APPLICATION OF THEORY OF CONSTRAINTS AND CRITICAL CHAIN METHOD FOR PROJECT MANAGEMENT IN ULTRA MEGA POWER PROJECTS (UMPP)

SIDDESH PAI

National Institute Of Construction Management And Research (NICMAR),, siddeshp@nicmar.ac.in

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SIDDESH PAI[1] & S.GIRIDHARAN[2]

[1,2]National Institute Of Construction Management And Research (NICMAR),
email: siddeshp@nicmar.ac.in

Abstract:-In Developing countries like India, there is a huge demand for Power and the country itself faces challenges in meeting the demand in an effective manner. In India, Planning commission has come up with a solution by bringing in Ultra Mega Power projects (UMPP) in recent years. Large number of power projects (XI and XII five year plans) is under construction to overcome the power shortages and meet the growing energy requirements in the country. So Government of India has planned for Mega / Ultra Mega Power Generation projects with revised tariff regulations for existing central government projects, competitive bidding for all future power generation projects, tariff norms for renewable energy / introduction of Renewable Energy Certificates, new transmission pricing grid code, power market regulations, Re – structured Accelerated Power Development Reform Programme (APDRP2), National Electricity Fund, etc. Ministry of Power and Central Electricity Authority (CEA) have projected a total investment requirement of Rs. 11,35,142 Crore for the power sector during the 12th Plan period, which also includes investment for generation of additional capacity of about 1,00,000 MW to the existing capacity of about 1,64,508 MW for the country.

The above stated reforms are good sign of development but India's performance in power sector (Planning to Operation) is not remarkable. Always delays are encountered in all phases. The Second main constraint in UMPP is managing the criticality of material and inventory for the project. But, this criticality has been overcome effectively in Mundra project which is an UMPP. The Phase- 1,2,3 of Mundra Power plant has been successfully completed and will start its effective operation soon (Capacity of 800 MW each).The success includes timely completion with available resource in a significant manner. The success delivery is by application of Theory of Constraints and Critical chain management in critical phases. So, the effectiveness of the above said concepts has to be realised and adopted in other ongoing and proposed UMPP for better service to the country on time.

Key words – UMPP- Ultra Mega Power Plant, CCM- Critical Chain management, TOC- Theory of constraint, Material management, etc.

INTRODUCTION:

As India is facing power crisis, planning commission has come up with setting up of Ultra Mega Power projects in various locations as follows. Krishnapatnam (AP); Nayunpalli (AP), Mundra (Gujurat); Surguja (Chhattisgarh); Tadri (Karnataka); Tilaya (Jharkhand) respectively.

We all know that materials such as coal, steel play a major and vital role in case of power projects and its availability for the project is not sufficient; but the project can be completed by effective and efficient planning of activities taking material constraints into consideration and has been implemented in successful way in case of Mundra UMPP in Gujarat.

Mundra UMPP in Gujarat was planned in 5 phases, each constituting 800 MW and comprising a total of 4000MW. Tata Power has undertaken the project and has successfully completed three phases of 800 MW each in planned time and cost with less overrun in both time and cost. The success is tremendous as it was achieved in spite of challenging constraints.

The coal for the power plant is an imported coal and the rising price of imported coal was a threat but somehow it was handled in a better way by TATA Power. Next and the very important constraint is material constraint as the power plant construction involves loads of activities that are critical and the material for which has to be specially fabricated and brought to site for erection and commissioning. So, just planning and scheduling the project by traditional methods of management doesn't solve the purpose and hence, advanced methods of project management have to be adopted to exploit the constraint and complete the project on time and within cost.

The Advanced methods include **Theory of constraint** and **Critical Chain project management.**

The application of TOC was restricted only with manufacturing industries but this paper proposes that Theory of constraints and Critical chain project management can be adopted in case of large infrastructure projects. So the change in project management methods makes our country competent with other developed countries in field of construction.

The Concepts of TOC and CCPM with its application in case of large infrastructure projects like UMPP have been discussed below with case study of Mundra UMPP- Gujarat.

LITERATURE REVIEW

Theory of Constraints- TOC

Let me just start with the concept of Theory of constraint developed by Dr. Eliyahu Goldratt and today it is a significant method within the world of best management methods.

One of the attractive characteristics of the Theory of Constraints is that it inherently prioritizes improvement of activities. The top priority is always given to the current constraint. In environments where there is an urgent need for improvement, TOC offers a highly focused methodology solution.

A successful Theory of Constraints implementation will have the following benefits:
- Increased profit
- Fast improvement
- Improved capacity
- Reduced lead times
- Reduced inventory

Core Concept

The core concept of the Theory of Constraints is that every process in a project has a single constraint and that total process output/performance can only be improved when the constraint is improved. A very important corollary to this is that spending time for optimizing non-constraints in the process will not provide significant benefits; only improvements to the constraint will make significance.

Thus, TOC seeks to provide precise and sustained focus on improving the current constraint until it no longer limits the performance.

The Five Focusing Steps

According to Theory of constraints there are five main focusing steps which has to be performed for betterment of performance. They are as follows.
1. Identify the Constraint.
2. Exploit the constraint.
3. Subordinate everything else.
4. Elevate the constraint.
5. Repeat the cyclical process till the required efficiency is achieved.

Critical chain Project management- CCPM

The first step towards project success is creating realistic and accurate schedules. In Project Scheduling, PERT and Critical Path Method (CPM) are widely known methods. Using CPM, early Start and Finish dates and Late Start and Finish dates are calculated by forward & backward pass of the project network diagram paths. But this method, does not take resource limitation into consideration. After identifying the path, resources are picked up & levelled. In general, activity owners add safety margin (buffers) to each of the activities in order to cope up with uncertainties. But this cause waste in time when activities can be completed well before the estimated finish date to be clear.

Critical Chain Method is a schedule network analysis technique that takes into account of task dependencies, limited resource availability & buffers.

As in the case of Critical Chain Management first step is identifying set of activities that results in longest path to project completion which are called critical chains. It may be longer than CPM schedule as it includes resources into consideration,. Resources used in those critical chain activities are critical resources. Set of activities that are in non-critical chain but point into critical chain are called feeders. Next step is use effective buffer management for shortening the project schedule by reducing the activity duration estimates. CCPM focuses on eliminating the schedule delays, overestimation of task duration and wastage of internal buffers respectively.

In Critical path method, if an activity is completed ahead of planned time or estimated time the time gap is not added to the successor activity but delays are added to the successor activity and may result in change of the critical path of the project.

In Critical chain management, the calculation of safety margin /buffer is based on the set of activities in the critical chain. The time gain or delay are passed throughout the chain activities and the internal buffers/safety margins added to the individual activity are made explicit and summed up respectively. This summed up buffer is the project buffer which remains active throughout the project and not for the individual activities. So critical chain activity focus on project completion than activity completion which is the most important and significant part of Critical chain management. In critical chain management the project buffer remains the part of the project and protects it from uncertainty.

In CCM, pooled project buffer is used as protector of the entire project & even it is utilized up to 50% allows project completion well within the schedule.

Another salient feature of the CCM is use of resource buffer which neither consume time nor cost in the project. They are just indicators. The resource buffers are just inserted before the critical chain activities where critical resources are required. So these buffers indicate the start of the critical chain activity and warn the critical resource to be ready for the critical chain activities even when they are associated with the non critical chain activities.

Another type of buffer used in CCM is feeding buffer which are just introduced when the non critical chain activity converges into the critical chain activities. These buffers are same like project buffers pooled safety margin at the end of non critical chain activities.

So I have given a brief note on Theory of constraint and Critical chain management above and now let us discuss how it can be applied in case of mega projects especially in case of Ultra mega power projects.

Application of TOC and CCM in ultra mega power projects

As I discussed about the Ultra mega power project and its purpose, let me go straight into the core of

it.ie. Project management aspects in case of Ultra mega power projects.

The significant technological development in case of such mega power projects is supercritical Technology because of its better fuel efficiency. As we all know that the availability of coal for the power plant is decreasing and hence imported coals are used in many projects.

Let me discuss on the various constraints in such mega power projects. They are Material constraint which includes steel; Resources constraint.etc.

Use of TOC to exploit material constraint which is the most influencing constraint in case of power projects can bring a better throughput and availability of the materials for project.

Hence TOC can be adopted in increasing the production of steel required for the project and also for the distribution/ supply chain management of steel for the project.

TATA steel supplier of steel in case of Mundra power plant in Gujarat have adopted TOC for the better throughput and to meet the requirement of the Mundra power project which is done by TATA power. Because of which there is no criticality caused to the Mundra power project in case of steel. The company was able to meet the requirement of the project on time by using Theory of constraints. Not only TATA steel but there is wide range application of TOC in production/manufacturing Industries.

Next let me discuss on the application of Critical chain management in case of ultra mega power projects in detail.

As mentioned earlier in the introduction part of the CCM, CCM focuses on the completion of project as a whole and not an individual activity completion. The Ultra mega power projects include civil works, Mechanical works, Electrical works and Electronic works.

Therefore completion of all the activities and testing marks the project completion. If traditional concept of CPM is used it focuses on the completion of activity and as a result the project duration estimate will no longer be accurate and hence project ends up with time overrun and cost overrun.

So for mega projects like UMPP, Critical chain management should be adopted for accurate time estimate. The project has to be completed through realistic and effective scheduling technique which is CCM technique.

The Resource constraint has to be considered while scheduling and hence any delay will be adjusted within the project buffer. But the feeding buffer from the non critical chain activities are used by the critical chain activities first and then the project buffer are used and in such a way that the project completion is as per the estimated duration respectively.
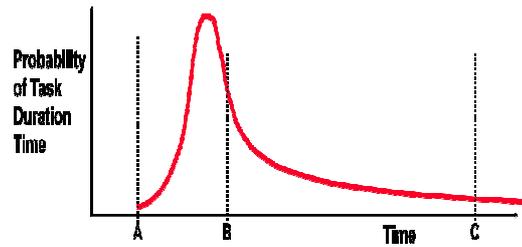

CRITICAL CHAIN USES TIME 'B'

In case of power projects Boiler erection forms the set of activities in critical chain. The other task or set of activities scheduled during boiler erection are in the non critical chain. The resource buffer can be introduced before the critical chain activities here boiler erection begins which gives an alarm for the critical resources required for the boiler erection to be ready before critical chain activity.ie. The boiler erection starts, leaving the non critical chain activities.

The Buffer in the non critical chain activities which merge into the boiler erection activity (critical chain activity) in the network can be utilized by the Boiler erection activity. If it is not used it gets added to the project buffer. But when the feeding buffer from non critical chain gets exhausted then the critical chain activity here is the boiler erection utilizes the project buffer.

So this method of scheduling focuses on the completion of set of activities in the critical chain which marks the completion of the project. So thereby the buffer management makes the schedule realistic and also any delay encountered are protected by the buffer and any early finish are added to the buffer. But the most important is to have best buffer management practise and there must not be any student syndrome in scheduling.

The merging of Path A, Path B, Path C to the Boiler erection activity with buffers are shown below in the figure.
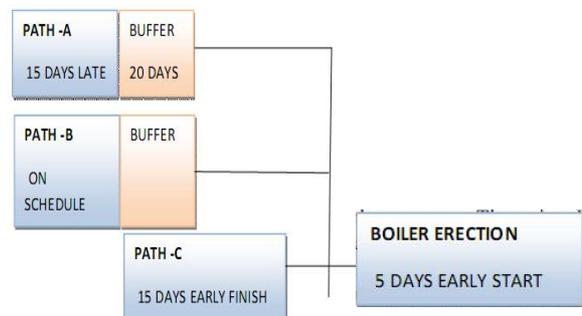
CRITICAL CHAIN MANAGEMENT

However buffer should be closely monitored and the

success of this method of project management depends on the effectiveness of the buffer management. So once the buffers are managed effective any type of mega projects can be completed on time and can solve the purpose of its implementation. This method of project management is not used in India but managers should realize the effectiveness of this method and should start formulating different way of application in ultra mega power projects and other mega construction projects.

Tata power has adopted a little of this type of critical chain management system and were able to complete 3 units of 800MW capacity each as early as possible overcoming resource and material constraint respectively.

The most important point to be noted is that project completion time is been targeted and exploited, not the individual activity completion time.

The added and major advantage of this method of management reduces the Inventory. So this serves the basis of Just in time inventory management system. So it directly controls the cost spent on inventory and also the resource buffers which are provided doesn't consume any resource and hence doesn't increase the cost eventually.

There by mega projects can be completed as per the requirement to serve the purpose on time which is a big question mark in our country. Because of the delay in implementation of such projects indirectly affects the infrastructure and economy of the company. The points I have mentioned are just overview and any further research in implementation of such mega projects using advanced methods of project management will be fruitful to our country.

Almost all the developed countries started adopting CCPM for construction projects. But In India still this method is not adopted. So the main aim of this paper is to just give a spark about adopting CCPM in mega projects like UMPP which are resource constrained and also to trigger research on this with greater efficiency.

CONCLUSION

The application of concepts of Critical chain management and Theory of Constraints was used only in manufacturing industries, Software industries, Aerospace.etc. But The Application of Critical chain management and TOC in UMPP for handling the material constraints and managing it without affecting the project causing any delay is a Success mark of the project. The application must be made familiar to infrastructure projects to achieve greater efficiency and thereby marking the success of the country through effective implementation of various infrastructure projects on time favourably.

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