management (**CCPM**) is a method of planning and managing projects that emphasize on the resources required to execute project tasks. The idea of CCPM was introduced in 1997 by Eliyahu M. Goldratt. CCPM shifts the safety times associated with the critical chain tasks to the end of the critical chain in the form of a project buffer to protect the project due date promised to the customer from variation [5].

2. METHODOLOGY

The case study was conducted in a construction company of six projects at Bangalore. Following steps were followed to find out the CCPM durations of the six projects and for the comparative study,

(1) The existing project schedules of the 6 projects are collected.
(2) The durations of activities from the existing schedule are used to find out the durations to be used for CCPM schedules.
(3) The plan is worked backward starting from the completion date, with each task starting as late as possible.
(4) 50% of activity durations in existing schedule are calculated and are assigned as activity durations for CCPM schedule [5]. This is because traditional project scheduling method uses pessimistic durations, in which an inbuilt buffer is included in every activity. But, for CCPM scheduling total buffer from all the individual tasks are pooled together to form the project buffer at the end of the project. Hence, CCPM uses most-likely activity durations which come up to 50% of the pessimistic durations.
(5) Multi-tasking of resources is eliminated and the longest sequence of resource levelled tasks makes the critical chain.
(6) Project buffer is calculated using the both cut and paste method and root square error method.
(7) The longest sequence of the most likely task durations (critical chain) plus the project buffer gives the project duration.
(8) The project durations from the existing schedules and the new project durations using critical chain scheduling are tabulated.
(9) Project durations are found out separately for both cut and paste method and root square error method and the results are compared.

(10) Locations of the projects are considered and the additional costs that would come up due to CCPM are discussed.
(11) An approach model suitable for CCPM is proposed.
(12) Based on the results, advantages and disadvantages of CCPM over traditional scheduling techniques are summarised.

3. RESULTS AND DISCUSSIONS

3.1 Project buffer calculation

The project buffers for the six schedules done by critical chain scheduling were calculated using two approaches,

Cut and paste method [9]:-

Project buffer,

A = ½ (Σ Pessimistic duration-Σ Most-likely duration)(1)

Root square error method [9]:-

$$\text{Uncertainty of task i, } U_i = M_i - P_i \qquad (2)$$

Where,

M_i is the most likely duration used in CC scheduling

P_i is the pessimistic duration used in conventional scheduling

$$\text{Project buffer, } B = \sqrt{\left(\sum (U_i)^2\right)} \qquad (3)$$

The most likely durations for the project buffer calculation are the durations of critical tasks obtained from the critical chain scheduling method and the pessimistic durations were obtained from the traditional scheduling method.

The duration of the critical chain and project buffers calculated for the six projects using the two methods are tabulated in table 1.

Table 1: Project buffer calculated using two methods.

S No	Project	Critical chain(no of days)	Project buffer, A(no of days)	Project buffer, B(no of days)
1	A	135	58	24
2	B	130	56	28
3	C	146	62	24
4	D	191	81	25
5	E	275	116	29
6	F	233	101	32

It is clearly seen that project buffers calculated using C&PM are very large compared to those calculated using RSEM. In C&PM method as the length of the critical chain increases, the project buffer also increases. Therefore, the buffers generated by C&PM does not seem to be efficient in all site conditions due to their large durations.

At the planning stage of the project, the schedules of the six projects were prepared in the conventional CPM method. This data was directly obtained from the organization. The project durations of the 6 projects using traditional scheduling technique are given in table 2.

Table 2: Actual project durations

S No	Project	Start date	Finish date	No of days
1	A	15-08-2017	03-02-2018	172
2	B	01-08-2017	03-02-2018	186
3	C	25-07-2017	18-01-2018	177
4	D	01-06-2017	27-02-2018	271
5	E	01-05-2017	13-03-2018	316
6	F	15-05-2017	01-03-2018	290

For this study, the schedules prepared initially at the planning stage were modified according to the assumptions of the critical chain method. The project buffers generated by RSEM were taken into consideration to find the project durations.

The total duration of projects by critical chain scheduling would be the sum of the critical chain plus the project buffer. The results are summarized in table 3.

Table 3: Critical chain scheduling project durations.

S No	Project	Start date	End date	No of days	Project buffer (in days)	Total duration (in days)
1	A	15-08-2017	03-02-2018	126	24	150
2	B	01-08-2017	03-02-2018	131	28	159
3	C	25-07-2017	18-01-2018	145	24	169
4	D	01-06-2017	27-02-2018	207	25	232
5	E	01-05-2017	13-03-2018	233	29	262
6	F	15-05-2017	01-03-2018	241	32	273

The obtained total project durations in table 2 and 3 are represented in figure 1.

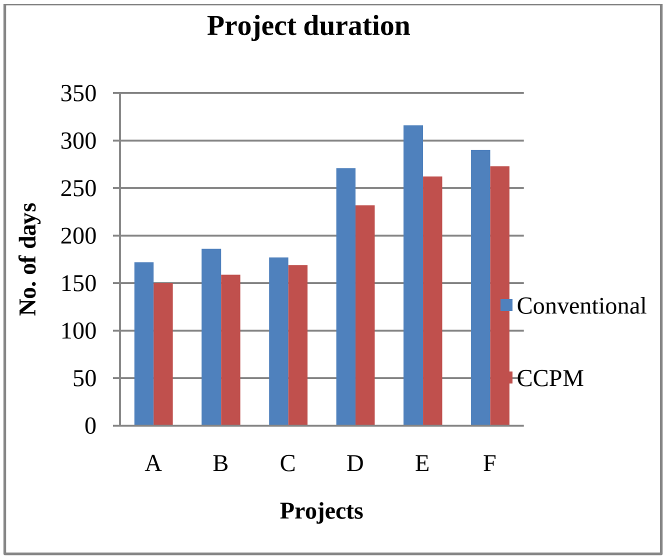

Figure 1: Comparison of project durations

Comparing the results obtained in figure 1, the CCPM durations are lesser than the actual durations in all the six projects. It can be understood from the literature that the CCPM durations depend on the critical chain duration and project buffer. In the current study, the project buffer calculation was carried out using the RSEM approach. Using the buffers calculated by the C&PM method would have led to much longer project durations, but the use of such long buffers is not applicable practical cases. This study clarifies that critical chain scheduling with buffer calculation using RSEM approach results in lesser project durations than conventional scheduling techniques.

3.2 Project Locations

The locations of the projects are given in table 4.

Table 4: Project locations

S N o	Project	Location
1	Project A	HSR layout
2	Project B	Kanakpura road
3	Project C	Katriguppe
4	Project D	Jayanagar
5	Project E	Marathahalli
6	Project F	Kormangala

The project locations are plotted in the figure 2 and the distance is found out.

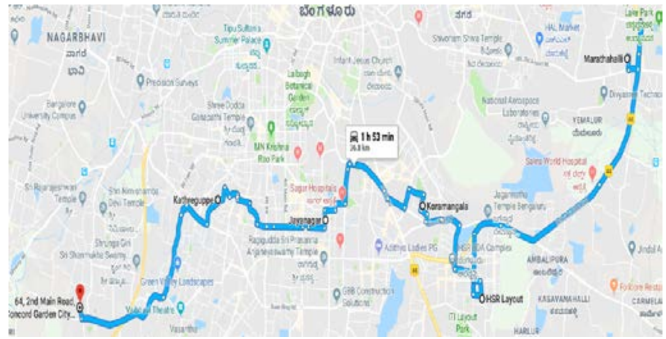

Figure 2: Project locations

The 6 projects are spread over a distance of 36.8 kms. Currently, material procurement and storage of materials are done for individual projects. Materials are ordered and delivered directly to individual sites based on the project requirement. The required storage facility is also provided at individual sites.

When CCPM is applied, centralized procurement and storage of materials should be taken care of. Also pooling up of resources will be required. To facilitate centralized resource availability, the planning should be done at the top management. The following steps are to be followed,

(1) Projects should be prioritized
(2) Resources required by each project should be calculated
(3) Time of requirement of resource should be fixed, so that the resources can be made available before the time (providing resource buffer)
(4) Proper co-ordination has to be ensured between each of the individual projects and the top management

Figure 3 illustrates the flow of information to and from the top management to facilitate centralized resource availability.

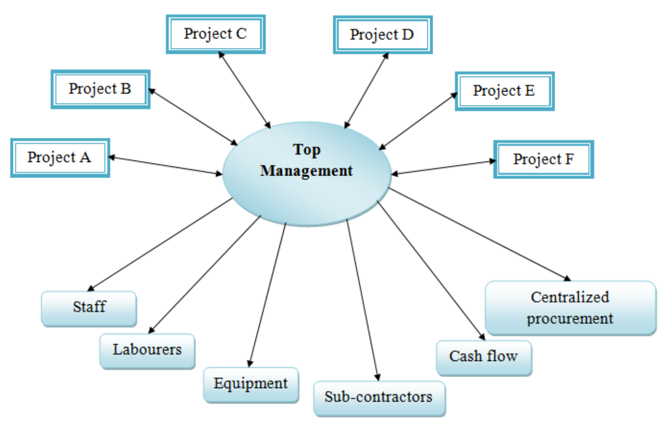

Figure 3: Flow of information to and fro top management

3.3 Additional costs

CCPM implementation would lead to extra charges for transportation and storage which will have to be divided among the projects. But also, CCPM implementation would mean cutting down on delays and making maximum use of the available time and resources as compared to other management techniques.

Buffer penetration method is an efficient method for project monitoring and it ensures that the projects are completed on time without giving rise to any delays. Reducing delays means cutting down on time and resources, which means no additional costs that generally arises due to delays.

Therefore, investing a little more in CCPM methodology (for transportation and storage facilities) would ensure timely completion of projects without any delay.

3.4 Pipeline model approach

The steps in the approach can be broadly classified into,

1. Initialising
2. Planning
3. Execution
4. Completion

The first step initializing includes creating the list of projects included in the system for a particular timeframe. Projects can be added into the system during this step. New projects should not be added into the pipeline after this step. The second step which is planning includes prioritization of the projects and their scheduling. Project execution comprises the third step. It is in this step that the calculated project buffer has to be monitored for each project to understand the progress of the projects. Over consumption of project buffer indicates lagging of project. The fourth step is the project completion step. Based on the monitoring done in the previous step, if any project is behind schedule or lagging, corrective measures have to be implemented to bring the project back on track. The different steps of the approach are summarized in figure 4.

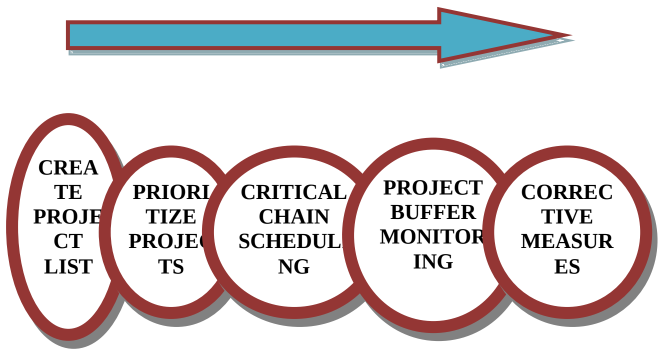

Figure 4: Pipeline model approach

4. CONCLUSION

The study addresses the drawbacks of conventional scheduling techniques and the concepts of a new evolving scheduling technique CCPM. Provision of buffer with every activity is present in traditional scheduling techniques but this doesn't contribute to the overall project management. This drawback is overcome by the introduction of buffer pooling and formation of project buffers in CCPM. Comparison of two buffer sizing approaches concluded the RSEM approach is practically applicable. On comparing the CCPM project durations with the actual durations, it is observed that, there is a reduction in number of days when critical chain scheduling is opted. This variation is due to the RSEM approach of buffer calculation.

CCPM involves centralized planning and resource supply. The top management takes care of planning, cash flow, resources and labour supply, etc. for all the individual projects. If the material procured for one project comes in excess, it can be used for another project and vice-versa. This is a more centralized approach and all the decisions will be taken by the top management team rather than the individuals heading each individual project.

The only additional cost that will get added up by following CCPM methodology would be the additional transportation and storage charges that will be incurred due to the pooling of resources and centralized system. But, in turn CCPM ensures very less or no delays which leads to lesser losses.

CCPM methodology has to be implemented right from the planning stage of the projects. The multiple projects should be prioritised based on their importance at this point. On the basis of the prioritization, projects have to be released into the project pipeline. Controlling of all the projects is taken care by the top management as shown in figure 5.

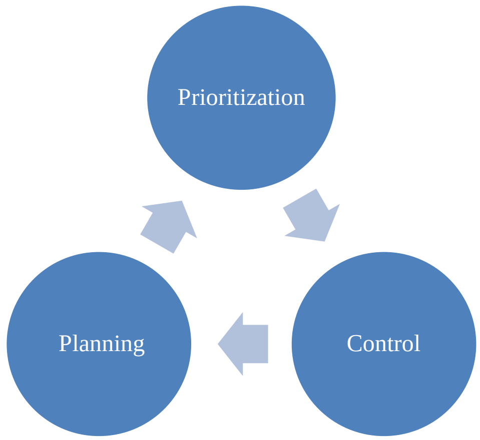

Figure 5: CCPM cycle

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