



OPTIMUM PROJECT COST AND DURATION BY USE OF DIFFERENT TECHNIQUE: A REVIEW WITH CASE STUDY

CHOTHE O. K.¹, TIWARE V.S.², PATIL A.D.³

¹Assistant Professor (M.E. Construction Management)

Bharati Vidyapeeth's College of Engineering, Kolhapur, Maharashtra, (India)

²Assistant Professor (M.Tech. Construction Management)

Bharati Vidyapeeth's College of Engineering, Kolhapur, Maharashtra, (India)

³UG student Dept of Civil Engg ,

Bharati Vidyapeeth's College of Engineering, Kolhapur, Maharashtra, (India)

ABSTRACT

As we know that construction industry is on a boom these days. The new innovations of various technologies as well as materials have been considered as the boon for the economic development. The economy of nation depends directly or indirectly upon the infrastructural development being prevailed in the nation as there are many foreign investments being involved in it.

Time and cost are the two prime concerns which are to be considered appropriately while planning of any project to establish it successfully in time. We know that there is time delay in any project due to various factors which effects directly upon the Total Project Cost. Thus to minimize the total project cost by completing the project in minimum duration we have suggested to use the "NETWORK COMPRESSION TECHNIQUE" to be assigned over the collective activities considered in any project and obtain an optimum solution.

In this paper , we have considered **1 Case Study**, one of a bungalow for which we have collected data regarding to its plan, quantities required, material required, labour required and derived a chart which would direct give us the appropriate cost and time involved in that activity. By use of network compression technique we have crashed the network in order to get the optimum solution.

Keywords: Crash Cost, Direct- indirect costs, Network Compression Technique, PERT planning, Project cost minimization

1. INTRODUCTION

Buildings are structures which provide shelters for man, his properties and activities. They must be properly planned, designed and constructed in order to get benefits from the nature. A building project is a task which is undertaken to achieve a goal of completing a certain construction within time and the given budget. But then to the results of expected cost investment cannot be made as certain in each plan as the project varies as per the plan and extent. Thus it becomes important therefore to arrange the tasks within the project sequentially in correct order and optimise it to get the appropriate results. The proper implementation and construction of a

8th NATIONAL CONFERENCE On 'Emerging trends in Engineering and Technology'

Bharati Vidyapeeth's College of Engineering, Kolhapur (NCETET-2018)



10th March 2018

www.conferenceworld.in

ISBN : 978-93-87793-03-3

project occurs only when planning, scheduling, resource allocation, management, simultaneous activity performance is carried out in time as per predefined. A project is a collection of numerous small interrelated activities. Among which some are independent and can be completed with respect to time needed while some are dependent over the previous activities which can be performed only after the commencement of preceding activity. Therefore the risk of building failure may arise more prominently if the buildings are constructed prior to the required time.[1].

India is a developing nation and the construction industry plays an important role in the development. Time and cost are two main concerns in a construction and they are used for planning a project. Thus the concern has increased the importance of consideration of time and cost in construction activity. It is necessary to determine the total cost and time required to complete the project within specification to get the optimum results. Thus optimization is the best option to be carried out which gives more margin benefit and saves time as well required. Cost Optimization can be defined as the achievement of real and lasting reduction in the unit cost of services provided without damaging their suitability in plan used. There are multiple ways to obtain cost optimisation but still many of the projects still are not using it in actual implementation. Optimising avails us with number of methods associated to perform a specific activity to complete the project within less time.[20].

Hence it is necessary to arrange sequentially all the activities and collect proper data related to it. The method and materials used in construction also play an important role for determining the time required for completion. One way of overcoming such problems is through the use of network models. Network models are conventional methods of finding the most appropriate way to link a number of activities directly or indirectly in so that it can satisfy supply and demand requirements at different activity locations and project scheduling. The need for networking arises in building construction to programme and monitor the progress of the stages involved so that the building project is completed in the minimum time. In this project we will list down the activities related to construction of a building, find out its expected time and cost and use network compression method to compress it and determine a critical path which would give us a minimum time for the project along with its optimum cost.[7].

Project management is a tool that is used by many companies to improve results, production as well as the output. Projects and their execution require a proper resource allocation. An important aspect of project management is risk management. Different types of risk are present in any given project but the main worries are related to the time required and the cost required. If the project is completed on time it won't create any worry but as the duration increases it also leads to the increment in cost. Late project completion generally has negative effects for the company such as penalty costs and customer dissatisfaction. If a project is running late project managers might be able to bring the project back on track by assigning additional resources and methods [3]

In project management, the method of justifying risk is known as crashing. The traditional method of crashing CPM/PERT networks only considers average activity times for the calculation of the critical path it ignores the uncertainty related with the duration of the activities. Adding variable durations in the crashing process allows the generation of the project completion within time distribution and enables the analysis of the real effect that a specific crashing arrangement may have on the project.[2]



II. LITERATURE REVIEWS

Florentin Smarandache states that in his paper, the algorithm proposed for unit crashing reduces the cost of project. When activities are crashed by one day then only the crashing cost corresponding to one day is increased thereby reducing the project duration as well as cost. A C++ program is developed to achieve the above results. This approach is well suitable for places where cost is of major consideration. In this paper the technique called Unit Crashing is used to reduce the total cost of project. The output of this method reduces the cost of project, and is useful at places where cost is of major consideration. Even if there are no direct costs in the form of penalties for late completion of projects, there is likely to be intangible costs because of reputation damage. It also states steps in PERT planning and benefit of it, how the crashing of network occurs and the relations developed between the activities and events. It describes a procedure for solving the project time/cost trade-off problem of reducing project duration at a minimum cost. The solution to the time & cost problem is achieved by locating a minimal cut in a flow network derived from the original project network. This minimal cut is then utilized to identify the project activities which should experience a duration modification in order to achieve the total project reduction.[3].

Anuja Rajguru, states review of different techniques for optimization in paper. To minimize the construction cost and duration at each phase is important. It is a need to meet the present day requirements and to complete the project within the estimated time, cost, and available resources. Mainly affecting the factor on cost of project is delay in project and material. Several methods have been developed and applied to analyse the time-cost problems, but they can optimize only one parameter. Various low cost material also suggested for optimizing the cost of project along with maintaining the quality and strength of the project. Project cost is one of the most important criteria of success of project. The authors are focusing on identification of significant causes affecting construction cost. Also various mathematical method and software based models studied for optimization. In this approach study of various factors which affect the cost of projects is made. In this approach the study of various techniques and various materials used for cost optimization. Also the need of optimization is discussed. From study they found that contractor efforts to manage the project cost by concentrating on the management on the project resources. The author provides base line information on strategies used for managing project cost.[7].

Adebowale S. A. presents that the task of building project management can be improved if network analysis technique is adopted. This will identify minimum time a building project can take before completion. It will eliminate any sort of redundancy or dangling of activities, so that the developer can meet the needs of other clients who need its services at other building sites. The authors recommend that severe adherence to the minimum possible time to complete a specific part of building process will check the effects of building collapses. This paper states the basic terminologies related to PERT and CPM. It also states the activities and methodologies that are to be undertaken appropriate to the activities. The critical path developed helps us to get the optimum cost and thus the total project duration also gets reduced.[1]

Nafish Sarwar Islam explain the algorithm proposed for unit crashing reduces the cost of project. The purpose of this study was to explore the suitability of a new method to crash PERT networks. This approach is well suitable for places where cost is of major consideration. Plans for future research include running the simulation on



additional networks, preferably real-world projects. The project crashing algorithm described in this section is designed to give the mathematically correct time-cost trade-off curve for small project networks which are to be solved by hand.[2].

Tatar published the paper on "Optimization tools for time cost trade off applicable in construction project management". The main objective of this study is to explore a various time-cost optimization frameworks that can provide an optimum time & cost value for a project taking into consideration the effect of float loss which involves the funding variability that formulates financial feasibility as a stochastic constraint, transforms it into a deterministic equivalent at a pre-specified confidence level, and solves the system by means of classical optimization techniques. This study presents two new frameworks that are developed to solve the time-cost optimization problem taking into account the float loss impact namely a stochastic framework and a Non-Linear Integer Programming (NLIP) framework. The stochastic framework uses Monte Carlo Simulation (MCS) to calculate the effect of float loss on risk.[9].

Powar published paper on "Time and Cost Planning in Construction Project". They considered planning is the most important techniques of management in terms of time and cost. The author highlights the causes of delay and planning and scheduling for saving time and cost. And lastly they give some remedies for saving time and cost.[12]

III. DIFFERENT TECHNIQUES USED FOR OPTIMIZATION OF CONSTRUCTION COST

Following are the some techniques used for optimization of construction cost

1. Optimization of Construction Cost Applying Advanced Techniques

Seyed Ali MousaviDehmourdi presents a practical application of linear programming in a real life project problem with two objectives as optimization of transporting cost of equipment and finding the best solution for reducing the functional costs of the equipment. Specially structured linear programming model is used for optimizing the transporting cost of equipment. The break-even analysis is also explored to determine the break even working period of the equipment considered for the purpose of any construction activity the result shows that optimization with advanced techniques really helps in minimization of cost of project. So the Objective of this paper are to apply the principles of engineering economics, finance, basic economic concepts and quantitative techniques to modelling and analysis of civil engineering projects.[12]

2. The Artificial Neural Networks

Gopal et al. 2013, published paper on "Project Cost and Duration Optimization Using Soft Computing Techniques". The main objective of the paper is to increase the productivity and necessary to forecast the costs arriving from resources so that the total cost of project can be reduced. The Artificial Neural Networks have become well established as viable, multipurpose, robust computational methodologies with solid theoretic support and with strong potential to be effective in any discipline, especially in construction. From survey results comes out that the Neural Networks approach has optimized the total project cost by 3.91%, and the duration of the project has been reduced around 5% of the total duration of the project.[18].

3. Genetic Algorithm Techniques For Time-Cost Optimization



Daisy published the paper on "Applying Genetic Algorithm Techniques For Time-Cost Optimization". Completing a construction project with the least time and cost is critical factor and usually requires the engagement of additional labour and plant or the adoption of alternative construction techniques which add extra cost liabilities to the contractor. For time-cost optimization several analytical models have been developed. From those the Genetic Algorithms (GA) could be used to establish the fitness of solutions by evaluating the objective function and its constraints. The objective of paper is to compare the analytical power of the GA with other techniques proposed for TCO. The results come out which indicate that the GA techniques could generate the most optimal outcome for construction Time-Cost Optimization it is more beneficial when the project is large and/or complex.[19]

IV. NETWORK COMPRESSION TECHNIQUES

Theory :-

1) Crashing: To decrease total project duration, different equipment used to crash the duration of that activity. The declining of the project duration take place after a careful and thorough analysis of all possible project duration minimization alternatives in which motive is to attain the maximum schedule duration for the least additional cost. The aim of crashing a network is to find out the optimum project plan. Crashing may also be required to accelerate the execution of a project, irrespective of the increase in cost. Each phase of the project consumes some resources and hence has cost associated with it. In most of the cases cost vary to some extent with the amount of time consumed by the design of each phase. The aim is always to strike balance between the cost and time and to obtain an optimum project schedule. An optimum minimum cost project schedule implies lowest possible cost and the associated time for the project management.

2) Project time-cost relationship: Total project costs consist of direct costs and indirect costs of the project. If each activity of the project is scheduled for the duration that results in the minimum direct cost (normal duration) then the time to complete the entire project may be too long and large penalties associated with the late project completion might be incurred. At the other extreme, a manager might choose to complete the activity in the minimum possible time, called crash duration, but at a maximum cost. Thus, planners perform network compression to determine an optimum solution for completion of the project. This can be done by selecting some activities on the critical path to shorten their duration. direct cost should be affect because of increase or decrease in duration of activity and respective cost .

SLOPE OF DIRECT COST CURVE:

The direct cost curve can be approximated by straight line or more than a straight line depending upon flatness of curve. The straight line or segmented approximation of direct cost curve is helpful in carrying out the project cost analysis and for such analysis "COST SLOPE" is used.

COST SLOPE: The cost slope is the slope of the direct cost curve, approximated as straight line. It is defined as

$$\text{Cost slope} = \frac{(\text{Crash cost}-\text{Normal cost})}{(\text{Normal duration}- \text{Crash duration})}$$

8th NATIONAL CONFERENCE On 'Emerging trends in Engineering and Technology'

Bharati Vidyapeeth's College of Engineering, Kolhapur (NCETET-2018)



10th March 2018

www.conferenceworld.in

ISBN : 978-93-87793-03-3

The slope of the line connecting the normal point (lower point) and the crash point (upper point) is called the cost slope of the activity.

CASE STUDY :-

Name - Residential bungalow

Area - Rajarampuri , Kolhapur

Following table indicate the number of activity and the respective durations.

(* curing timing not considered)

ACTIVITY	EVENT	NORMAL COST (NC)	NORMAL DURATION (ND)	CRASH COST (CC)	CRASH DURATI-ON (CD)	COST SLOPE
1-2	LINEOUT	3000	2	6000	1	3000
2-3	EXCAVATION	12600	7	3600	1	-1500
2-4	CENTERING	36800	5	36800	5	0
3-5	PCC FOOTING	13300	2	10500	1	-2800
4-6	FORMWORK	9000	2	9000	2	0
5-6	CONCRETING	14700	2	13300	1	-1400
6-7	P.B. (CENTERING)	64600	4	64600	4	0
6-8	P.B. (FORMWORK)	9000	2	9000	2	0
7-9	P.B. (CONCRETING)	54000	2	38500	1	-15500
8-10	MURUM FILLING	2800	2	3200	1	400
9-10+	BRICKWORK (2 FT.)	23600	2	37800	1	14200
10-11	COMPACTION	1200	2	4000	1	2800
11-12	PCC ON PLINTH	52600	2	49000	1	-3600
12-13	BRICKWORK	113200	6	192600	4	39700
12-14	COLUME FORMWORK	4200	2	2000	1	-2200
13-15	CONCRETING COLUME	24600	2	16000	1	-8600
15-16	STAIR (CENTERING + FORMWORK)	17000	2	18500	1	1500
15-17	LINTEL + CHAJJA (CENTERING)	16000	2	16000	2	0
16-17	FORMWORK + CONCRETING	13600	2	12500	1	-1100
17-19	BRICKWORK (3 FT.)	33500	3	58000	2	24500

8th NATIONAL CONFERENCE On 'Emerging trends in Engineering and Technology'

Bharati Vidyapeeth's College of Engineering, Kolhapur (NCETET-2018)



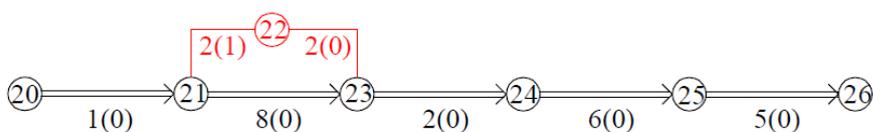
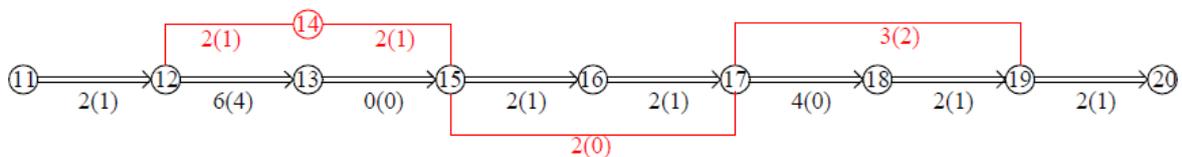
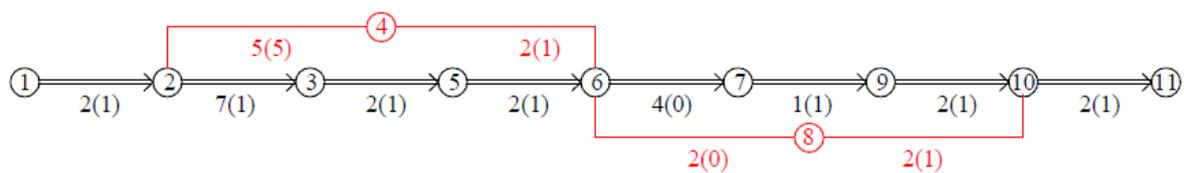
10th March 2018

www.conferenceworld.in

ISBN : 978-93-87793-03-3

17-18	SLAB + BEAM (CENTERING)	238000	4	238000	4	0
18-19	SLAB +BEAM (FORMWORK)	9000	2	7600	1	-1400
19-20	CONCRETING	206000	2	141750	1	-64250
20-21	REMOVE FORMWORK	1200	1	1200	1	0
21-22	PARAPET WALL	55000	2	93600	1	38600
21-23	PLASTERING	64000	8	64000	8	0
22-23	GRILL FITTING ON WINDOW	5000	2	6000	1	1000
22-24	PLUMBING	25000	2	25000	2	0
23-24	ELECTRIFICATION	12000	2	12000	2	0
24-25	FLOORING	75000	6	75000	6	0
25-26	COLOURING	26000	5	26000	5	0

CRITICAL PATH:



8th NATIONAL CONFERENCE On 'Emerging trends in Engineering and Technology'

Bharati Vidyapeeth's College of Engineering, Kolhapur (NCETET-2018)



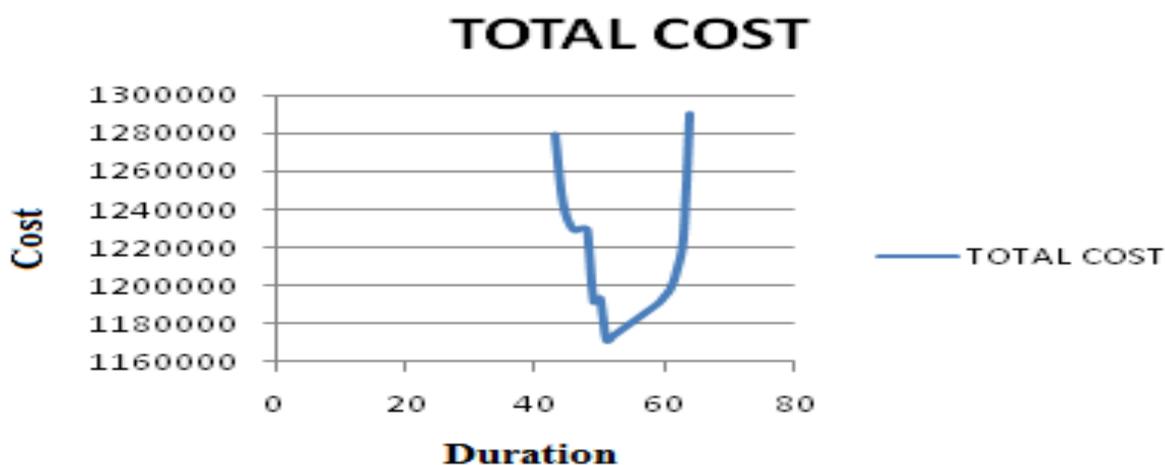
10th March 2018

www.conferenceworld.in

ISBN : 978-93-87793-03-3

TOTAL PROJECT COST:

SR. NO.	ACTUAL DURATION	DIRECT COST	INDIRECT COST	TOTAL COST
1	64	1232500	57600	1290100
2	63	1168250	56700	1224950
3	62	1152750	55800	1208550
4	61	1144150	54900	1199050
5	60	1140550	54000	1194550
6	59	1137750	53100	1190850
7	57	1134750	51300	1186050
8	55	1131750	49500	1181250
9	53	1128750	47700	1176450
10	52	1127250	46800	1174050
11	51	1125850	45900	1171750
12	50	1148950	45000	1193950
13	49	1147850	44100	1191950
14	48	1186450	43200	1229650
15	47	1187950	42300	1230250
16	46	1187950	41400	1229350
17	45	1193750	40500	1234250
18	44	1208350	39600	1247950
19	43	1240650	38700	1279350
20	42	1271750	37800	1309550



Graphical representation of total project cost



V.CONCLUSION

As per the case study , we can define that the optimum duration for the project 51 days. Curing timing not considered in this project duration. Optimum project cost for that duration is 1171750/-.

As per the above table indirect cost goes in increases and direct cost goes in decreasing form upto some limit and again goes increases. Network compression techniques is more suitable for large project. The difference between normal duration cost and crash cost is 118350/- as per the case study. Normal duration can be crash by using different equipments.

REFERENCES

- [1.] Adebowale S. A, 2010, Network analysis and building construction Implications for timing and costing of activities", Department of Epidemiology. Medical Statistics and Environmental Health, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Oyo State, Nigeria. Pg.No.1-12.
- [2.] NafishSarwar Islam, 2013, -Complex Project Crashing Algorithm", IOSR Journal of Business and Management (IOSR-JBM), e-ISSN: 2278-487X, p-ISSN: 2319-7668. Volume 11, Issue 4 (Jul. - Aug. 2013), PP 10-17 Department of Business Administration, East West University, Bangladesh.Pg.No.1-5
- [3.] FlorentinSmarandache, et al., 2012, -A Unit Based Crashing Pert Network for Optimization of Software Project Cost-,Pg.No.3-6
- [4.] Wayne A. Haga, 2001, "Crashing Pert Networks: A Simulation Approach", 4th International conference of the Academy of Business and Administrative Sciences Conference Quebec City, Canada.Pg.No.1-3.
- [5.] KomeshSahu et al., 2014, "Cost & Time and Also Minimum Project Duration Using Alternative Method", International Review of Applied Engineering Research, Volume 4.Pg.No.1-6.
- [6.] Michael E. Kuhl, 2008, "A Dynamic Crashing Method for Project Management Using Simulation-Based Optimization", Winter Simulation Conference.Pg.No.3.
- [7.] AnujaRajguru, 2015, "Effective Techniques in Cost Optimization of Construction Project: An Review", International Journal in Research and Technology, Badnera,
- [8.] India.
- [9.] P.K. Suni, 2008 "Simulator for Optimization of Software Project Cost and Schedule", Journal of Computer Science 4, ISSN 1549-3636.Pg.No.1-7.
- [10.] Bhushan Tatar, March 2015, "Optimization tools for time cost trade off applicable in construction project management", International Journal of science, technology and management, Vol.No.4, India. Pg.No.1-10.
- [11.] Mr. Chinchore, Dec.2014, "Planning and selection of heavy construction Equipment in civil Engineering", International journal of engineering research and application, Vol.No.4, Pg. No.5-18.
- [12.] Mr. Memon, Dec.2010, "Factors affecting construction cost in Mara Large construction Project: Perspective of project management consultant.", International Journal of sustainable construction engineering and technology, Vol.No.1.
- [13.] Sayed Ali, August 2014, "Optimisation of construction cost applying advance techniques", Research paper, ISSN 2319-6009, Vol.No.3.

8th NATIONAL CONFERENCE On 'Emerging trends in Engineering and Technology'

Bharati Vidyapeeth's College of Engineering, Kolhapur (NCETET-2018)



10th March 2018

www.conferenceworld.in

ISBN : 978-93-87793-03-3

- [14.] Khyomesh Patel, May 201 1," Construction materials Management on project sites", National conference on Recent trends in engineering and technology, pg.no.1-6.
- [15.] O.K.Chothe , 2013,"Comparative Study Of Conventional Methods And FRP Composite Method For Rehabilitation Of Bridges", International Journal of Engineering & Science Research, Vol-3, Issue-5/4012-4020.
- [16.] Barbole et al, 2013," Impact of cost controlled and cost reduction techniques on manufacturing Sector", Indian streams resource journal, Pg.No.1-10.
- [17.] Zhou et al. 2013, "A review of methods and algorithms for optimising construction scheduling". Journal of Operational research society, Pg.Nio.1-3.
- [18.] Mr. Zherw, Sep.2002," Applying genetic algorithm techniques for time-cost optimisation", Association of researchers in construction management, Vol.No.2, Pg.No.1-6.
- [19.] A.Balarnurgan, "Effective utilization of equipments and its management in construction industry", research paper, Vol.No.4, pg.No.1-6.
- [20.] Gopal et al. 2013, "Project Cost and Duration Optimization Using Soft Computing Techniques", International conference on science and technology.Pg.No.1-6. 19. B.C.Punmia, "Introduction to CPM & PERT"- Reference Book.
- [21.] Daisy X.M. Zheng,2002," APPLYING GENETIC ALGORITHM TECHNIQUES FOR TIME-COST OPTIMIZATION", 18th Annual ARCOM Conference, University of Northumbria. Association of Researchers in Construction Management, Vol. 2, 801-10.
- [22.] Onkar K. Chothe,2016,"Comparative Study of traditional method and innovative method for Trenchless Technology: A Review", International Research Journal of Engineering and Technology, Volume: 03 Issue: 05.