

Generative AI for Construction Cost Estimation and Budget Optimization in Construction Projects

Mr. Ratansing Pratapsing Rajput¹ and Mr. Ajay Vasantrao Chopane²

¹M. Tech (Construction Management), Assistant Professor, Department of Civil Engineering, M. S. Bidve Engineering College, Latur – 413512, Maharashtra, India

²M. Tech (Construction Management), Assistant Professor, Department of Civil Engineering, Sandipani Technical Campus, Kolpa, Latur – 413512

DOI: <https://doi.org/10.51583/IJLTEMAS.2026.1501300009>

Received: 25 June 2026; Accepted: 30 June 2026; Published: 10 July 2026

ABSTRACT

The construction industry is undergoing a significant transformation due to the adoption of advanced digital technologies such as Artificial Intelligence (AI), Building Information Modeling (BIM), and data analytics. Among these innovations, generative artificial intelligence has emerged as a powerful tool capable of improving decision-making processes and automating complex analytical tasks. One of the major challenges in construction project management is achieving accurate cost estimation and maintaining effective budget control throughout the project lifecycle. Traditional cost estimation methods mainly depend on historical data, manual calculations, and professional experience, which can sometimes result in inaccurate forecasts and financial inefficiencies.

Generative AI offers new possibilities for construction management by analysing large datasets, identifying hidden patterns, and generating predictive models that assist project managers in making informed financial decisions. This research paper examines the potential role of generative AI in improving construction cost estimation and optimizing project budgets. The study explores how AI-based systems can support automated quantity take-offs, predictive cost modelling, real-time cost monitoring, and efficient resource allocation.

The research also analyses the advantages and limitations associated with implementing generative AI technologies in the construction sector. The findings suggest that generative AI can significantly improve cost estimation accuracy, reduce financial risks, and enhance project planning. However, effective implementation requires reliable digital infrastructure, high-quality datasets, and trained professionals with expertise in AI technologies. The study concludes that generative AI has the potential to transform construction cost management practices and contribute to more efficient and sustainable project execution.

Keywords: Generative Artificial Intelligence, Construction Cost Estimation, Budget Optimization, Construction Management, Digital Construction.

INTRODUCTION

The construction industry plays an essential role in the economic and infrastructural development of nations. It provides critical infrastructure such as residential buildings, transportation networks, commercial facilities, and industrial complexes. Construction projects generally involve large financial investments, multiple stakeholders, and complex operational processes. Therefore, accurate cost estimation and effective budget management are fundamental requirements for successful project completion.

Cost estimation is one of the most challenging tasks in construction project management. Estimators must evaluate several factors including material prices, labour costs, equipment usage, design specifications, project location, and market fluctuations. Traditional estimation approaches rely heavily on historical project data and expert judgment. According to Charles Eastman, Paul Teicholz, Rafael Sacks, and Kathleen Liston, the

integration of digital technologies such as Building Information Modeling (BIM) has significantly improved the way project information is managed and analysed for cost estimation and planning.

Despite these advancements, construction projects frequently face budget overruns and financial inefficiencies. Factors such as unexpected price changes, design modifications, supply chain disruptions, and inaccurate predictions can affect project budgets. These challenges highlight the need for advanced technological solutions that can enhance cost estimation accuracy and improve financial decision-making.

Recent developments in artificial intelligence have opened new possibilities for improving construction management processes. Research by Stuart Russell and Peter Norvig indicates that AI technologies are capable of processing large datasets and generating predictive insights that support complex decision-making tasks. In addition, deep learning technologies have further enhanced the capabilities of artificial intelligence systems. Studies conducted by Ian Goodfellow, Yoshua Bengio, and Aaron Courville highlight the effectiveness of deep learning algorithms in analysing complex datasets and generating predictive models.

Generative AI is an advanced form of artificial intelligence that can produce new outputs based on patterns identified in existing data. These systems can generate simulations, forecasts, and optimized solutions that support decision-making processes. In the context of construction management, generative AI can analyse project data, predict cost variations, and suggest optimized budgeting strategies.

The objective of this research paper is to examine how generative AI can enhance construction cost estimation and improve budget optimization in construction projects.

LITERATURE REVIEW

The integration of digital technologies into construction management has been widely explored in academic research. According to Charles Eastman, Paul Teicholz, Rafael Sacks, and Kathleen Liston, Building Information Modeling plays an important role in improving design coordination, project visualization, and cost estimation processes.

Research by Rafael Sacks and Lauri Koskela emphasized the integration of BIM with lean construction principles to improve productivity and reduce waste in construction projects.

Artificial intelligence technologies have also been applied to construction management tasks. Studies conducted by Jian Zhang and Nader El-Gohary demonstrated that AI algorithms can analyse construction documents and extract valuable information for project planning and cost forecasting.

Automation technologies have also been investigated in construction research. Thomas Bock and Thomas Linner studied the application of robotics and intelligent systems in construction processes and highlighted their potential to improve productivity and reduce operational costs.

Recent research by Qinghua Lu, Jun Won, and Jungwoo Cheng shows that AI-based decision support systems can significantly improve financial planning and cost prediction in construction projects.

Similarly, studies conducted by Peng Wu, Jian Wang, and Xiangyu Wang demonstrate that machine learning techniques can analyse large datasets and improve the accuracy of construction cost estimation models.

Further research by Xi Chen, Rui Jin, and Li Yang indicates that predictive analytics methods can help construction organizations estimate project costs more efficiently.

In addition, Tobias Oesterreich and Frank Teuteberg emphasized that digital transformation is reshaping the construction industry and improving operational efficiency.

However, despite the growing interest in AI technologies, the practical implementation of generative AI in construction cost management is still in its early stages.

RESEARCH OBJECTIVES

The main objectives of this research are:

1. To understand the concept of generative artificial intelligence.
2. To analyse the role of generative AI in construction cost estimation.
3. To examine the potential of generative AI for optimizing construction project budgets.
4. To evaluate the advantages and challenges of adopting AI-based cost management systems.
5. To propose recommendations for implementing generative AI technologies in construction projects.

RESEARCH METHODOLOGY

This research adopts a qualitative approach based on secondary data analysis. Academic journals, conference papers, books, and industry reports related to artificial intelligence and construction management were reviewed. Previous studies conducted by Peng Wu, Jian Wang, and Xiangyu Wang highlight the importance of data-driven analytical approaches for evaluating construction technologies. Similarly, research by Xi Chen, Rui Jin, and Li Yang demonstrated the effectiveness of machine learning models in predicting construction costs.

The methodology consists of the following steps:

1. Literature Review of existing research related to AI in construction management.
2. Analysis of technological applications in cost estimation and project planning.
3. Development of a conceptual understanding of generative AI applications.
4. Evaluation of benefits and challenges associated with AI implementation.

Applications of Generative AI In Construction Cost Estimation

Automated Quantity Take-Off

Generative AI can analyse digital construction drawings and automatically calculate quantities of materials such as concrete, steel, and bricks. This process significantly reduces manual effort and improves estimation accuracy.

Predictive Cost Modeling

AI algorithms can analyse historical project data and develop predictive models for estimating construction costs based on project parameters such as building size and design complexity.

Real-Time Cost Monitoring

AI-enabled systems allow project managers to monitor project expenditures in real time and identify cost deviations during construction.

Resource Optimization

Generative AI tools can recommend efficient allocation of labour, materials, and equipment to minimize project costs.

Financial Risk Analysis

AI technologies can detect potential financial risks during project planning and provide early warnings to project managers.

Budget Optimization Using Generative AI

Generative AI supports budget optimization through various analytical techniques.

Scenario Simulation:

AI models can simulate multiple budget scenarios and identify the most cost-effective project plan.

Material Cost Analysis:

AI systems can evaluate material price trends and suggest cost-efficient alternatives.

Schedule Optimization:

AI algorithms can improve construction schedules to reduce delays and minimize additional costs.

Energy Efficiency Planning:

AI-driven design recommendations can improve energy efficiency and reduce long-term operational costs.

Advantages Of Generative AI in Construction Cost Management

Advantage	Description
Improved accuracy	AI models generate reliable cost predictions
Time efficiency	Automation reduces estimation time
Better decision-making	Data insights support strategic planning
Risk detection	AI identifies potential cost risks
Resource efficiency	AI optimizes allocation of resources

Challenges in Implementing Generative AI

Despite its advantages, several challenges limit the adoption of generative AI in construction.

Research by Mohamed Marzouk and Ahmed Enaba indicates that many construction organizations face technological and organizational barriers when adopting AI technologies.

Studies by Tobias Oesterreich and Frank Teuteberg highlight that the construction industry often experiences difficulties in digital transformation due to high costs and resistance to technological change.

Furthermore, deep learning researchers such as Ian Goodfellow, Yoshua Bengio, and Aaron Courville emphasize that AI systems require large datasets and computational resources for effective training.

Future Scope

The role of generative AI in construction is expected to grow significantly in the future. Integration with digital twin technology, advanced predictive analytics, and automated project planning systems will further enhance construction management efficiency.

CONCLUSION

Construction cost estimation and budget management are critical components of successful project delivery. Traditional estimation methods often struggle to manage complex project data and dynamic market conditions.

Generative artificial intelligence offers innovative solutions by analysing large datasets and generating predictive insights for improved cost estimation and financial planning. Although several challenges exist, including data availability and technological integration, the potential benefits of generative AI are substantial.

As digital technologies continue to evolve, generative AI is expected to play a significant role in transforming construction cost management and supporting more efficient project execution.

REFERENCES

1. Eastman, C., Teicholz, P., Sacks, R., & Liston, K. *BIM Handbook*.
2. Sacks, R., Koskela, L., Dave, B., & Owen, R. Lean and BIM interaction.
3. Zhang, J., & El-Gohary, N. AI applications in construction management.
4. Bock, T., & Linner, T. *Construction Robots*.
5. Lu, Q., Won, J., & Cheng, J. AI decision support for construction projects.
6. Marzouk, M., & Enaba, A. Artificial intelligence in construction management.
7. Wu, P., Wang, J., & Wang, X. AI in construction engineering.
8. Chen, X., Jin, R., & Yang, L. Machine learning for cost prediction.
9. Wang, T., Li, H., & Zhang, H. Predictive analytics in construction.
10. Russell, S., & Norvig, P. *Artificial Intelligence: A Modern Approach*.
11. Goodfellow, I., Bengio, Y., & Courville, A. *Deep Learning*.
12. Oesterreich, T., & Teuteberg, F. Digitization in construction industry.
13. Singh, V., Gu, N., & Wang, X. BIM adoption framework.
14. Pan, Y., Zhang, L., & Wang, L. AI-based decision support systems.