

Identification of Factors Affecting Material Cost in Road Construction

Deepa V¹ and Sahimol Eldhose²

¹M.Tech Student, Department of Civil, Toc H Institute of Science and Technology, Arakkunnam, Ernakulam, Kerala, PIN- 682313

²Assistant Professor, Department of Civil, Toc H Institute of Science and Technology, Arakkunnam, Ernakulam, Kerala, PIN- 682313

E-mail: ¹deepamaniyur@gmail.com, ²sahimol27@gamil.com

Abstract—In a construction project, materials account for more than 40% of the total project cost. A small saving in material cost through efficient management of materials can result to a large saving in the total project cost. One of the root causes of improper material management is that materials are ordered based on the information from project schedule. Hence the study is conducted to identify the factors affecting material cost used in road construction. The study involves mainly three stages, namely factors identification, data collection and its analysis. Data collection is based on literature survey and questionnaire survey. These were analyzed and results are validated using actual case studies. Efficient planning of materials can result in substantial savings in project costs.

1. INTRODUCTION

The construction of road gives the better transportation facility around the country. For better development of the country in the construction assertive, the project management is necessary. Time and cost are the two basic parameters to control work in the execution of the road construction. Optimization is a systematic effort made to improve profit margins and obtain the best results under given circumstances. Flow of cost and its usage is very important aspect for beneficial point of view. It is necessary to develop the planning in terms of material to easy the works and risks arise in the projects. For the material cost analysis of the road works, MRP technique is used to overcome the problems raised during execution.

Material control is widely discussed area yet continues to record poor performance in terms of its effectiveness. The factors affecting material cost used in road construction are identified. This is beneficial for achieving cost effectiveness thereby improving the profit of the organization.

2. RESEARCH OBJECTIVE

The main objectives of this study is to identify factors affecting material cost used in road construction and there by achieve cost effective road construction.

3. SCOPE

Improve material management in construction site there by reducing cost.

4. METHODOLOGY

The methodology adopted for the present study is illustrated in Figure 1.

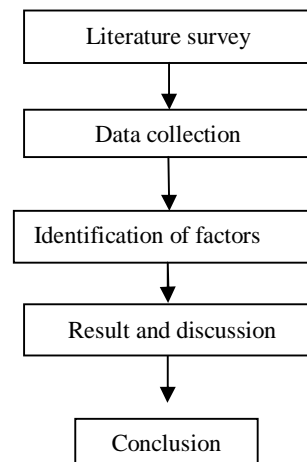


Figure 1: Research methodology

Literature survey includes citing to previous works that dealt with road construction and Material Requirement Planning and MRP techniques were also acquired. Identification of factors contains inflation factor, project schedule, quality of plans and specifications, size and type of construction project, engineering review, contingency etc. Data collection consists of material management at a road construction site, identification of major materials and factors affecting their cost used in road construction and types of pavements. Details on cost of materials, lead time and transportation cost between

source and site, quantity of materials and number of labors would thus lie as secondary concerns. Result and discussion contains importance of the identified factors and its feasibility in construction works.

4.1. Literature survey

The basic objective of construction project is to create a unique facility, product or service within the specified scope, quality, time and cost. Some road construction projects face losses due to inadequate construction management and cost performances done by the contracts. It is necessary to probe in to previous studies, some key points like major road construction materials and sections relevant to study are referred from some papers sited as follows.

Table 1: Literature survey

Literature	Findings
Amey a. Kelkar et.al (2017)	In road construction, equipment's and materials play a major role. Costs and productivity play a major role in making the project profitable to the company. Road work can improve through planning and scheduling.
Swati Singh (2017)	MRP provides a framework for handling massive amount of data on the interrelationships between raw materials. EOQ, DOQ are the best techniques of MRP. MRP system which attempts to find a feasible solution & minimize total cost.
Anuja Rajguru et.al (2016)	Cost is one of the main aspects to be considered in the planning of every project. Cost optimization is an important issue in construction project management. Problem faced by the contractors in optimizing the cost are duration of project, ever changing environment, availability of qualified expertise.
Abdallah Ali Imeti et.al (2015)	MRP is a system of production planning and inventory control, which is used to manage manufacturing processes. MRP systems are used to ensure, <ul style="list-style-type: none"> ▪ Materials are available for production, ▪ Products are available for delivery to customers ▪ Lowest possible material cost ▪ Product level is maintained in store ▪ Plan delivery schedules and purchasing activities Achieve goals in terms of quantity, quality and costs.

Urmila A Mahadik (2015)	Aim of project control is to ensure the projects finish on time, within budget and achieving other project activities. Factors affecting construction cost are, <ul style="list-style-type: none"> ▪ Construction material costs, labour wage rates ▪ Construction site conditions, inflation factor ▪ Project schedule, quality of plans and specifications ▪ Reputation of engineer ▪ Size and type of construction project ▪ Location of construction ▪ Engineering review Effective construction techniques, material and different management strategies during the execution of project plays important role in saving time as well as cost.
Dhananjay S. Patil et. al (2013)	Important parameters for good pavements are pavement design and materials. Major materials used for road construction are soil, WMM, GSB, aggregates, bitumen etc. Cost of flexible pavement construction can be reduced by placing cost effective materials instead of conventional materials.
Shanmugapriya S et.al (2013)	Time overruns and cost overruns has been a major issue in many Indian construction projects. Major causes for cost overruns are, change in material specification, high transportation cost, and escalation of materials price.
A.S. Ali et.al (2010)	A factor which contributes to cost overrun was inaccurate or poor estimation of original cost and mistakes design to control construction cost. Cost overrun is most serious problem.
Davood Gharakhani (2010)	MRP focuses on optimizing inventory. DOQ orders just as much material as required. EOQ determines the ideal order quantity. Minimize the total cost of inventory management. Ordering material in required quantity. EOQ & DOQ methods are suitable for specific demand scenarios.
K V Krishna Rao et. al (2007)	Road pavement is a structure consisting of superimposed layers of processed materials above the natural soil sub-grade. Two types of pavements are flexible and rigid. Flexible pavement consists of four layers. Their function is to distribute the applied vehicle loads to the sub-grade.

4.2. Data collection

The data relevant to this study are identified through literature survey and questionnaire survey. The questionnaire survey was carried out to gather information from technical professionals and contractors who were involved in the road construction projects.

4.3. Identification of factors

There are many factors which affect the optimization of material cost are as following:

- 1) **Quality of Plans & Specifications:** A good quality construction plans and specifications reduce the construction time by proper execution at site without delay. Any vague wording or poorly drawn plan not only causes confusion, but places doubt in the contractor’s mind which generally results in a higher construction cost. Improper planning may increase material quantity and improper specification causes variation in material cost and durability of project.
- 2) **Project Schedule:** Duration of construction project affects the cost. Increase in project duration can increase the construction project cost due to increase in indirect costs, while reduction in construction cost also increases the project cost due to increase in direct costs. Therefore, construction project schedules also need to be considered during project cost estimation.
- 3) **Inflation Factor:** A construction project can continue for years before completion. During the construction period, the cost of materials, tools, labors, equipments etc. may vary from time to time. This variation in the prices should be considered during cost estimation process. If 5% inflation cost arises it may lead to increase in actual project cost than estimated.
- 4) **Size and Type of Construction Project:** For a large construction project, there can be high demand for workforce, materials and equipments. These may incur extra costs such as projects and also for the type of construction project where specialized workforce is required. As size of work increases the quantity of material required also increases, which leads to variation in the total cost.
- 5) **Skill and Experience:** Technical review of construction project is necessary to make sure that the project will serve the required purpose with optimum operational and maintenance cost. Proper guiding and review reduces the cost than improper work making excess cost.
- 6) **Contingency:** It is always advisable to add at least 10% contingency towards the total project costs for unforeseen costs and inflation.

4.3.1. Case study: The case study is conducted during the construction of village roads in Calicut district.

Table 2: Identification of factors

Factor	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Quality of Plans & Specifications	✓	✓	✓	✓	✓	✓
Project Schedule	Excel	Excel	Excel	Excel	Excel	Excel
Inflation Factor	0.9%	0.1%	0.2%	0.15%	0.2%	0.3%
Size and Type of Construction Project	High	Medium	Medium	Medium	Medium	Medium
Skill and Experience	Senior project engineer, site engineer, overseer, DLR, A class, C class & Non members	Senior project engineer, site engineer, overseer, DLR, A class, C class & Non members	Senior project engineer, site engineer, overseer, DLR, A class, C class & Non members	Senior project engineer, site engineer, overseer, DLR, A class, C class & Non members	Senior project engineer, site engineer, overseer, DLR, A class, C class & Non members	Senior project engineer, site engineer, overseer, DLR, A class, C class & Non members
Contingency	✓	✓	✓	✓	✓	✓

Inflation factors such as carrying cost, holding cost, ordering cost, transportation cost may require additional cost, which increases the material cost and thereafter increase in total project cost. So it is necessary to evaluate inflation factors before going through the construction works. Better control on inflation factors can reduce the total material cost.

Carrying cost or holding cost means the cost required for holding the items. Ordering cost refers to the cost incurred for placing an order for a material and cost for transporting the materials to the work site is referred as transportation cost. Variations in these costs will be reflected to the inflation factors.

4.4. Result

Inflation factors play an important role in material cost optimization. For cost effective material purchasing the inflation factors should be considered to be minimum. Quality of plans & specifications, project schedule, size and type of construction project, skill and experience and contingency also have an influence on material cost.

5. CONCLUSION

The planning of materials in road construction is considerably a complex process. In this paper, the factors affecting material cost in road construction is identified through literature and questionnaire survey. Mainly affecting the factor on cost of project is delay in project and material. Material cost can be reduced by minimizing the inflation factors such as holding cost, carrying cost, ordering cost, transportation cost etc. As the size and type of project varies the inflation factors also changes in accordance with it.

REFERENCES

- [1] Abdallah Ali Imetieg. Miroslav Lutova. (2015), "Project Scheduling Method With Time Using Mrp System – A Case Study: Construction Project In Libya", *The European Journal Of Applied Economics*, pp 58-66, ISSN 2406-2588.
- [2] Adelia Chandradevi. Nia Budi Puspitasari. (2016), "Material Requirement Planning (MRP)", *Performa*, Vol. 15, No.1: 77-86.
- [3] Ajinkya Kolekar. Vineet Gosrani. (2017), "MRP using DOQ and EOQ IoT Sizing Techniques", *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 6, Issue 3.
- [4] Amey, A, Kelkar. Pankaj Suresh Rayamane. (2017), "Productivity Escalation and Cost Optimisation of Equipment's used in Pavement Construction", *International Research Journal of Engineering and Technology (IRJET)*, Volume: 04 Issue: 09, e-ISSN: 2395-0056.
- [5] Anuja Rajguru. Parag Mahatme. (2016), "Effective Techniques In Cost Optimization Of Construction Projects", *International Journal of Informative & Futuristic Research*, Volume - 3, Issue - 5, ISSN: 2347-1697.
- [6] Anuja Rajguru . Parag Mahatme. (2015), "Effective Techniques In Cost Optimization Of Construction Project: An Review", *International Journal of Research in Engineering and Technology*, Volume: 04 Issue: 03, pp 464-468.
- [7] Ashwija, K, C. Maheshwar, S, Maregoudru. Monish Kumar, K. Sparsha, B, P. (2017), "Cost Analysis of Road Construction Project by Earned Value Analysis using Primavera", *International Research Journal of Engineering and Technology (IRJET)*, Volume: 04 Issue: 07, e-ISSN: 2395-0056.
- [8] Bindu, K. Jayasanthosh Kumar, U. (2016), "Resource Optimization in Road Construction Projects", *Resource Optimization in Road Construction Projects*, Volume 4, Issue 2, ISSN: 2321-9939.
- [9] Prof. Chetna, M, Vyas. Khyomesh, V, Patel. (2011), "Construction Materials Management on Project Sites", *National Conference on Recent Trends in Engineering & Technology*.
- [10] Davood Gharakhani. (2010), "Optimization of material requirement planning by Goal programming model", *Asian Journal Of Management Research*, Volume 2, Issue 1.
- [11] Donyavi S, Flanagan R (2009), "The impact of effective material management on construction site performance for small and medium sized construction enterprises", *25th Annual ARCOM Conference*, Nottingham, UK, Association of Researchers in Construction Management.
- [12] Jonas Wennstrom. (2014), "Life Cycle Costing in Road Planning and Management: A Case Study on Collision-free Roads", TRITA-BKN, Bulletin 125- 2014, KTH School of ABE ISSN 1103-4270.
- [13]. Krishna Rao, K, V. Tom, V, Mathe . (2007), "Introduction to pavement design", NPTEL.
- [14] Lester, A, Hoel. Rod, E, Turochy. Robert' S, Doty. (oct 2001), "Highway Project Cost Estimati Ng Methods Used In The Planning Stage Of Project Development", *Virginia Transportation Research Council ,VTRC 02-TAR3*.
- [15] "Managing Maintenance of Rural Roads in India", National Rural Roads Development Agency Ministry of Rural Development Government of India (2014).
- [16] Susan Rose, Binu Sara Mathew, Kuncheria Palampoikayil Isaac (2017), "Development Of Probabilistic Deterioration Models And Prioritisation Of Low Volume Roads For Maintenance", *International Journal for Traffic and Transport Engineering*, pp 216-231.
- [17] Swati Singh. (2017), "Evaluation of Different Lot Sizing Techniques in a MRP System", *International Journal of Advance Engineering and Research Development (IJAERD)*, e-ISSN: 2348 – 4470.
- [18] Tam W. Y (2011) "Cost Effectiveness Of Using Low Cost Housing Technologies In Construction" *Science Direct*.
- [19] Tom V Mathew, Krishna Rao K V (2007), "Introduction To Pavement Design", *Introduction to Transportation Engineering*, NPTEL, pp 19.1- 19.7.
- [20] United States Department Of Agriculture (2013 March), "Cost Estimating Guide for Road Construction", Forest Service Northern Region Engineering Cost.
- [21] Urmila A Mahadik. (sep 2015), "Cost Reduction in Construction Project", *International Journal of Engineering Technology, Management and Applied Sciences*, Volume 3, Special Issue, ISSN 2349-4476.