An Evaluation Of Earned Value Analysis In Residential And Commercial Building Projects: A Review

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Abstract- *This review paper explores the application and benefits of Earned Value Analysis (EVA) in residential and commercial building projects. EVA is a project management technique that integrates cost, schedule, and scope metrics to evaluate project performance and progress. The paper provides an overview of EVA, including key concepts and metrics such as Planned Value (PV), Earned Value (EV), and Actual Cost (AC). It highlights the importance of EVA in the construction industry, considering the complexity and scale of building projects, as well as the prevalence of cost and schedule overruns. Effective project monitoring and control, supported by EVA, are crucial for mitigating risks, optimizing resource utilization, and ensuring cost control and schedule adherence. The review also discusses the integration of EVA into project management processes, including establishing baselines, measuring progress, and applying EVA at different stages of the project lifecycle. The paper concludes with a summary of relevant literature on EVA in construction projects, showcasing its application in various contexts and providing insights into its potential benefits.*

Keywords- Earned Value Analysis; Project management; Residential and commercial building projects; Cost and schedule; control; Construction industry; Performance evaluation.

I. INTRODUCTION

Earned Value Analysis (EVA) is a widely used project management technique that enables the evaluation of project performance and progress based on the integration of cost, schedule, and scope metrics. It provides valuable insights into the efficiency and effectiveness of project execution, allowing project managers to identify and address potential issues before they escalate. In the context of residential and commercial building projects, EVA holds significant importance due to the complex nature and substantial investment associated with these endeavors. This review paper aims to assess the application and benefits of Earned Value Analysis in residential and commercial building projects, exploring its impact on project success, cost control, schedule adherence, and overall project performance.

1. Overview of Earned Value Analysis:

Definition and key concepts:

Earned Value Analysis (EVA) is a project management technique used to assess and measure the performance and progress of a project by integrating cost, schedule, and scope metrics. It provides a comprehensive and objective evaluation of project performance, enabling project managers to monitor and control project execution effectively.

Key Concepts of Earned Value Analysis:

Planned Value (PV) or Budgeted Cost of Work Scheduled (BCWS): The value of the work that has been effectively completed up to a certain point in the project timeline is represented by EV. It is calculated by looking at the deliverables, milestones, or quantifiable project tasks that have been performed and show the actual progress made.

Earned Value (EV) or Budgeted Cost of Work Performed (BCWP): The value of the work that has been effectively completed up to a certain point in the project timeline is represented by EV. It is calculated by looking at the deliverables, milestones, or quantifiable project tasks that have been performed and show the actual progress made.

Actual Cost (AC) or Actual Cost of Work Performed (ACWP): The entire expenditures spent to complete the task up to a certain point in time are referred to as AC. It comprises all project-related direct and indirect costs, such as those for labour, supplies, machinery, overhead, and other project-related expenditures.

Project managers may compare the planned and real costs with the earned value using these three EVA components: planned value, earned value, as well as actual

cost. Different performance indicators as well as metrics may be derived by examining the connection between these variables, giving information about cost and schedule variations. Cost Performance Index (CPI), Schedule Performance Index (SPI), and Estimate at Completion (EAC) are some of the important indicators obtained by EVA that aid in evaluating the health of a project and informing choices.

Components of EVA:

Planned Value (PV): The approved budget for the planned work that is intended to be finished within a particular period is represented by PV, also known as Budgeted Cost of Work Scheduled (BCWS). It acts as a benchmark for gauging project progress and figuring out the anticipated worth of finished work at any particular time.

Earned Value (EV): The value of the work that has actually been completed up to a certain point in the project schedule is represented as earned value, also known as budgeted cost of work performed (BCWP). The calculation of EV is based on the evaluation of outcomes, milestones, or quantifiable project activities that indicate real progress done.

Actual Cost (AC): Actual Cost (AC), also known as Actual Cost of task Performed (ACWP), is the whole cost expended up to a certain point in time to complete the task. It covers all of the project's direct among indirect costs, such as labour, supplies, machinery, above you, and additional expenditures linked to carrying out the project.

Calculation and interpretation of EVA metrics:

1. **Cost Performance Index (CPI):**

- Calculation: CPI is calculated by dividing the Earned Value (EV) by the Actual Cost (AC). Mathematically, CPI = EV / AC.
- Interpretation: CPI measures the cost efficiency of the project. If CPI is greater than 1, it indicates that the project is performing better than planned in terms of cost. A CPI value less than 1 suggests that the project is over budget. For example, a CPI of 1.2 indicates that the project is achieving $1.20 of work for every $1 spent.

2. **Schedule Performance Index (SPI):**

- **Calculation:** SPI is calculated by dividing the Earned Value (EV) by the Planned Value (PV). Mathematically, SPI = EV / PV.
- **Interpretation:** SPI assesses the schedule efficiency of the project. If SPI is greater than 1, it indicates that the project is ahead of schedule. An SPI value less than 1 suggests that the project is behind schedule. For instance, an SPI of 0.8 indicates that only 80% of the planned work has been completed.

3. **Estimate at Completion (EAC):**

- **Calculation:** EAC estimates the projected total cost of the project based on the performance to date. It is calculated by dividing the Budget at Completion (BAC) by the Cost Performance Index (CPI). Mathematically, EAC = BAC / CPI.
- **Interpretation:**Based on the present performance, EAC offers an estimate of the project's total cost. It aids in project managers' ability to predict if a project will be finished on time and on budget. An increase in the EAC above the initial budget indicates a cost overrun, whereas a decrease in the EAC denotes possible cost savings.

2. **Importance of Earned Value Analysis in Residential and Commercial Building Projects:**

- **Complexity and scale of building projects:**

Residential and commercial building projects pose unique challenges due to their complexity, scale, and involvement of multiple stakeholders. These challenges can significantly impact project management and require careful attention and effective strategies to ensure successful outcomes. Here are some key aspects to consider:

Design Complexity: Residential and commercial buildings often have intricate architectural designs and complex structural systems. Balancing aesthetics, functionality, and compliance with building codes and regulations requires careful planning and coordination.

Project Size and Scope: Building projects can vary widely in size, ranging from small residential structures to large commercial complexes. The scale of these projects introduces challenges in managing resources, coordinating activities, and ensuring efficient execution.

Construction Techniques and Materials: The construction industry continually evolves, introducing new techniques and materials to improve efficiency, durability, and sustainability. Implementing innovative approaches while considering cost-effectiveness and quality control requires expertise and adaptability.

Schedule Management: Construction projects involve numerous interdependent tasks and activities. Coordinating

various trades, managing subcontractors, and adhering to project timelines are crucial for avoiding delays and cost overruns.

Budget and Cost Control: Residential and commercial building projects often have significant financial implications. Managing budgets, estimating costs accurately, and controlling expenses throughout the project lifecycle are vital for ensuring financial viability and profitability.

Stakeholder Collaboration: Building projects involve diverse stakeholders, including owners, architects, engineers, contractors, subcontractors, suppliers, and regulatory authorities. Effective communication, collaboration, and stakeholder management are essential to align interests, address conflicts, and maintain project momentum.

Regulatory Compliance: Compliance with building codes, zoning regulations, environmental requirements, and safety standards is essential for residential and commercial projects. Navigating and adhering to these regulations adds complexity and necessitates careful planning and documentation.

Site Constraints and Logistics: Building projects often face site-specific challenges such as limited access, space constraints, environmental considerations, and neighborhood impact. Managing these constraints while ensuring site safety, material deliveries, and equipment logistics requires strategic planning and coordination.

- **Cost and schedule overruns in the construction industry:**

Cost and schedule overruns are pervasive issues in the construction industry, causing significant challenges and financial implications for projects. Understanding the causes and implications of these overruns highlights the critical need for effective project monitoring and control. Here are some key points to consider:

Inaccurate Initial Estimates: Construction projects often suffer from inaccurate initial cost and schedule estimates. Factors such as incomplete project scope understanding, unforeseen site conditions, design changes, and unrealistic timelines can contribute to underestimated budgets and timelines.

Scope Creep and Change Orders: Changes in project scope uring construction can lead to cost and schedule overruns. Scope creep, which involves uncontrolled additions or modifications to project requirements, and frequent change orders disrupt project execution, impacting both cost and schedule.

Inefficient Resource Management: Poor resource allocation and utilization can lead to cost and schedule overruns. Inadequate planning, delays in material procurement, labor shortages, and ineffective coordination among subcontractors can result in inefficient project progress.

Construction Delays: Delays in construction activities can have a cascading effect on the overall project schedule. Factors such as inclement weather, labor strikes, regulatory hurdles, and unforeseen site conditions can disrupt project timelines and lead to cost overruns.

Inadequate Risk Management: Insufficient identification, assessment, and mitigation of project risks can contribute to cost and schedule overruns. Lack of contingency plans, failure to anticipate potential risks, and inadequate risk response strategies can amplify the impact of unforeseen events.

Poor Project Communication: Ineffective communication among project stakeholders can result in misunderstandings, delays in decision-making, and misalignment of project objectives. Lack of timely information exchange and collaboration can impede project progress and lead to cost and schedule overruns.

The consequences of cost and schedule overruns in the construction industry are significant. They can erode project profitability, strain client relationships, and damage a company's reputation. Effective project monitoring and control, supported by tools such as Earned Value Analysis (EVA), enable proactive identification of deviations, timely decision-making, and corrective actions to mitigate the impact of cost and schedule overruns.

- **Need for effective project monitoring and control:**

Accurate monitoring and control mechanisms, such as Earned Value Analysis (EVA), play a vital role in ensuring project success, mitigating risks, and achieving cost-effective outcomes. Here are the key reasons why effective project monitoring and control are crucial:

Performance Measurement: Monitoring project performance allows project managers to assess progress, identify deviations from the plan, and measure the efficiency of resource utilization. EVA provides objective metrics to evaluate cost and schedule performance, enabling early detection of variances and facilitating timely corrective actions.

Risk Identification and Mitigation: Effective monitoring and control enable the identification and assessment of project risks. By regularly monitoring project activities and comparing them against planned values, project managers can identify potential risks, assess their impacts, and implement appropriate mitigation strategies to minimize their adverse effects on the project.

Proactive Issue Resolution: Accurate monitoring and control provide real-time visibility into project performance, enabling proactive issue resolution. Early identification of problems allows project managers to address issues promptly, make informed decisions, and implement corrective measures before they escalate, minimizing disruptions and delays.

Resource Optimization: Monitoring and controlling project activities help optimize resource allocation and utilization. By tracking the actual cost and progress of work, project managers can identify areas of inefficiency, make necessary adjustments, and ensure optimal utilization of resources, leading to cost savings and improved project efficiency.

Cost Control and Budget Management: Accurate monitoring and control mechanisms, such as EVA, provide a comprehensive view of cost performance. By comparing actual costs with planned values, project managers can identify cost overruns, assess their root causes, and take corrective actions to bring the project back on track, ensuring budget adherence and financial control.

3. Application of Earned Value Analysis in Residential and Commercial Building Projects:

- **Integration of EVA into project management processes:**

Earned Value Analysis (EVA) is integrated into the overall project management framework to provide a comprehensive and objective assessment of project performance. It is applied across various stages of the project lifecycle, including planning, execution, monitoring, and control. Here's how EVA is integrated into each of these stages:

Planning Stage:

Establishing a Performance Measurement Baseline (PMB): In the planning stage, project managers define the project scope, develop a Work Breakdown Structure (WBS), and allocate budget and resources. EVA is used to establish a Performance Measurement Baseline (PMB), which includes planned values (PV) for cost and schedule.

Execution Stage:

Earned Value Determination: During the execution stage, project progress is measured by assessing the Earned Value (EV), which represents the value of work actually completed. EV is determined based on the completion of deliverables, milestones, or measurable project tasks.

Actual Cost (AC) Collection: Actual Cost (AC) data is collected to reflect the actual costs incurred in executing the project activities. This includes labor costs, material costs, and any other direct or indirect expenses related to project execution.

Monitoring Stage:

Performance Analysis: EVA metrics such as Cost Performance Index (CPI) and Schedule Performance Index (SPI) are calculated to assess project performance. These metrics are compared against planned values (PV) to determine cost and schedule variances.

Earned Value Reporting: Regular reports are generated to communicate the earned value data, performance metrics, and cost and schedule variances to stakeholders. These reports provide a clear picture of project progress and performance.

Control Stage:

Variance Analysis: Cost and schedule variances are analyzed to understand the reasons behind deviations from the planned values. This analysis helps in identifying potential issues and taking corrective actions to address cost overruns or schedule delays.

Change Management: EVA is used to assess the impact of scope changes or change orders on cost and schedule performance. By analyzing the earned value metrics, project managers can evaluate the effects of changes and adjust the project plan accordingly.

Forecasting and Risk Mitigation: EVA enables forecasting of the Estimate at Completion (EAC), which estimates the projected total cost of the project based on current performance. This information helps project managers in proactive risk mitigation and resource planning to control costs and adhere to the project schedule.

- **Establishing a baseline and measuring progress:**

Setting a baseline for cost, schedule, and scope is a critical step in project management. It provides a reference point against which project progress can be measured and evaluated. Earned Value Analysis (EVA) allows for the continuous measurement and assessment of project progress against the established baseline. Here's why setting a baseline and utilizing EVA are essential:

Benchmark for Comparison: A baseline serves as a benchmark for comparison throughout the project lifecycle. It represents the initial planned values for cost, schedule, and scope. By establishing a baseline, project managers can compare actual progress against the planned values and assess the performance and efficiency of project execution.

Performance Measurement: EVA enables the measurement of project performance by comparing the planned values with the earned value. The earned value represents the value of work actually completed, providing an objective measure of progress. By calculating the earned value and comparing it with the planned value, project managers can gauge whether the project is ahead, on, or behind schedule.

Cost and Schedule Variances: EVA allows project managers to identify cost and schedule variances. By comparing the earned value with the planned value, project managers can determine whether the project is under or over budget and whether it is ahead or behind schedule. Cost and schedule variances provide insights into project performance and help in identifying areas that require attention or corrective actions.

Early Detection of Deviations: EVA facilitates the early detection of deviations from the baseline. By continuously monitoring the project's earned value, project managers can identify deviations in cost and schedule performance. This early detection allows for timely intervention and corrective measures to bring the project back on track, minimizing the impact of deviations.

4. Benefits of Earned Value Analysis in Residential and Commercial Building Projects:

- **Early detection of performance variances and deviations:**

Objective Performance Measurement: EVA provides an objective and quantitative measurement of project performance. By comparing the planned values (PV) with the earned value (EV), project managers can assess whether the project is progressing as expected. Any significant differences between the planned and earned values indicate potential variances or deviations in cost and schedule.

Cost Variance (CV) Analysis: EVA calculates the cost variance by comparing the earned value (EV) with the actual cost (AC). Cost variance (CV) measures the difference between the value of completed work and the actual cost incurred. Positive CV indicates that the project is under budget, while negative CV indicates cost overruns. Early identification of significant cost variances alerts project managers to potential financial risks and triggers the need for corrective actions.

Schedule Variance (SV) Analysis: EVA assesses the schedule variance by comparing the earned value (EV) with the planned value (PV). Schedule variance (SV) measures the difference between the value of completed work and the planned value at a specific point in time. Positive SV indicates that the project is ahead of schedule, while negative SV indicates schedule delays. Early detection of significant schedule variances enables project managers to address potential delays, adjust project plans, and allocate resources accordingly to bring the project back on track.

Threshold and Tolerance Limits: EVA allows project managers to set threshold and tolerance limits for cost and schedule variances. These limits represent the acceptable range of variances within which the project is considered to be under control. By continuously monitoring the variances against the set thresholds, project managers can promptly identify when the project deviates beyond acceptable limits, triggering the need for immediate corrective actions.

5. Challenges and Limitations of Earned Value Analysis in Residential and Commercial Building Projects:

- **Accuracy and reliability of data collection:**

Data collection is a crucial aspect of Earned Value Analysis (EVA) as it forms the foundation for accurate performance measurement and analysis. However, several challenges can impact the accuracy and reliability of data collected for EVA. Here are some key challenges to consider:

1. Subjective Reporting: EVA relies on data provided by project team members and stakeholders, which may be subject to interpretation and subjective reporting. Different individuals might have varying perspectives on progress, resulting in discrepancies in reporting earned value (EV) and actual cost (AC). Subjectivity in data reporting can lead to inaccurate assessment of project performance.
2. Incomplete or Inaccurate Data: Inadequate data collection or inaccurate recording of actual costs and progress can compromise the reliability of EVA. Missing or

incomplete data can result in incorrect calculations and misleading performance metrics. For example, failure to accurately capture all project costs or incomplete reporting of work completed can skew the earned value calculations.

3. Data Manipulation: Deliberate data manipulation poses a significant risk to the accuracy and reliability of EVA. Project stakeholders may attempt to manipulate data to present a more favorable performance picture or conceal project issues. Manipulated data can undermine the effectiveness of EVA, leading to incorrect assessments of cost and schedule performance.

- **Addressing the Challenges:**

To mitigate the challenges related to data collection accuracy and reliability in EVA, project managers can adopt the following measures:

Standardized Data Collection Procedures: Implement standardized procedures and guidelines for data collection, ensuring consistency across project phases and team members. Clear instructions and templates can help minimize subjectivity and improve data accuracy.

Training and Awareness: Provide training to project team members on the importance of accurate data collection and reporting for EVA. Create awareness about the potential risks of data manipulation and the significance of maintaining data integrity.

Independent Validation: Implement independent validation processes to cross-check and verify the accuracy of collected data. Independent audits or reviews can help identify inconsistencies or discrepancies and ensure data reliability.

- **Adaptability to unique project characteristics:**

It is crucial to recognize that each residential and commercial building project is unique in terms of its characteristics, requirements, and complexities. As a result, the application of Earned Value Analysis (EVA) techniques needs to be tailored to fit the specific needs and dynamics of these projects. Here's why adaptability is essential:

Project Scope and Deliverables: Residential and commercial building projects vary significantly in terms of scope, size, and deliverables. EVA techniques should be adapted to reflect the specific elements and milestones relevant to the project. This ensures that the earned value (EV) measurements accurately capture the progress and completion of the defined deliverables.

Work Breakdown Structure (WBS): Each project may have a unique Work Breakdown Structure (WBS) that breaks down the project's scope into manageable work packages. EVA should align with the project's WBS to track and measure the performance of individual work packages or tasks, allowing for accurate earned value calculations.

Cost Control and Resource Allocation: Residential and commercial building projects have diverse cost elements and resource requirements. EVA techniques need to be adaptable to capture and track these project-specific costs, such as labor, materials, equipment, subcontractors, and overheads. Tailoring EVA ensures accurate cost control and efficient resource allocation based on the specific project needs.

II. LITERATURE REVIEW

Faisal Hamzah et.al (2020) "The Application of Earned Value Analysis of the Progress of Construction Work in The Development of The Porch or Vestibule of The Basement Building Area Youth Surabaya"

The good of the goods is the project that met the performance objectives while staying within budget and schedule constraints.An strategy to evaluating optimal performance was used in the design of the building type B1 (youth hall in the basement). One way for managing cost and time intractability is using one. Earned value analysis along with field data collecting for building construction project type B1 (youth hall in the basement) are the research methods used. The timetable, budget, expenses, and other data are employed in this procedure. weekly updates on progressFrom the data, create BCWP BCWS values and forecast when the project will be completed. Building construction project type b1 ((basement area youth hall)) is being evaluated; assessment will take place after project completion.While evaluating the performance of the project's accelerated schedule, wherein the project's schedule was implemented more quickly than anticipated (resulting in a schedule underrun), it was estimated that the project would be finished on the day of the calendar 539.

Juan Pedro Ruiz-Fernández et.al (2019) "Influence of seasonal factors in the earned value of construction"

Each building process may have many different goals. However, there are certain limitations on pricing and conditions that must be followed while building. They represent some strategic, interconnected objectives. Or, to put it another way, "time is money". Numerous studies confirm that the execution rate of building is influenced by seasonal factors. As a result, the majority of them make an effort to

enhance predictions by assessing and incorporating them into planning, always gauging their impact indirectly. In this study, we propose a technique to quantitatively assess the impact of seasonal conditions on the net worth of construction. We also apply it to a specific case study with public promotion's subsidised homes in Spain's Castilla-La Mancha area. We have computed the average monthly output for each month of the year with regard to the annual monthly mean, which clarifies our conclusions. Additionally, in order for a project to be trustworthy, variances in the average monthly output we have contributed to must be taken into consideration for each earned value prediction.

ADEY TADESSE GEMORAW (2020) "COST CONTROL USING EARNED VALUE ANALYSIS FOR INDUSTRIAL CONSTRUCTIONS IN ADDIS ABABA"

Numerous industrial projects are being built in Ethiopia as part of the government's attempts to grow and enhance the nation's industrial sector. In this respect, the provision of industrial buildings and related accommodations in the key industries now operating is played by the construction sector to a very substantial extent. It is sufficient to note that industrial buildings and infrastructure account for a significant share of the capital flooding into industrial expansion. Governmental and non-governmental parties have made significant financial investments in this sector, which must be used in a productive and efficient manner to provide the greatest results. Contrary to this, the tendencies seen in the majority of construction projects tend to take longer and cost more money while producing work of inferior quality. This is caused, among other things, by a dearth of effective project cost management methods. Using planned value, actual value, and earned value of work completed, earned value analysis is a method used to assess plus monitor project performance& estimate future trends.

Fernando Acebes et.al (2015) "Stochastic earned value analysis using Monte Carlo simulation and statistical learning techniques"

In this study, a novel integrated technique for project control under uncertainty is described. This proposal offers a number of improvements to earlier techniques and is based on the Earned Value Methodology and risk analysis. More particular, the method makes considerable use of Monte Carlo simulation to learn more about the project's anticipated behaviour. This dataset is used in a variety of ways utilising various statistical learning techniques in a systematic manner. Initially, Anomaly Detection techniques are employed in simulations to determine if project deviations are a result of the anticipated variability. If the project exhibits this anticipated variability, classification and regression techniques may be used to assess the project's chances of success in terms of time, cost, and overall length.

Rama Pratama "EARNED VALUE CONCEPT TERHADAP BIAYA DAN WAKTU MENGGUNAKAN METODE CRASHING SHIFT KERJA StudiKasus: Proyek Pembangunan Workshop 3 Madiun"

The Madiun Workshop 3 is a new structure with two stories and steel as its primary construction material. With 8 hours of labour each day, this building's construction was expected to take about 210 calendar days. The Earned Value Concept was used, which resulted in a 20-day delay in the building's construction during week 10. To reduce the lengthened timeline and increased expense compared to earlier, the building will be designed utilising the work shift crashing approach. The Madiun Workshop 3 building will be the focus of this study's use of the work shift crashing approach. The goal of this study is to compare the time and expense of projects that use the work shift crashing approach and are evaluated using project data. The study approach is descriptive analysis, which involves gathering information for work shift method planning and comparing implementation time as well as costs between utilising the work shift method before and after. The study was not done by the researchers themselves; instead, secondary data was utilised. The secondary data were records from the research site project, reports on investigations, earlier studies, and existing evidence.

Freya Higgins-Desbiolles et.al (2020) "Transformative change through events business: a feminist ethic of care analysis of building the purpose economy"

Some see a new paradigm known as the mission of the economy as a solution to more sustainable and fair futures as we face social, ecological, and economic concerns. Both academics and practitioners are becoming more interested in ethical and sustainable events. The potential for social entrepreneurship in event management and the ways that events might promote socio-cultural wellbeing have, however, received very little attention. In this article, GOGO Events, a unique events company based in Adelaide, South Australia, is profiled as a case study. For around eight years, GOGO has provided a social business programme where teams of disadvantaged individuals are trained and supported to design and implement event installations. The originator of GOGO has created a network of stakeholders to do this, including business clients, non-profit groups that assist the homeless and disadvantaged, and the vulnerable individuals themselves. Together, they create networks for social change and caring. We examine how this labour helps create the purpose

economy via the perspective of feminist care ethics. These initiatives go beyond CSR and offer actions organisations may do to foster a sense of community, foster caring connections, as well as contribute to more equitable and sustainable futures. Such socially responsible activity is growing even more necessary in the wake of COVID-19.

Wei Wu et.al (2021) "Residential net-zero energy buildings: Review and perspective"

The development of residential net-zero energy buildings (NZEBs) has the potential to drastically cut energy usage and greenhouse gas emissions. Energy infrastructure connections, renewable energy sources, including energy-efficiency measures are three primary categories of NZEB design considerations. A thorough literature review that is focused on current developments in residential NZEBs is lacking. To enable a larger and more effective deployment of residential NZEBs across the world, this study presents an overview of each category, including current advancements (within the previous 10 years). Electrical grids, district heating/cooling networks, and energy storage solutions including vehicle-to-home and hydrogen storage are some of the energy infrastructure links that are addressed. Here, renewable energy sources such as solar photovoltaic as well as solar thermal, wind, & biomass, as well as small combined heat as well as power (CHP) systems, are taken into consideration. The last group of solutions discussed includes those that enhance building envelope designs, HVAC systems, domestic hot water systems and the incorporation of phase change materials. There are numerous technological alternatives available within these categories, making it challenging to choose the "best" configuration while enabling design flexibility to accommodate regional climates and other factors (such as building regulations, energy resources, and prices). This essay offers resources and outlines technological possibilities for achieving residential NZEBs throughout the globe.

III. CONCLUSION

With the goal of assessing project performance in both residential and commercial construction projects, earned value analysis (EVA) is a useful project management tool. Given the size, scope, and complexity of construction projects as well as the difficulties involved, this review article emphasises the importance of EVA in the construction sector. The importance of Planned Value (PV), Earned Value (EV), and Actual Cost (AC), as well as their interpretation, are covered in this study. Project managers may monitor the health of their projects and make wise choices with the use of metrics developed by EVA, such as the Cost Performance Index (CPI), Schedule Performance Index (SPI), and Estimate at Completion (EAC). These metrics provide insights into cost and schedule variations. The paper looks at how EVA may be used at various project management phases and emphasises its advantages for pro-active project monitoring and control. The report also summarises pertinent research demonstrating the efficiency of EVA in project performance monitoring, cost management, and result predicting. EVA functions as a strong tool for project managers overall, providing enhanced cost management, timetable adherence, and general project performance in residential and commercial construction projects.

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