Road Construction Time Reduction through Scheduling the Project with CPM

Anamika Rajput[1] Shumaila Saleem[2]
[1]Research Scholar [2]Assistant Professor
[1]RGPV, Bhopal India [2]SISTEC-R, India

Abstract— The paper is based on the input data from a road project which is completed few months ago, the raw material for construction purpose was available at different quarries. It means that there was option available to contractor to receive quarry from either ends of road project. The road project is drawn and collected under the CPM network analysis methodology. The object is to find the critical path of the network drawn with CPM technique and to achieve best path for acquiring construction material under predefined quarry locations and distance. The final result is presented with the objective of time reduction in term of days utilized to complete the project. Target is achieve with shorter time requirement as compared to the actual time taken by the project. Economically it is required to save time and money, and to identify the factors which are not taken under consideration by contractors till time.

Key words: CPM, Network Analysis, Road Construction, Activity Scheduling

I. INTRODUCTION

CPM which is known as critical path method is the networking technique and utilized frequently by the researchers to plan, schedule and control big projects in systematic manner with the objective of completing project within the pre-demanded and pre-planned limit of time.

T.Subramani and M.Sekar, 2015, This study gives brief explanation for preplanning project management, Pre planning helps to schedule the working period in a proper manner and also purchase the goods at the right time.

Shailla, 2014, In this paper MOST uses backward integration which helps in knowing the ground realities very easily. The redrawing without rescheduling of activities is done in a simple manner. It is easy to update and is useful in cases of arbitration.

Ming Lu and Heng Li, 2003, the researcher pointed the limitations of existing construction methods and a method with name resource-activity critical-path is proposed to use. The method solves and optimizes the scheduling problems by improving utilization and availability of the resources.

Enas Fathi Taher & R. K. Pandey, 2013, Researchers analyses schedule activity delays and aims to minimize the delays from the project. Time Impact Analysis method was used to analyze, identify and minimize the delays in schedule and activities.

R. E. Orgut, et. al., 2012 Objective of this study was to level resource utilization of a 9.7 km long asphalt highway project using the branch and bound (B&B) algorithm. This research proposed a mathematical model for leveling resources of a linear construction project, namely a highway construction project, scheduled with location-based planning technique.

RL Bregman, 2009, Paper focuses to introduce effective and best method to analyze the project completion time and solves probabilistic networks to make decisions in project management cycle.

Dan Trietsch, 2005, The work performed by the researcher Eliyahu Goldratt is critically examined and studied to define and identify the presence of PERT/CPM in Goldratt's "Theory of Constraints" (TOC). It was concluded that Critical Chain provides a more holistic approach than the typical practice before.

Margaret W. Emsley, 2015, Researcher in present study studied large numbers of journal and conference papers to write significance and importance of CCPM. This study divides collected papers in to various groups such as introductory, critical, improving, empirical, case-reporting and exploiting papers. The result and conclusion notify CCPM as important analysis method in network techniques.

Omar M. Elmabrouk and Fardous Aljiebali, 2012, The paper presents linear model with a objective to help project manager to investigate effects on cost due to fluctuating duration of the project manager is helped to investigate and determine best path and to reduce the project cost using linear model presented in this paper.

II. PROBLEM FORMULATION

The empirical input data for the purpose is collected from a specific part of road project named Khurda – Kample Road (i.e. From Deoguradia to Ujjaini) in Indore district. It is having a length of 10.8 km in the state of M.P wich actually takes 119 days to complete. Major problem is taken under consideration to reduce these number of days utilized to complete this construction project.

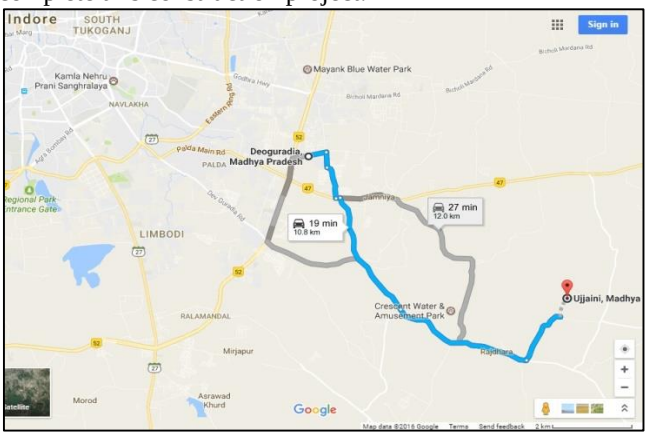

Fig. 1: Research Road Section Location

The present study is conducted to prepare a live example case with a objective of minimizing cost and time expected to require for similar projects in future. The data collected from the contractor and is analyzed with CPM networking technique. Contractor started the road construction work for taken 10.8km section and the required

material in the construction of road is Murram for earth work, Granual sub base (GSB) which is 80-100mm stone mixture, Grade I material mixture with 65-80mm stone mixture and Grade II material mixture with 40-50mm stone mixture. And the layering sequence of the material was Murram – GSB – GI – GII.

Availability of material for this project purpose was available at two nearby quarries which are given name A, and B for research purpose. Only Murram was available at quarry A which was and it was with the distance of 1.7kms and 5.4kms from initial and end nodes of the project. Quarry B is available with all of the required material i.e. Murram, GSB, GI, GII. The distance was 3.9kms and 4.3kms from initial and end nodes. The construction work was done with a random selection of quarry as reported by the contractor. But we as a researcher strongly believe that if the contractor goes with CPM analysis and follow the CPM technique may complete the project in shorter time, and hence same is taken as problem in this report. The aim of the research is to study the purpose of the project management through CPM technique.

III. METHODOLOGY

CPM in its standard format is proposed to utilize and conduct the research study time achieved by the project under consideration and can be analyzed to propose schedule and alternate options proposed in the result of the study. The cost can be minimize with CPM by minimizing project duration using CPM network analysis technique.

A. Data Collection and Analysis

CPM network analysis is initiated with the arrangement of the activities utilizing different required material from various quarries. The table is with the content list for activities and the duration required for the activity. The activity can be explained with the expression Yi (X), where 'Y' represents raw material, 'i' is representing the i^{th} kilometer of the road section and 'X' is for the quarry selected for the particular activity.

Sr. No.	Activity	Description	Duration
1	M1(A)	Muram from quarry A in 0-2 km	8
2	M2(A)	Muram from quarry A in 2-4 km	10
3	M3(A)	Muram from quarry A in 4-5 km	6
4	M4 (B)	Muram from quarry B in 5-6 km	5
5	M5 (B)	Muram from quarry B in 6-8 km	14
6	M6 (B)	Muram from quarry B in 8-10.8km	9
7	GSB1(B)	GSB from quarry B in 1st km	12
8	GSB2(B)	GSB from quarry B in 1st km	10
9	GSB3(B)	GSB from quarry B in 1st km	3
10	GSB4(B)	GSB from quarry B in 1st km	3
11	GSB5(B)	GSB from quarry B in 1st km	10
12	GSB6(B)	GSB from quarry B in 1st km	7
13	GI 1(B)	Grade I from quarry B in 1st km	12
14	GI 2(B)	Grade I from quarry B in 1st km	10
15	GI 3(B)	Grade I from quarry B in 1st km	3
16	GI 4(B)	Grade I from quarry B in 1st km	3
17	GI 5(B)	Grade I from quarry B in 1st km	10
18	GI 6(B)	Grade I from quarry B in 1st km	7
19	GII 1(B)	Grade II from quarry B in1st km	10
20	GII 2(B)	Grade II from quarry B in1st km	10
21	GII 3(B)	Grade II from quarry B in1st km	3
22	GII 4(B)	Grade II from quarry B in1st km	3
23	GII 5(B)	Grade II from quarry B in1st km	10
24	GII 6(B)	Grade II from quarry B in1st km	7

Table 1: Activity List (road Construction Project)

The few possible paths for the mentioned activities are listed below, other than mentioned path there several paths which can be listed but they are not critical, hence are neglected.

Critical Path is mentioned as critical path for CPM network analysis.

Path 1	1-2	2-3	3-5	5-7	7-9	9-11	11-14	14-15	15-18	18-19	19-21	21-26	26-27	27-28
Path 2	1-2	2-3	3-8	8-22	22-24	24-25	25-26	26-27	27-28					
Path 3	**1-2**	**2-4**	**4-6**	**6-10**	**10-13**	**13-15**	**15-18**	**18-19**	**19-21**	**21-26**	**26-27**	**27-28**		
Path 4	1-2	2-4	4-5	5-7	7-8	8-12	12-16	16-19	19-21	21-26	26-27	27-28		
Path 5	1-2	2-3	3-5	5-7	7-9	9-11	11-14	14-16	16-19	19-21	21-23	23-27	27-28	
Path 6	1-2	2-4	4-6	6-7	7-9	9-11	11-14	14-15	15-18	18-20	20-21	21-26	26-27	27-28

Table 2: Alternate Network Activity Paths

B. Critical Path Finding

The critical path is one which is having maximum project time for completion. In presented CPM network diagram the critical path computed is:

1	**2**	**4**	**6-**	**10**	**13**	**15**	**18**	**19**	**21**	**26**	**27**

-2	**-4**	**-6**	**10**	**-13**	**-15**	**-18**	**-19**	**-21**	**-26**	**-27**	**-28**

The table can be arranged for critical path to compute earliest starting (E_E) time and earliest finish time (E_L). Firther the table can also be extended column wise to caompute slack for the sets of critical path activity.

Activity Start	Activity End	Days	E_E	E_L	Slack
1	2	8	8	8	0
2	4	10	18	18	0
4	6	6	21	21	0
6	10	5	29	29	0
10	13	14	43	43	0
13	15	00	43	43	0
15	18	10	53	53	0
18	19	00	53	53	0
19	21	10	63	63	0
21	26	00	63	63	0
26	27	10	73	73	0
27	28	7	80	80	0

Table 3: Activity Computation with Zero Slack

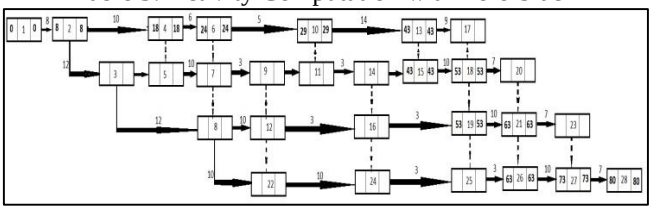

Fig. 2: CPM Network Graphical Representation of Road Construction with Zero Slack

IV. RESULT

The value of total slack for any CPM network analysis the conclusion can be made for critical path computation that when the slack for the sets of activities is positive, shows that the available resources for the activity are more than sufficient.

The result path has zero delay and is termed as critical path for the present CPM network analysis. The time to complete the project is reduced from 119 days to 80 days. The project can be completed in 80 days with availability of resources and following CPM critical path.

V. CONCLUSION

It is always a challenge to allocate the resources to the activity. CPM assumes that every activity is available with resources required to perform that particular activity in time. There may be delays like heavy rain which may produces unavailability of the material and may interrupt the project growth. Also if CPM critical path is successfully applied, then it saves lots of cost for construction point of view and profit point of view.

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