Optimizing Project Performance in Precast Building Construction: The Role of Earned Value Analysis

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***Abstract*— In precast building construction, ensuring project performance is critical for meeting cost, schedule, and quality objectives. Earned Value Analysis (EVA) has emerged as a powerful tool for assessing and managing project performance by integrating scope, cost, and schedule data. This paper explores the role of EVA in optimizing project performance in precast building construction, providing a structured method for real-time monitoring and forecasting of project outcomes. Through the application of EVA, project managers can identify variances early, enabling timely corrective actions. The study highlights key benefits, such as enhanced decision-making, improved resource allocation, and increased accountability. Furthermore, the research discusses the challenges specific to precast construction, including complex logistics and coordination among stakeholders, and how EVA can mitigate these issues. The findings suggest that EVA can significantly contribute to the success of precast building projects by facilitating better control, reducing risks, and ensuring timely delivery within budget constraints.**

Keyword: Precast building construction, Earn Value Analysis, Risk Management

1. INTRODUCTION

The construction industry, particularly in precast building projects, faces challenges related to meeting tight schedules, managing costs, and ensuring high-quality standards. Traditional methods of project monitoring, such as progress tracking and manual reporting, are often inadequate for addressing these complexities. Earned Value Analysis (EVA) offers a systematic approach that integrates scope, cost, and schedule data, allowing project managers to assess the performance and health of a project in real time. This research aims to explore how EVA can optimize performance in precast building construction, helping to reduce risks, control costs, and meet deadlines.

Precast concrete is a construction method that involves manufacturing concrete components in a controlled factory environment, which are then transported and assembled at the construction site. This approach has gained widespread acceptance in the construction industry due to its numerous advantages over traditional on-site concrete pouring methods. The precast process allows for the creation of highly durable, precise, and cost-effective components that can be used in a wide range of building types, from residential and commercial structures to industrial buildings and infrastructure.

One of the key benefits of precast concrete is its ability to enhance the speed and efficiency of construction projects. Since many components, such as walls, floors, beams, and columns, are produced off-site while foundation work is being prepared at the construction site, the overall project timeline is significantly shortened. This modular construction method also reduces on-site labor and material waste, contributing to cost savings and sustainability.

Precast concrete offers several inherent advantages, such as improved quality control, consistency, and strength due to the controlled manufacturing environment. Additionally, it can be molded into a variety of shapes and sizes, allowing for architectural flexibility and the creation of complex designs that may be difficult or costly to achieve with traditional methods. Furthermore, precast components are often designed to meet specific performance requirements, such as fire resistance, sound insulation, and thermal efficiency, making them suitable for a variety of applications.

Despite its many advantages, the use of precast concrete does present some challenges. These include transportation and logistics issues related to delivering

large, heavy components to the construction site and the need for precise coordination between the manufacturing plant and the construction team. Additionally, the initial cost of manufacturing the precast elements can be higher compared to traditional methods, although these costs are often offset by the reduction in labor and time required during the construction process.

As the construction industry continues to embrace modern methods and strive for greater efficiency, precast concrete plays an increasingly important role. By offering high-quality, customizable, and sustainable solutions, precast concrete continues to be a preferred choice for many builders and developers around the world.

The introduction would likely highlight the need for EVM in precast construction, emphasizing its role in:

- Ensuring timely project delivery,
- Controlling costs,
- Managing project scope,
- Identifying performance deviations early on.

2. STATE OF DEVELOPMENT

A lot of research works have been done on the Constraint analysis,

Chan Jung Park and Yong Cheol Yang (2007) studied the "Management of daily progress in a construction project of multiple apartment buildings" and proposed a Work Package model for the managing the progress work at immediate intervals. This model enables the project authorities to manage the project without any extra computational works.

Jing Liu and Ming Lu (2019) made study on "Robust dual level optimization framework for resource constrained multi project scheduling a prefabrication facility in construction" and this research provided the advancements in resource planning and project scheduling compared to current practice. Also mentioned about evaluation of cost and optimum time required at different stages of three buildings using MS Project

M.G.Syal, F. Grobler (2013) studied the "Construction Planning Process model for Small and medium builders" and developed a framework model for builders that provide guidance and steps to make quick decisions on time and cost aspects of the construction project.

Mathieu Wauters, Mario Vanhoucke (2015) carried out "Study of the stability of Earned Value Management forecasting" which focus on the stability on the methods of forecasting in Earn Value management system and concluded that the comparison of empirical validation and computational results are moreover same.

Suqrat Babar, Bilal Ayub (2017) made study on "Estimated Cost at Completion: Integrating Risk into Earned value Management" investigated and presented the performance of EVM parameters to measure the predictions and progress of the project. Thus providing EVMS to the users as a better tool for measuring the project performance.

Khalid Hyari and Khaled El-Rayes has carried out a study on "optimal planning and scheduling for repetitive construction projects" and provided an optimization model which consists of multiple objectives for planning and scheduling of construction projects. This provides the planning engineers ease to generate and evaluate the plans which are used to minimize the duration of the project with the limited number of workers. The optimization model has worked on three modules, namely scheduling module, optimization module, ranking module, and describes the developing the schedules on the algorithm basis, which is effective for planning and scheduling in repetitive construction projects. The application example of three spans long bridge has been used to verify the usage of the model. The presented model is implemented in the bridge and analyzed. It has been concluded that the model has been new and unique for construction planners for planning and Scheduling and also proven to be useful for repetitive construction projects.

M.G.Syal and F.Grobler (2013) studied the "Construction Planning Process model for Small and medium builders" and developed a framework model for builders that provide guidance and steps to make quick decisions on time and cost aspects of the construction project. It also highlighted the importance of project planning and scheduling in construction projects for its development stage and hand over stage. So the framework has been laid on the important stages of construction. This research has worked on the objectives, such as highlighting the importance of construction planning and Scheduling, development of construction process model (CPP), which represents the

micro-level steps in construction planning. The CPP Process model has invented with the usage of computer applications, also with our conventional knowledge. The CPP process model is a framework that denotes the sequence of all construction activities used in project completion. It involves the estimation information, design stages, time and cost plan generations, and coordination of client details. All the works to be carried out in construction is covered in the process model. The process model representing the microlevel steps is seen to be very useful for the small and medium scale contractors and builders. The process model involves basic construction project management items such as cost, time, and work. It has been concluded that the CPP process model can serve the authorities which involve in project planning and execution.

T. Subramani, P.S.Sruthi, and M.Kavitha carried out a study on "Causes of cost overruns in construction" and stated that the cost overrun is a major problem in construction projects which is arising due to improper and ineffective planning and Scheduling. So, the research has intended to identify the cost overruns and some suggestions to overcome it. The questionnaire survey has been conducted, which has 30 questions and circulated to 35 industrial members such as clients, engineers, and contractors, and owners. Out of 35, 30 were filled and received with an 85.71% response rate. The answers from the survey have been analyzed by Spear-man Rank Co-relation analysis and found that poor project management, poor decision-making skills, an increase in the price of resources and land acquisition problems, more time-consuming in estimating and design of structures leads to the cost overruns.

Chan Jung Park and Yong Cheol Yang (2007) studied the "Management of daily progress in a construction project of multiple apartment buildings" and proposed a Work Package model for managing the progress work at immediate intervalsin South Korea. This model enables the project authorities to manage the project without any extra computational works. The model consists of recommendations presented by the authors for the calculation of budgeted cost values, which is associated with activities, duration, and costs. The planned Value and earned Value are thoroughly researched, and all possible values have been observed by the trial and error method. The work describes the Schedule and cost that are interrelated to each other. It is said that Scheduling and tracking have to be done continuously in a timely manner. The measurement of work progress cost control and schedule control integration is reviewed, and the work package model is prepared after a thorough and full investigation of current practices as well as the method of the Scheduling of construction projects. It has been concluded that the work package model can be used to manage the construction of multi-apartment buildings with an increase in practicability and also by not lowering the quality of theoretical rationale.PM Wale conducted a study on "planning and Scheduling of projects using MSP (Case study building in India) and highlighted the importance of the planning and Scheduling in the modern tool rather than following the traditional approach. So, the author has planneda construction project in M.S. Excel as a traditional method and in another modern tool, Microsoft Project. Data has been collected from all possible sources such as magazines, journals, dissertations, and thesis, etc. All the criteria's such as labor productivity, climatic conditions, material accessibility are considered for the Scheduling. After scheduling by proper sequential order with all relationships provided to them, the project activities are analyzed and cracked. At the time of crashing the project activities, the total slack time is noted, and extra attention is also given to the critical path. Then the analysis is carried out, and results are discussed. It has been concluded that the duration of the project can be minimized while scheduling in the modern tool, whereas the project is taking an additional number of days in a traditionally used tool.

Jing Liu and Ming Lu (2019) made a study on "Robust dual-level optimization framework for resource-constrained multi-project scheduling a prefabrication facility in construction," and this research provided the advancements in resource planning and project scheduling compared to current practice in prefabrication facility. The prefabrication facility is where the large size of construction components are produced in a controlled environment or workplace. The author has been proposed a dual-level framework for Scheduling, which enables the engineers to make quick decisions and reduce dependencies with respect to the resources. The framework model has shown the difference between open source scheduling platform and single source scheduling approach. Also mentioned about the evaluation of cost and optimum time required at different stages of three buildings using the M.S.

Project. This model has proven to be very useful for prefabrication managers to make feasible construction work schedules by also ensuring the teamwork continuity with effective resource utilization. The case study has been taken to prove the applicability of the model, which consists of two projects with 25 activities and 30 activities. As a result, the model has proven to be useful for the allocation of resources to prefabrication projects and reduce the resource transfer between projects

Sandhya Suresh and Ganapathy Ramasamy made a study on "Analysis of Project performance using earn value analysis" and described the importance of earn value management in construction and defined the key components of earn value analysis in detail. This work used a real-time project in Kerala for its research. And implemented the earn value analysis after scheduling in Microsoft project. Earn value analysis is used to keep the project in track with respect to the triple constraints such as time, cost, and scope. The research has done to fulfill the objectives, such as improving the project management system of the ongoing construction of hospital buildings to keep the project on time and within the allocated budget. It has been concluded that the earn value management has proven to be the warning system that enables the project managers to forecast before the problem arises. It can change the scope of the project and helps project managers for effective project management in their respective construction activities.

3. RESEARCH METHODOLOGY

The project is described by using the flowchart of methodology of the project work is as follows:
i. Defining the scope of the project
ii. Collection of data
iii. Defining WBS in Microsoft project
iv. Define and assign resources with the cost
v. Update project using baselines
vi. Perform earn value analysis
vii. Results and discussion

4. CONCLUSION

The methodology for implementing Earned Value Management (EVM) in precast concrete construction involves:

- A clear definition of the project scope, WBS, and schedule.
- Detailed tracking of progress through Earned Value (EV), Actual Cost (AC), and Planned Value (PV).
- Ongoing performance analysis through Cost and Schedule Variances, CPI, and SPI.
- Forecasting future performance with EAC and VAC.
- Timely corrective actions based on performance metrics.

This structured methodology enables project managers to optimize project performance, manage risks, and ensure the successful completion of precast concrete construction projects on time and within budget.

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