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Research Paper

OPTIMIZATION OF CONSTRUCTION COST APPLYING ADVANCED TECHNIQUES

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Construction industry is an important index for social and economic development of the nation. It is one of the largest industries in the nation; construction activities are becoming more complex day by day due to rapid improvement in planning, design and technology. In the cost optimization problems, existence of objective functions and the constraints related to the problem make the description of the problem impossible by using traditional mathematical programming. This paper 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 economic decision analysis techniques used in finding the economic life of equipment apart from linear programming model. Applications of this approach, the methods followed in determining the need for the replacement and the maintenance analysis are based on the econometric approach to the realistic problems. 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.

Keywords: Optimization cost, Construction Techniques, Economic Analysis, Break-even Analysis

INTRODUCTION

Optimizing performance of the different techniques adopted at one stage of the construction process may not be beneficial overall if the methods used are not to up the efficient level. Hence it is required to follow and implement the techniques in every stage of the construction process with the analyses of the information available. In this project, the methods and equipment used at the time of Earthwork excavation, i.e., at implementation and execution stage are considered for the analysis if optimum utilization of resources.

The methodology and the type of the equipment used in a construction industry is also plays very important role for the successful

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completion of a project. The different methods and equipment adopted for the purpose providing good quality of service and effective utilization of resources. The following methods are identified as most related methods and techniques in regarding to the earthmovers as equipment.

1. Quantitative Method and Techniques
2. Economic Decision Analysis Techniques

So the Objective of this paper are to apply the principles of engineering economics, finance, basic economic concepts and quantitative techniques to modeling and analysis of civil engineering projects.

- To minimize the construction cost in each case related activity like cleaning of site, earthwork excavation, back filling, etc., by using linear programing problem.
- To reduce the cost equipment by selection equipment economically using the advanced techniques like quantitative techniques and economic design and analysis techniques.
- To minimize the transportation cost of equipment by considering different project location in different location.
- To study the Break-even analysis of the equipment.

To meet the present day requirements and to complete the project within the estimated time, cost, and available resources, the need of Advanced Techniques are essential. Systematic planning and programming with effective management is necessary for timely completion of the project. Decision-making plays an important role in the construction industry. The project manager should take the decisions based on the effective cost optimization techniques, and also should rely on the knowledge and experience as well as statistical methods to execute projects.

METHODOLOGY

In order to deal with very important aspect of construction industry, optimizing constructions cost, a case is selected and the selected case study is briefly presented as follows:

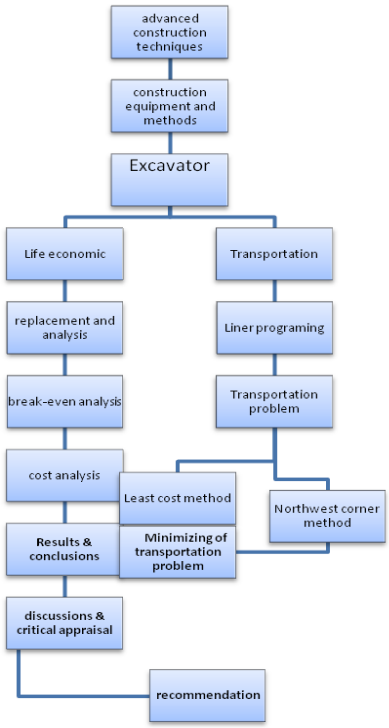
A company is considered and that company is having different work sites all over the country. Earthmover equipment is considered for detailed study of optimization of construction cost. It is also observed that number of earthmover equipment is equal to that of actual requirement in all projects. It is now necessary that a detailed study of effective utilization of available movers in all project sites. The procedure adopted to do so is as follows.

In the process, all events related to earthmover equipment in all projects are listened out. The network representation of all the projects is shown in the figures. Consolidated tables are prepared with details of requirement in each project site like dates of requirement in each project, distance between each project site, importance of the project, stage of construction in each project site. This table will enable us to see all equipment's demand and also allows us to when and where equipment is freed and is

transported to another site. The optimum transporting cost is calculated using the transportation method of linear programming.

The equipment after reaching to their destinations it is found that one machine at one of the destination sites is at bad working condition and its quality of service is poor. For this economic life of the equipment is found out and suggested whether the equipment has to be replaced or not. If it is has to replace by a new one, the Break-even analysis is also done for effective usage of the new machine. Extra cost in each stage due to these organizational adjustments is determined for all possible solutions and minimum possible total cost would be incurred extra for this organizational adjustment is worked out. Parallel to this is a detailed study of buying new equipment to counter this extra cost is also worked out.

The Schematic Representation of Methodology



Calculations to Determine the Depreciation

End of the year	Fixed Depreciation	Net Depreciation	Book value
0	182400	0	4000000
1	182400	182400	3817600
2	182400	204281	3613319
3	182400	230603	3382716
4	182400	256475	3126241
5	182400	287252	2838989
6	182400	321722	2517267
7	182400	360329	2156938
8	182400	403568	1753370
9	182400	451996	1301374
10	182400	506236	795138
	Total Depreciation	3204862	

To find the Break-even hours of the new machine

Total life time of the machine = 10 years x 365 days x 8 =29200 h

1. Cost

Fixed cost /h = 3204862/29200

= Rs. 110

Variable (Operation and Maintenance) Cost /h =Rs. 650

Total Cost /h = Rs. 760

2. Income

Rate/h = Rs. 1100

Net profit /h = Rs. 340/-

Total number of hours required to reach Break-even hours is calculated from dividing the total Depreciation with Net profit.

i.e., 3204862/340 =9426 h.

DISCUSSIONS ON TRANSPORTATION PROBLEM

Total optimum distance for transportation of equipment is determined as 2700 km from least cost method and northwest cost method. Considering Rs .45 per km the total cost of transportation comes about Rs. 121,500. Hence, we have to adopt that particular trajectory for transportation of equipment using any method, this cost is an extra expenditure for the company and it has to be considered and appropriate manipulations are to be done for profit calculations. However this is unavoidable and has to get along.

DISCUSSIONS ON ECONOMIC LIFE OF AN ASSET

It was observed that one of the machines that are transported from is not in very good condition and it is necessary that its economic life have to be determined.

This particular conclusion is made, as it was evidence from its working condition from earlier sites. The economic life of that particular machine is determined as 10 years .Already it's been in use for 3 years and though its functioning, keeping in view of importance of the project it may be required to be replaced Hence it is required to analyses further the cost incurred due to this replacement.

DISCUSSIONS ON REPLACEMENT ANALYSIS

From the result of replacement and maintenance analysis, the annual equivalent cost of Existing machine is Rs. 692,400. The annual equivalent cost of new machine is determined as Rs. 692,400. As it is very clear that annual equivalent cost of new machine is less when compared to old machine, it may be appropriate to go for the new machine.

DISCUSSIONS ON BREAK-EVEN ANALYSIS

The Break-even working hours of a new asset are determined as 9,426 h whereas total working hours of the machine is 29,200 hours. This machine is used in Hyderabad Project is Rs. 250 cr.

Let us assume that 1% of total project cost is utilized for the earth work excavation only.

Total amount to be spent on earth work is Rs. 2.5 cr. Total amount to be spent on earthwork by machinery component is Rs. 1.5 cr.

Considering minimum of three machines be employed in the site, the contribution of this new machine shall be 0.5 cr.

If 15.0 M3 of volume of earth is done by machine per hour and the rate per M3, Rs. 75/ - is considered,

Total number of working hours for the new machine in this project is = 5000000/ (15*75

4444 h.

This clearly indicates that the new machine is reaching about 40% of it break-even hours only.

In this project and it's justified to go for this option.

RECOMMENDATIONS

There are alternate methods available for finding the optimum solutions in transporting the equipment.

They are Vogel's Approximation method et, may be used to find whether the cost can further be reduced. In the solving of the transportation problem considered for case study analysis. However the condition of the equality of demand and supply is attained, the check for the no of allocations made for calculation of optimal solution is not made as the no of allocations is not equal to the m+n–1 allocations., here m x n is size of the cost matrix.

Similarly, same alternate study can be made in case of replacement analysis and also for 1 machine.

Alternatively all other possible options like using the same machine and deploying rented or new ones simultaneously may also be adopted if it's found productive.

CONCLUSION

It is evident from this paper and analysis of case studies, that construction industry can do a better job by using advanced construction techniques. Systematic data collection, analysis, reviews to monitor progress will reduce the possible errors in any project thereby avoiding all possible extra expenditure. In major construction industry, as the implementation, customer satisfaction, time management, etc., is very important, it is necessary to adopt new techniques and methods from the policy, level itself. These techniques in construction industry provide excellent support for the management in its decision-making, policy review and also assist in regular monitoring and evaluation.

From the analysis of the case study of this project work using the calculations and the results, and also from the discussions and the limitations, the following conclusions are made and they are as follows.

From the results of transportation problem, it is clear that by adopting the construction techniques the total transportation cost is Rs. 121,500 which is the optimum cost of transportation and anyone method of solving the transportation problem, i.e., Least cost method or North-West corner method, can be considered.

As the Economic life of the existing machine is calculated as 10 years, and it's already been

used for 3 years, keeping the importance of the project it may be required to replace the existing machine with new machine. Due to this the cost of the Operation and maintenance cost is reduced by 40%.

The annual equivalent cost of existing machine is Rs. 698,020. The annual equivalent cost of new machine is determined as Rs. 692,400. As it very clear that annual equivalent cost of a new machine is less when compared to old machine, it may be appropriate to go for the new machine. When the new machine has to be purchased, it is necessary that all required analysis regarding its depreciation and break-even analysis is to be done.

The break-even working hours of a new asset are determined as 9,426 h whereas total working hours of the machine is 29,200 h. The clearly indicates that the only 32.28% of total life of the machine,'' has, to be completed to reach the break – even hours.

The total number of working hours for the new machine in this project is 4444 h. This clearly indicates that the new machine is reaching about 40% of its break-even hours only in this paper and it is justified to go for this option.

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