MAXIMIZING REAL-TIME MONITORING FOR EFFECTIVE DELAY ANALYSIS IN BRIDGE CONSTRUCTION PROJECTS WITH EVM SCHEDULING

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ABSTRACT

A bridge is a civil engineering construction that has been used for generations to cross any obstacle below it. There are many conflicts in bridge construction, and they are getting worse every day. A flyover bridge has been constructed to reduce traffic congestion. Project costs may directly rise if there is a delay in completing the work. The act of analyzing a project's delay and determining its underlying causes is known as delay analysis. A contractual issue at the Zone 3 junction has caused project delays, which have impacted on the project time limit. Delays caused by factors beyond the parties' control (Force Majeure) and Delays caused by an unbalanced contract. The EVM technique is used for evaluating Bridge Construction,which allows for project tracking. Construction project performance is investigated to determine the possibility of cost and time overruns, as well as the Estimation at Completion (EAC) and To-Complete Performance Index (TCPI) to evaluate how efficiently the remaining financial resources are used. To conduct analysis on the construction project's performance and identify critical issues regarding schedule andcost, a delayed construction project was chosen as a case study for this project. Delay Analysis was also conducted to determine the causes behind the project's variance in duration.

KEYWORDS- Stake holder involvement, Contingency plan, Procurement scheduling, Resource management, Contractual consideration.

INTRODUCTION:

Delayed bridge construction can lead to several problems in a project, including late completion, decreased productivity, increased costs, and contract termination. A flyoverbridge was built to relieve traffic congestion in the area. This eliminated the path for a more than 45% reduction in underground traffic congestion. Cost and timing are crucial factors in the construction of the Flyover bridge. EVM not only specifies thecurrent state of the project, but also expects its prospects for the future. It also shows thecost and time variations from the plan. Delays in project completion can directly increase project costs. Various effective strategies and technologies are available to avoid cost and time overruns. My primary focus is on leveraging the Earned Value Method (EVM) as a strong monitoring and controlling tool in the goal of maximizing real-time monitoring for effective delay analysis in the construction of the Flyover project. This strategic method attempts to thoroughly evaluate and appraise the project's development,providing an in-depth insight of both cost and time dynamics at various phases. EVM Rescheduling approaches notonly assessing the current condition of the project, but also to anticipate the time required for its completion in the future. This coordinated approach of real-time monitoring, delay analysis, and EVM Rescheduling not only strengthens the project's resilience in the faceof uncertainty, but also assures that it proceeds as planned. The comprehensive approach to project management will be critical in managing the complexities of construction, ensuring optimal resourceutilization, and delivering an effective structure within the time and budget constraint.

LITERATURE REVIEW

(Rudresh, 2017) Managing project performance in the face of increasing conflict is essential in the construction company. Using techniques such as earned value approach assists in evaluating and assessing project performance, revealing insights into progress, and identifying concerns. In addition, using the Project software, delay analysis analyses project delays and identifies core causes. This project focuses on looking at a delayed construction investigation, with the goal of measuring and analyzing project performance in terms of cost and schedule, identifying major issues and deviations in duration to effectively address and mitigate delays.

(Ekström, 2015) Construction efficiency is a constant the need from contractors and an important issue for designers. Early stages of a project, particularly project planning and design, provide excellent opportunity to define a structure and its eventual qualities. Despite the obvious requirement for construction knowledge in design, there is an absence of systematic exchange of experience between construction and design engineers. The project's findings, based on a literature review, meta-analysis, and industry study,

advocate for a comprehensive, production-oriented design approach for better bridge a critical element in alleviating bridge construction delays.

(VEIJOLA, 2015) The Project Level Bridge Management System, which focuses on individual bridges, integrates network-level recommendations into restoration planning. This essential instrument facilitates daily bridge repair scheduling by utilizing damage data. Within repair and reconstruction programs, the system allows alternative research and profitability assessments. Delays influence accomplishing condition targets that coordinate with maintenance suggestions in the planned program**.**

(Salimi, 2015) Earned Value Analysis (EVA) technique on the Kotay bridge building project involves establishing cost and schedule baselines as well as updating work and expense data. The data is obtained straight from the project's onsite office. EVA has been used to measure project performance over the last five months, and both the Cost Performance Index (CPI) and the Schedule Performance Index (SPI) have been found to be less than 1.0, implying poor performance. The report identifies significant signs of cost and schedule overruns, highlight the impact of bridge construction delays.

(Kataria, 2015) The Cyclades network project, supported to improve the human factor in shipping by emphasizing collaboration between the Bridge and the Engine Control Room (ECR) during ship design and operation. The study examines communication obstacles and goals in several contexts, such as trip planning and safety activities, using semi-structured interviews with varying workers. The study's goal is to improve crew-centered design by clarifying information exchange details. By emphasizing the necessity of excellent communication in maritime operations, this analysis may have consequences for bridge building delays.

(Taitokari, 2013) The Finite Element Method (FEM) was used to give results for an elevated bridge concept design. Towers with suspension cables are used in the design to reduce deflection and bending forces. Cable topology, deck dimensions, and material possibilities (low and high-strength steel) are all design factors. The goal of decision variables such as cost and safety is to maximize client happiness. Both steel alternatives have optimal shape, with the softer steel preferred because to its lower cost. The FEM results agree well with the fuzzy model, demonstrating its applicability beyond probabilistic models.

(Huang, 2021) Building Information Modelling (BIM) technology has transformed China's construction landscape, moving from two-dimensional CAD to three-dimensional BIM technology. This move improves visualization, cooperation, and automation, allowing construction stakeholders to do better and more efficiently. However, China's continuing expansion of bridge architecture has added complexity and diversities, providing challenges to a variety of businesses. These difficulties may have an impact on building timetables, perhaps causing delays in bridge construction projects due to increased complexities and demands.

(Nanni, 2012) CPI and the University of Missouri - Rolla (UMR) worked on a creative all-composite bridge project that was constructed on the UMR campus. bridge was designed to AASHTO H20 load rating and underwent rigorous FEA and testing. The bridge was made of pultruded 3-inch square tubes and was made up of eight layers that were glued and screwed together, with carbon-reinforced layers. The matrix was made of vinyl ester resin with flame retardant additives. The structure was outfitted with fibre optic sensors. Despite the project's complexity, CPI successfully built and delivered the bridge to UMR in a single piece, demonstrating breakthroughs in composite technology for efficient bridge construction.

(Lesniak, 2019) Construction projects slowly planned, are subject to unforeseen circumstances that cause delays in completion. Bridge building, which is essential to road developments, is open to such issues, affecting transportation network expansion. The purpose of this study is to establish a link between the independent variables that characterize bridge projects and the occurrence of delays. To overcome this issue, two models, logit and profit, were proposed. Data from road bridges built in Poland during the last 12 years (2005-2017) were used to generate these models, providing insights into the factors driving bridge construction delays.

(Wu, 2021) BIM technology its application in bridge construction uses virtualized analysis and visual interpretation, allowing construction professionals to discover and address construction concerns, ultimately improving bridge construction quality and efficiency. The use of BIM technology to integrate a building information model stages such as construction, design, operation, and maintenance, eliminating collision issues and managing engineering quantity statistics. unique applications of BIM technology in bridge construction, clarifying the benefits and manifestations of the technology.

(Mommens, 2021) A lack of understanding makes effective stakeholder management difficult. a participatory decision-making approach for urban construction logistics governance, stressing economic, environmental, and sociological issues. The framework, which has been implemented in the Brussels-Capital Region, makes use of Multi-Actor Multi-Criteria Analysis to highlight site-specific, actor-dependent processes. The study emphasizes the framework's flexibility, scalability, and potential role in multi-level governance to successfully manage construction logistics, addressing potential bridge construction delays.

(Sulaiman, 2019) The Public Works Department's (PWD) Bridge Design Division pioneered its application in a 300-meter bridge. This program intends to reduce the number of intermediary piers while also lowering with a span of 70 meters, the project acts as a PWD pilot, applying the Malaysia Civil Engineering Standard Method of Measurement (MYCESMM) to improve cost-effective engineering projects. The new approach could lead to more timely and efficient bridge construction, potentially reducing delays.

(Li*, 2021) The Fuzzy Analytic Hierarchy Process (FAHP) is used in the financial review of a bridge construction project to examine economic elements, develop evaluation and decision criteria, and to construct an extensive index system. A three-tiered economic factor system with eleven sub-factors is developed using expert surveys, and the economic status is evaluated using probability determination. FAHP is used for both qualitative and quantitative analysis of factor indices, which produce financial scores and orders.

(Melbourne, 2007) The physical behaviour, service life, economy, aesthetics, and safety of transportation system bridges and structures are all influenced by a variety of elements of world-class highway and transportation network. Looking ahead, the challenge for the new millennium is to strengthen this network even further. Bridge engineering is currently focused on structure kinds, design features, novel materials, aesthetic considerations, and significant policy challenges. A prognosis of the state of bridge engineering 20 to 30 years into the next millennium is made. The report envisions these forecasts becoming a reality, perhaps influencing decisions to reduce bridge building delays.

(Dhungan, 2020) The research integrates an extensive literature review, primary and secondary data, and interviews to evaluate perceptions in the "design and build model" of bridge projects. Utilizing questionnaires, the survey identifies 56 causes for delays, with eight key factors highlighted, including stakeholder analysis, portfolio management, pre-execution planning, site management, budget allocation, reward/penalty provision, survey depth, and contractor workload. Addressing these issues promises to enhance Nepal's construction industry competence by ensuring cost, quality, and schedule efficiency in bridge construction projects.

Romanovsky, et al. (2022) Digital technology's proliferation in engineering has given rise to diverse digitization methods, with Building Information Model (BIM) extending to infrastructure. This research focuses on implementing BIM for bridges, using Revit software to create a digital model based on project documents and field measurements. Analyzing existing technologies and methodologies like Bridge Information Model (BIM), the study explores global BIM in infrastructure management. The process of digitizing old structures is detailed, encompassing data acquisition, georeferencing, and modeling, employing TLS and aerial photographs. The study showcases the transition from survey to visualization and data transfer.

Howes, et al. (2000) Earned Value Analysis (EVA) called Work Package Methodology (WPM) to enhance project control. WPM focuses on individual work packages, employing logical time analysis to update project cost and time performance. By applying WPM, the paper aims to improve the predictive accuracy of EVA, especially in cases where the Cost Performance Index (CPI) and Schedule Performance Index (SPI) deviate significantly from unity, particularly in the project's early stages. The comparative analysis between WPM and traditional EVA utilizes adapted test data from previous projects to identify variations in results.

WPM acts as a complementary tool, offering an alternative perspective through logical time and cost analysis based on work sequence and construction methods, thereby refining the predictive performance of EVA.

Chen Wang, et al. (2010) The Malaysian construction industry despite its well-established benefits in monitoring project performance. Employing qualitative methods, including structured interviews and flowchart development, the research aims to identify the advantages of EVA compared to other project control methods, assess its suitability for implementation in construction projects, and create a practical flowchart guide. The findings underscore EVA's notable advantages in terms of accuracy, flexibility, and adaptability, especially when compared to stochastic methods, Fuzzy logic models, and miscellaneous approaches. The study reveals that EVA offers a robust framework for project management in complex construction scenarios. Recognizing the potential, the Malaysian government has endorsed the implementation of EVA to elevate project management standards nationwide.

Spuler, et al. (2013) There are difficulties in repairing steel and concrete bridges. To evaluate destruction and improve the strength and durability of repairs, research is crucial. Recommendations are made for bridge designers. It's important to renovate bridges for lifespan, and past performance data is valuable. Analyzing it using lab-scale models or software simulations, past study of the bridge provides more information. In this case, modern structural health monitoring (SHM) technologies are crucial. SHM's involvement in maximizing the renovation of important municipality bridges, which benefits owners, users, and the environment, is shown by two ongoing projects.

EARNED VALUE MANAGEMENT (EVM)

EVM scheduling offers a comprehensive approach to project management by integrating schedule, cost, and performance indicators. Project managers can identify possible delays in advance by using EVM to improve their visibility into the status of the project. Using EVM, real-time monitoring makes it possible to evaluate schedule and cost variations in a timely manner, which speeds up the process of putting remedial measures in place. Despite many decades of practice and academic attention project performance, remains problematic, verifiable evidence suggests that projects do not generally achieve the required scope, are frequently delay, and perform badly on quality of deliverables as well as on cost budgets. When it comes to building bridges, where delays can have serious consequences, EVM optimizes resource allocation, reduces risk, and expedites project workflows. EVA is one of the most known project control systems used by project management professionals.

EVA sets parameters which allow project monitoring and controls the budgeted amount to be spent on the task completed in accordance with the original schedule at any point in time or with reference to baseline is defined as the planned value (PV). Planned Budgeted Cost of Work Schedule (BCWS) is

referred to as PV. Earned Value (EV) is the monetary value of the job performed (progress made) at any given point in time, expressed in terms of the planned cost. When it first started off, EV was known as the Budgeted Cost of Work Performed (BCWP). The term "Actual Cost" (AC) refers to the amount of money spent at any point to make progress. The Actual Cost of Work Performed (ACWP) is the term used to describe AC. The EVM approach can be useful in predicting project progress based on past results and in implementing the control measure. The EVM offers two major indicators for CPI and SPI. The value of CPI & SPI if less than 1, it shows the cost & time overrun at a given point of time. The EVM model will be applied in the present work by evaluating the Base Cost-based Earned Value and Expected Cost-based Earned. Value and further analyzing the risk effect on the project. The concept of the EVM is further extended to measure the cost overrun by reference to the threshold limits. The threshold limit is Expected cost (EC), which is the consequence of the pessimistic risk scenario. by considering all the risks that are likely to occur in the project. The actual cost of work done should not exceed the expected cost estimated in any case. The Expected Cost of Work Performed (ECWP) for a given will be identified, and the risk-based CPI for the project will be calculated.

CONCLUSION OF BRIDGE DELAY ANALYSIS

Maximizing real-time monitoring is crucial for effective delay analysis in bridge construction projects, especially when integrated with Earned Value Management (EVM) scheduling. EVM provides a comprehensive framework for evaluating project performance, allowing project managers to assess progress against planned schedules and budgets. Real-time monitoring enhances this process by providing instant insights into potential delays, enabling proactive decision-making. It is imperative to consider several factors and implement key steps. Firstly, a collaborative approach involving all stakeholders is essential for smooth communication and problem-solving. Additionally, incorporating advanced technologies, such as Building Information Modeling (BIM) and automated data collection, can enhance accuracy and efficiency. Streamlining permit processes, securing skilled labor, and optimizing the supply chain are critical steps for reducing bottlenecks. Improvising Bridge construction timelines. Regular feedback loops, lessons learned sessions, and the adoption of innovative construction methodologies contribute to ongoing enhancements. Overall, by integrating real-time monitoring with EVM scheduling and addressing key factors, the construction industry can achieve faster and more efficient bridge construction projects, meeting both quality and timeline objectives.

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