CHAPTER 115

Review of Project Cost Controlling Techniques for Construction Projects

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ABSTRACT

Project cost management is one of the significant knowledge areas in project management. Project cost control plays an important part to ensure that projects are completed within the specified budget. The objective of this study is to review various techniques used in controlling project cost. The scope of this study is limited to construction projects. Critical analysis and evaluation of the literature is conducted to examine the best practices. The focus of this paper is to identify the common issues and challenges experienced by construction professionals, leading to project cost overruns. This study will be useful for various stakeholders such as clients/owners, consultants, government and construction companies dealing with construction projects. The study attempts to provide better cost controlling techniques for smooth execution and implementation of construction projects.

Keywords: Project management; Cost control; Construction projects.

1.0 Introduction

The construction sector across the world plays a crucial role in economy building of a nation. Being one of the leading sectors in the world, the sector somewhat still is following conventional approach towards project cost estimations. The complexity and uniqueness of each and every project in the construction sector attributed to geographical, demo-graphical, environmental, and technical factors makes it quite difficult to complete the project within the stipulated cost budget with high quality results, resulting in the cost overruns. Cost overruns also known as budget overruns is considered as one of the major issues of the construction industry worldwide. As it is considered a problem both in developed and developing nations, it becomes crucial to address this issue on a larger scale to mitigate the issue. Application of project cost monitoring and control techniques needs to be implemented on the projects to decline the problem of cost overruns. It is basically a difference between the estimated budget of the project during the phase of planning and the actual cost which is during the execution phase of the project. It becomes crucial to address this issue on a larger scale. Application of project cost monitoring and control techniques needs to be implemented on the projects to decline the problems of cost overruns.

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Rising costs and budgets are usually a commonplace in the construction industry, with 9 out of 10 projects experiencing cost overruns, according to the study done by Flyvbjerg (2002). According to the research conducted by Aftab Hameed Memon in 2012, 92% of construction projects experience cost overrun, but only 8% of projects can achieve completion within the stipulated duration. Report on tools and techniques in controlling cost overruns in the construction sector will help the industry to opt for best technique in mitigating the cost overruns in the projects of construction sector.

2.0 Research Objectives and Methodology

Project cost control plays an important part to ensure that projects are completed within the specified budget. The objective of this study is to:

- Investigate the problems of cost overrun in the construction projects.
- Analyze the efficiency of cost controlling techniques in construction projects.

The above research objectives are investigated by referring to the secondary data in form of research publications.

3.0 Literature Review

A thorough review of literature was done using keywords like “Cost control”, “Cost overruns”, and “Tools and Techniques + cost control + cost overruns” in renowned journals and research papers. We have reviewed total of 32 research papers, out of which, only 26 were aligning with our research objectives. We have then categorized these selected papers into 8 segments as follows:

3.1 Earned value management

Premalal *et al.* (2016) stated that completion of any construction project not only depends on the accurate planning and scheduling of the project but also on the effective monitoring, controlling, and updation of cash flow. To gather information, the authors conducted a survey using questionnaires, interviews, and data analysis. This was used to identify the tools and techniques used by the contactors and sub-contractors to control and monitor the project cost. Out of all the seven techniques used, most common are Earned Value Management, Microsoft Project, and Daily material and Labour Controlling. Contractors and sub-contractors use monthly cost summary sheet, weekly machinery hire cost statements, and weekly direct labour cost statement documents for monitoring the project cashflow.

According to Marrero *et al.* (2014), project planning and project cost control are still considered as the open-ended issue as far as cost overruns in the construction sector is concerned. According to the authors, Gantt chart is the most used technique followed by Critical Path Method (CPM) for cost controlling.

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However, when it comes to effectiveness, Statistical Process Control (SPC) combined with Earned Value Management System (EVMS) performs better to give the desired results. The result of this combination of techniques are reliable as cost data is used and only spreadsheets is needed when it comes to software. Bhosekar *et al.* (2012) have performed slightly partial comprehensive study on project duration forecasting methods, thoroughly analysing Earned Value Metrics, statistical approaches to Earned Value Management (EVM), and the To Complete Performance Index (TCPI). The paper focuses on the application of Earned Value Analysis (EVA) by using several project management processes, which include project budget and performance control, and shows that these processes can improve project performance by reducing costs. The conclusions showcase the key role of EVA in project management, expected especially for construction contractors, contributing to effective management costs and, hence, meeting outcomes.

Dhawale *et al.* (2012) in their study articulated the employment of Earned Value Management (EVM) on construction projects, centering on cost control and progress monitoring. The authors push hard for the development of a complete project schedule which is a must have, has approved resource assignments and cost estimates. Furthermore, they urge the project team to rigorously control the schedule to ensure accuracy in variance analysis. The research could be used to promote the feasibility of EVM for improving monitoring efficiency of projects in terms of slower delays and better efficiency.

According to Jung *et al.* (2007), construction project performance can be determined by three factors- Time, Cost and Quality. Researchers and practitioners have been facing the issue with the integration of time control and cost control system. Earned Value Management System (EVMS) act as an efficient solution for this problem by providing detailed standards and procedures and maintaining data integrity. Measuring the progress of the project plays a vital role in EVMS. To identify the work activities along with the project measurement, Standard Progress Measurement System (SPMS) should be developed. Yu *et al.* (2022) says that cost control is more dominant in the construction phase of the project and the project cost can be reduced significantly if mandatory precautions are taken.

The authors identified and analysed the causes of cost overruns and methods adopted for cost control by the UK and Iraqi construction industry. It was analysed that use of cost control of the project is mainly restricted by the adoption of modern-day concepts and methods. Authors developed early cost earning system for the construction projects based on Earned Value Management System (EVMS) to deal with the causes. Author proposed a dynamic cost control system based on rough set theory for coastal engineering projects. Index system should be established based on the principal of Indicator Selection. The Cost Control Index Evaluation should be comprehensive and must have typical representation. Index Evaluation system is determined on the basis of direct and indirect costs. Direct cost is much higher as compared to indirect cost in the construction projects.

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3.2 Building Information Modeling (BIM) system

Zhao *et al.* (2014) in his paper emphasized that accuracy of estimation and budgeting is the main step towards the project cost control. Building Information Modeling (BIM) is nowadays an effective tool for project information delivery and extraction. 2D CAD drawings are less effective in determining the accurate cost and information of the project as compared to BIM Model. Although there are series of limitations with implementation of BIM model, such as complexity, cost, and sufficient expertise and training, it cannot be denied that BIM has a very high potential with its visualization, accuracy in information sharing, and automation.

As per the research done by Smith (2016), BIM presents both challenges and opportunities for the project manager for cost controlling. The main problem lies in the fact that designers provide limited information of the models they design to the Quantity Surveyor. This makes it difficult for the QS team to find and rectify the errors in the model. The main requirement of BIM model is accurate and comprehensive data. Data management and training to the site team is also crucial. He states that full potential of BIM has not been utilized yet.

Abdel-Hamid (2023) illustrated through a case study how integrating BIM technologies to the complete life cycle cost of a building project may shorten project durations and save costs. The study focuses on how five BIM aspects are used to manage project expenses. The many elements or layers of data that may be incorporated in a BIM model, such as facility management, sustainability, time, space, and cost, are referred to as the five dimensions of BIM. Recommendations for incorporating BIM into cost control procedures to enhance cost efficiencies by 9.27% of the original cost design.

Wen (2014) combined Lean Construction theory with BIM technology to perform an extensive study on cost control in construction projects. The study method used a case study approach focusing on how Lean Construction theory and BIM technology work to improve construction plans, anticipate construction issues in advance, oversee project advancement and guarantee quality, safety and project deadlines. The real-world example, from the J2 5 initiative, in Pearl River New City showcased how Lean Construction and BIM technology were effectively utilized to manage costs and ensure the success of the project. The research emphasized how Lean Construction and BIM technology play a part in optimizing project outcomes, reducing inefficiencies and efficiently overseeing construction expenses. The final remarks underscored the benefits of combining Lean Construction principles with BIM technology to improve the efficiency of construction projects, minimize tasks, manage costs effectively and ultimately fulfill customer needs.

3.3 Activity Based Costing (ABC)

Due to lack of cost accuracy and relevance, in place of Traditional Costing method, a new costing method know as Activity based costing (ABC) has been evolved (Kim *et al.*, 2001). ABC has two advantages - Prevention of cost distortion and reduction in wastages. Using ABC, it is easy to determine the activities where there are cost overruns and further it can be mitigated

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accordingly. The management can extract various other information other that cost information of a project through ABC like quality information and process information. Hafez *et al.* (2017) discusses challenges in cost control in construction projects, emphasizing the importance of Activity Based Costing (ABC).

The study highlights the need for better knowledge in tender pricing, cost estimation, and decision-making through the application of ABC. The study pointed out that the biggest difficulties in keeping project costs under control were things like change orders, mistakes in the design, economic situations, delays in the project, and rises in material prices. ABC helps to understand how to price bids in a better way, estimate costs more accurately, and keep track of costs more effectively. Activity based cost, target cost, value engineering, etc. can be used in modern cost management methods, according to Hafez (2015). In this study, Hafez also gives a case study of a project consist of five different floors and amphitheatre buildings in Egypt. They found that the main problem with traditional method is cost are directly assigned to the project, and second problem is calculation of cost over heads.

The result identified how different elements of cost control approach can be used in construction sector project such as activity-based costing. This method is very effective in calculation of cost over heads because of value adding activity and non-value adding activity and calculate cost over heads accordingly. Al-Jibouri (2003) explored three cost control monitoring pillars in the literature: the leading margin, variances method, and activity-based ratios method. This study focused on the role of choosing a monitoring system that is commensurate to the quantity of data required and which it is capable of being a communication tool. The latest research on this subject has been carried out by Al-Jibouri (2003) who has used the simulation approach. According to his study findings, activity-based ratios approach works better on short-term projects whereas the other methods appear to be more suitable for long-term projects. The experiment pinpointed the importance of the use of monitoring systems to detect variations from planned expenditure and proficiency.

3.4 Value engineering

Li *et al.* (2021) emphasised that BIM and Value Engineering (VE) plays vital role in construction cost control. The study depicted the advantages of BIM targeted at clash detection, 3D modeling, and cost data generation alongside VE's role to optimize resources and imply process changes in construction processes. The report was followed by recommendations to add value to the project, reduce completion time, and improve the quality in totality. Future research as to real data/time analysis of safety, schedule and quality aspects was called upon to come up with a complete framework for construction companies to apply VE.

3.5 Cost management software and AI integration

Li (2021) studied a case on a high-rise building construction project in China to verify the framework and showcase how BIM can be integrated with Virtual Environment. Results

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indicate that modification of design and information extraction, including cost data, are facilitated by the implementation of BIM in virtual environment. BIM has the potential to improve virtual environment practice in several ways. Functional analysis and material and building element cost control are only two of the many uses for VE in construction projects. Other uses for VE include assessing green residential structures to save on construction and energy costs and assessing the functionality and cost of new transportation projects. Integration of BIM and Virtual Environments has been shown to improve productivity in several studies. The cost and duration of the projects have been reduced by 10% through this method. The results show that in order to enhance the performance and functionality of building projects before, at, or after a construction phase, combining BIM with Virtual Environments is worth it.

Tembo *et al.* (2024) highlighted the significance of effective cost management in the Zambian Construction Industry, emphasizing the need to address poor cost performance. It underscores the importance of modern cost management tools like smart systems, big data, and BIM to improve efficiency and reliability in cost management practices. This study helped understand how construction costs are handled in Zambia. To improve accuracy and efficiency, modern techniques such as smart systems and cost estimating software are suggested. For future research, it's recommended to focus on higher-grade contractors and understand why there's resistance to using digital cost management methods. Also, there's a need to update training and education in universities to teach modern cost management techniques effectively, emphasizing the importance of IoT and smart systems. Vasista (2017) research highlights the importance of project cost management in construction, emphasizing the impact of estimation accuracy and the need for innovative techniques like Artificial Intelligence in decision-making.

It aims to explore existing models for cost management, focusing on three key stages: pre-design, post-detailed design, and during project execution, along with CRASP methodology for validation. CRASP model is a management methodology model to determine the project management success, by providing a comprehensive approach to access and enhance the project performance by monitoring and control. It says that having good engineering judgment is crucial, and it's also important to use automation and smart techniques in construction projects. They use a flowchart to explain how they did their research, and they look at different ideas in the literature, like Artificial Intelligence and Expert System Techniques, to help with making decisions about managing and controlling costs in construction.

3.6 Cost and risk integration techniques

Javier (2010) combines earned value management and risk management for project control and monitoring. In this study the authors compared the cost and schedule variance with variance due to risk given in risk analysis. Real projects have uncertainties and variability in every aspect of their operations. By opting of quantitative risk analysis, the author found the probability function and distribution of both project cost and schedule. The Monte Carlo simulation technique is an effective way to manage project uncertainty. The simulated project

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resulted into various values of activity costs and times after estimating probability distributions of costs and durations. The Cost Control Index (CCoI) and Schedule Control Index (SCoI) are two new metrics that were established to help integrate EVM and Project Risk Management.

Olawale (2010) focus on integration of risk management with cost control. This study was carried out using an integration of quantitative and qualitative methodologies. The top five reasons of UK construction industry that impede time and cost control were: design changes; risks and unforeseen challenges; erroneous project schedule estimations; complexity of activities; and non-performance of subcontractors. The most significant obstacle that practitioners believe impedes the capacity for regulation of construction project time and expense was design change. In this paper, a strong relation was shown between the issues impeding both cost control and time control.

Jackson (2003) made thorough research on cost management techniques in project management practiced in the electricity Industry. The author concentrated particularly on case of one Australian electric corporation. The study underscored the reluctance to establishing the cost management with small-scale projects which resulted in increased risks for the successful financial performance. These points highlighted the use of informal estimations of risks as well as applying cost contingency measures to deal with these obstacles. The audit stressed adequacy of reserves while estimating and shedding the light on the amount of assets to be used for emergencies. The findings were revealing a disparity in levels of understanding and application of cost management strategies, thereby, reminding us of the significance of decision-making and risk management skills to ensure the success of project budget performance.

3.7 Statistical and forecasting techniques

Bhosekar *et al.* (2012) have performed slightly partial comprehensive study on project duration forecasting methods, thoroughly analysing Earned Value Metrics, statistical approaches to Earned Value Management (EVM), and the To Complete Performance Index (TCPI). This research tests the effectiveness of EVA tools that have been designed in Visual Studio against the industry-standard products, for example, MS Project 2007 and Primavera P6. A strong correlation between the solutions was found. Cooray *et al.* (2018) in their research emphasized on the cost control amongst other techniques in the construction projects in Sri Lanka. The study goal is to know whether or not there are cost overruns and to determine how various project control methods and engineering software contribute to the success of a project. The cost control was a key element in the construction of the business. For instance, lessons on Earned value management (EVM), Gantt chart, Program evaluation and Review Technique (PERT), and software tools like Asta power project and Primavera were utilized. The conclusions demonstrated the significance of cooperation mechanisms of cost control to eliminate excessive costs and guarantee on-time project success in Sri Lankan building industry.

Shanmugapriya *et al.* (2013) investigated significant factors leading to time and cost overruns in Indian construction projects, identifying major causes like material market rate and

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high transportation costs. It emphasized the importance of addressing key factors such as contract modifications and escalation of material prices to mitigate time and cost overruns. The study pinpointed material market rate fluctuations, contract modifications, stringent quality requirements, project location challenges, and reliance on inexperienced staff as major contributors to time and cost overruns in Indian construction projects. Recommendations were provided to address these issues, urging contractors to vigilantly monitor material prices, ensure timely delivery, and appoint competent staff for effective project management. Owners were advised to revise bid documents, ensure prompt progress payments, and engage skilled project managers for comprehensive oversight. Consultants were encouraged to expedite the review and approval of design documents, hire qualified technical personnel, and maintain flexibility in assessing contractor works to mitigate delays and cost escalations. These recommendations underscore the importance of proactive measures in curbing overruns and enhancing project efficiency within the Indian construction industry.

The study by Bahaudin *et al.* (2012) explores the inadequacies of current cost control practices in Malaysian construction, revealing a reliance on traditional corrective methods. It emphasizes the need for a proactive approach to cost control to anticipate and prevent cost overruns in construction projects. The research methodology employed in the paper is qualitative, using a semi-grounded theory approach to examine construction cost control practices in Malaysia. Grounded theory is utilized to uncover theories implicit in the data rather than testing hypotheses, focusing on what theory explains the research situation as it is. The study followed a three-stage process for data collection, analysis, and interpretation, ensuring a thorough investigation of prevalent cost control practices and procedures in the Malaysian construction sector. While they express satisfaction with their current approach, there is room for improvement, especially in early detection of potential cost overruns.

Andrea (2016) did the literature review and analysed the results of nine empirical studies conducted in four different construction firms of Brazil. The main objective of the research was to propose a model of planning and cost control for construction firms. They conducted their study in small and medium building projects. Construction companies' traditional cost management systems have a number of issues, many of which have been extensively covered in the literature, their information is typically delivered too late and is frequently too skewed and aggregated to be useful for production management. The model's scope was restricted to construction projects executed by small and medium-sized businesses that engaged in both production and product development. The outcome of model suggests to integrate the three most effective cost management techniques: operational cost estimation, s-curve and target costing.

3.8 Effective project management

Otim *et al.* (2006) investigated cost control techniques in Uganda's building construction, identifying common issues like delays, lack of materials, and poor management.

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The study aims to identify and propose effective cost control techniques for building construction in Uganda, emphasizing the importance of managing construction costs to prevent losses and project failures. It focuses on the challenges faced by contractors in controlling costs on construction sites, explores commonly used cost control techniques, and suggests remedies to enhance cost control practices in the industry. Overall, the study suggests that better training and management could help Ugandan construction projects stay on budget and schedule. The study reveals that the primary challenge lies not in the absence of techniques but rather in the insufficient knowledge of these methods, poor management of cost control practices, and inadequate site organization and supervision. The research underscores the importance of continuous training for contractors in construction project management to address the lack of knowledge of cost control techniques and the necessity for effective supervision and communication on construction sites.

The study by Ali *et al.* (2022) focuses on cost and time management in construction projects in Khartoum State, Sudan, highlighting natural, political, and economic factors affecting project delays and the importance of coordination and fund management. It emphasizes the need for good coordination, monitoring, and appropriate fund management to reduce delays and cost overruns in construction projects in Khartoum State, Sudan. Analysis of the collected data was performed using the Statistical Package for the Social Sciences (SPSS) software to derive statistical insights and draw conclusions from the responses. It was found that unexpected economic changes, government actions, and natural events were the biggest reasons why construction projects ran late. Material delivery delays caused by worker shortages and price hikes were also common problems. By working together better and managing money wisely, those involved in construction projects can keep things on track and on budget.

4.0 Conclusions and Future Recommendations

The study tried to find answers to the research objectives i.e. 1- Investigating the problems of cost overruns in the construction projects. 2- Analysing the efficiency of cost controlling techniques in construction projects. A thorough literature review was conducted to provide the research objectives findings. Our research tried to analyse the efficiency of tools and techniques for project cost control along with the major challenges in keeping the project under budget and schedule. The primary challenges include improper project budgeting, estimation and planning, lack of contingency, lack of proper risk assessment, and rework. It is evident that to control the project cost effectively, systematic approaches are required to integrate real time project tracking in terms of cost and schedule with proper planning and budgeting. Project cost monitoring and controlling needs to be a continuous process throughout the project life cycle to accurately forecast the risk and timely reporting to the planning team.

Overall, the review emphasizes the importance of combining advanced methodologies such as BIM, VE along with earned value analysis and traditional techniques to improve cost

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control. The review highlights the need for accurate data, proactive planning, and continuous monitoring to address the construction industry's ongoing cost overrun challenges. The future research can be directed towards getting more insights through semi structured interviews, focussing on the practices adopted by industry professionals for controlling the project cost.

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