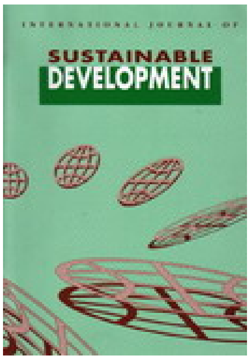


International Journal of Sustainable Development

ISSN online: 1741-5268 - ISSN print: 0960-1406
https://www.inderscience.com/ijsd

Cost control method of assembled building construction under digital technology

Yu Zhang

DOI: 10.1504/IJSD.2024.10062834

Article History:

Received:	18 July 2023
Last revised:	09 January 2024
Accepted:	11 January 2024
Published online:	15 July 2024

Cost control method of assembled building construction under digital technology

Yu Zhang

Changchun University of Architecture and Civil Engineering,
Changchun, 130607, China
Email: zhangyu880108@163.com

Abstract: In order to solve the shortcomings of the existing cost control methods for assembled building, such as the project cost is higher than expected and the cost control deviation is large, this paper proposes a cost control method for assembled buildings under digital technology. First, the construction cost data of assembled building are collected and preprocessed. Secondly, the data characteristics of the construction cost of assembled building are extracted, and the construction cost estimation model of assembled building is built using support vector mechanism. Finally, the kernel function is introduced to control the construction cost of assembled building. After verification, it was demonstrated that the application of this method for cost control resulted in an EV greater than AC, a cost performance index (CPI) value greater than 1, and a final cost control deviation of 260,000 yuan. Small deviation, effective cost control methods.

Keywords: digital technology; assembled building; SVM; support vector machine; RBF; radial basis function; cost control deviation.

Reference to this paper should be made as follows: Zhang, Y. (2024) ‘Cost control method of assembled building construction under digital technology’, *Int. J. Sustainable Development*, Vol. 27, No. 3, pp.325–338.

Biographical notes: Yu Zhang graduated from Jilin Jianzhu University with a Bachelor’s degree in Engineering Management in 2011, and graduated from Northeast Forestry University with a Master’s degree in Management Science and Master of Engineering in 2014. Now working in the Engineering Cost Teaching and Research Office of the Management of school Changchun University of Architecture and Civil Engineering.

1 Introduction

At present, the construction cycle is long and quality control is difficult, which restricts the technological progress and industrial upgrading of the construction industry. Li et al. (2022) assembled building is a kind of building mode based on factory prefabricated components and modular design and completed by onsite assembly (Lv et al., 2022). Compared with traditional buildings, assembled buildings have the advantages of long service life and low maintenance costs due to their carefully designed and manufactured components. The construction industry is a resource intensive industry with a high demand for energy, materials, and human resources. Reasonable control of construction costs can help optimise resource allocation. At the same time, in the fiercely competitive construction market, prefabricated components can reduce the waste of building materials and further achieve cost control for enterprises (Yu et al., 2021). By reducing construction costs, enterprises can provide more competitive prices, promote sustainable development of enterprises with lower cost advantages (Luo and Huang, 2021). By scientifically and reasonably controlling construction costs, the overall investment of the project can be reduced and the return on investment of the project can be improved. At the same time, cost control can also help predict and manage project cash flows, ensuring project sustainability. Therefore, studying the control of construction costs is of great significance for achieving economic benefits, improving competitiveness, optimising resource utilisation, ensuring quality, and improving project management level.

There have been many economic experts and scholars conducting research on the construction cost control of assembled buildings. Some researchers used the BIM model with highly integrated information to effective cost control for assembly building construction. According to the PDCA cycle concept, the cost control was divided into four steps: developing technical plans, data collection and collection, cost deviation analysis and correction. Use BIM modelling software to establish three-dimensional models, collect various costs of construction projects, collect structures for integration, establish operation centers on the BIM platform, set up construction cost control objectives, and achieve the control of construction costs of assembled building (Liu and Guo, 2022). However, there is still some room for improvement in the effectiveness of cost control in practical applications. Some researchers proposed to combine BIM technology with neural network algorithm to design a cost control method for assembled building. Build a model through BIM technology, obtain the cost information of each project, learning through neural network models, optimising weight thresholds using genetic algorithms, implementing cost control through assembly building cost control models (Lin and Luo, 2021). However, in the process of cost control, it is easy to be influenced by external factors, which increases the deviation of cost control and reduces the effectiveness of cost control. Relevant experts use a hierarchical ISM model to divide the influencing factors of assembly building cost control into three levels, take the standardisation, modularisation and design integration of components as the main influencing factors, and also consider the implementation of lifting scheme, installation technology of prefabricated components and construction quality to build DEMATEL-ISM model, and realise cost control of assembled building (Lin et al., 2022). However, in the actual application process, the project cost is higher than expected, and the CPI may be less than 1, resulting in poor cost control effectiveness.

Digital technology includes computer science, information technology, communication technology, etc. By leveraging digital technology, the cost control of assembled buildings can be greatly improved, leading to enhanced construction efficiency and cost reduction. In light of this, this paper explores cost control strategies for assembled buildings that are based on digital technology, aiming to overcome the limitations of traditional methods. The core research route of this paper is as follows:

1. Determine the cost categories for assembly building construction, including design, materials, construction, transportation, and installation costs, and collect historical data on various assembly building construction projects completed in the past.
2. Preprocessing assembly building cost data, calculate the information entropy of each assembled building construction cost data, eliminate redundant data, and complete the preprocessing of assembled building construction cost data.
3. Construct a sample dataset, extract the features of assembled building construction cost data, input them into a support vector machine (SVM), calculate the sensitivity coefficient and rate of change of output results for assembly buildings that are susceptible to impact, and complete the construction of a assembled building construction cost estimation model based on SVM.
4. Use penalty coefficients to constrain and optimise the complexity of the SVM model, and use radial basis functions (RBFs) to control the construction cost of assembled buildings.

2 Design of cost control methods for assembled building construction

The essence of digital technology lies in the utilisation of digital encoding and logical operations for processing and representing information. This technology is extensively employed across multiple domains and continues to drive technological and societal advancements (Chen and Wang, 2023). Digital technology has also gained widespread application in the construction of assembled buildings. The utilisation of digital technology can enhance the construction efficiency, minimise construction costs, and improve the overall construction quality (Wei and Liu, 2022). During the construction of assembled buildings, several applicable digital technologies are commonly utilised, including:

BIM is an integrated digital building design and management tool, which can carry out virtual modelling and collaborative design, predict and solve potential problems, and optimise the design and installation of components and modules during the construction of assembled building.

The application of digital technology in the production and manufacturing process of assembled buildings allows for precision control through computer numerical control, leading to enhanced production efficiency and quality control of the assembly process (Zhao et al., 2022).

Intelligent Internet of Things (IoT) and sensors: By embedding sensors and Internet of Things (IoT) technology in assembled building, the status and performance of building components and modules can be monitored and managed in real time, which helps to identify and solve problems in advance, optimise maintenance and repair, and improve the sustainability and efficiency of buildings.

Virtual reality and augmented reality technologies can be employed in the design and construction of assembled buildings. These technologies provide immersive and interactive experiences, enabling better visualisation and understanding of the design process, as well as improved construction efficiency and accuracy. Through virtual reality, designers and construction personnel can visually design and simulate in a virtual environment, reducing errors and modifications. Augmented reality can help construction personnel accurately locate and install components and modules during onsite operations.

By utilising artificial intelligence and machine learning, we can analyse Big data to monitor the production, construction, and operation processes of assembled buildings. This data analysis technology can help control construction costs and reduce investment in the assembly process.

Therefore, this paper focuses on utilising machine learning in digital technology for the construction cost control of assembled buildings. We employ information entropy, SVM, and RBF in machine learning to devise the construction cost control method for assembled buildings.

2.1 Collect construction cost data of assembled building

Assembled building is a kind of building mode that adopts modularisation, factory production and rapid assembly (Liang et al., 2021). Prefabricating building components or modules in the factory and transporting them to the construction site can reduce working time, achieve better quality control and resource utilisation, and further reduce costs (Wei et al., 2021).

There may be some differences between the construction cost of assembled buildings and that of ordinary buildings, mainly reflected in the four categories of design cost, material cost, construction cost, transportation and installation cost (Zhang et al., 2023). The specific analysis is as follows:

Design cost: assembled buildings need more workload and technical support in the design phase. Due to the need for modular design, component connections, and other work, this may result in slightly higher design and engineering costs than traditional buildings.

Material cost: assembled buildings usually use standardised, factory prefabricated components or modules, which can reduce the material cost. In addition, due to factory production, material loss and waste are relatively low (Luo et al., 2020).

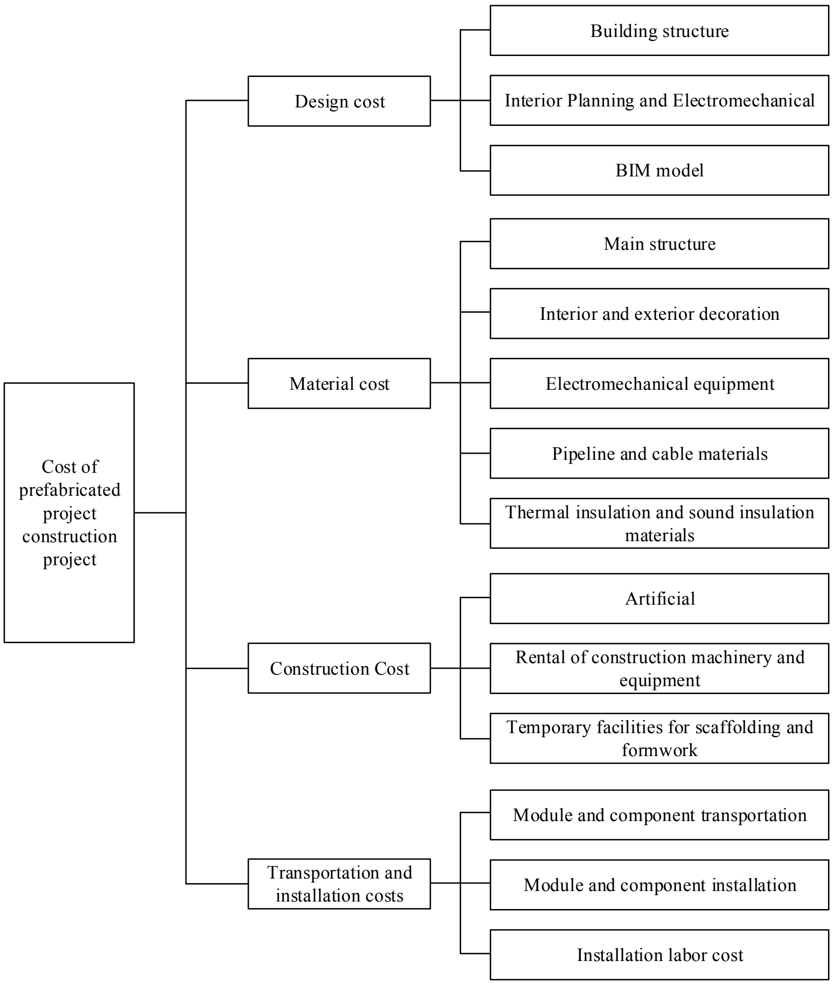
Construction cost: assembled buildings use factory prefabricated components or modules, so the onsite construction time is relatively short, thus reducing labour costs and other costs in the construction process. In addition, assembled building can usually reduce the demand for onsite personnel and equipment, further reducing construction costs.

Transportation and installation costs: assembled buildings need to transport prefabricated components or modules from the factory to the site for assembly. This may increase transportation and installation costs, especially for longer transportation distances and large modules (Xun et al., 2020).

To determine the construction cost of assembled buildings, analyse the four cost categories of design, materials, construction, and transportation and installation. The construction cost structure of assembled buildings is shown in Figure 1.

As Figure 1 reveals, there are 14 sub-costs within the four categories of construction costs for assembled buildings. Furthermore, the specific cost differences in the construction cost of assembled buildings can vary depending on factors such as project scale, design requirements, and geographical location. However, this aspect is beyond the scope of this study, and we only consider the cost content mentioned above. After determining the construction cost structure of assembled buildings, we gather all types of cost data from previously completed projects to ensure accurate and comprehensive data for subsequent cost control.

Figure 1 Construction cost structure of assembled building



2.2 Cost data preprocessing

If the construction cost types of assembled building at the current stage have i and sub costs have j, then the j sub cost in the i cost type can be represented by x_{ij}, so an original matrix *X* can be formed, as follows:

$$X = \begin{bmatrix} x_{11}, x_{12}, \ldots, x_{1y} \\ x_{21}, x_{22}, \ldots, x_{2y} \\ \ldots \\ x_{i1}, x_{i2}, \ldots, x_{ij} \end{bmatrix} \tag{1}$$

To prevent the order of magnitude and dimension of different assembled building construction cost data types from influencing the analysis, it is essential to normalise the construction cost data of assembled buildings (Zhao et al., 2020), so as to obtain the normalised matrix Y composed of normalised indicators. The details are shown in the following equation.

$$Y = \begin{bmatrix} y_{11}, y_{12}, \ldots, y_{1y} \\ y_{21}, y_{22}, \ldots, y_{2y} \\ \cdots \\ y_{i1}, y_{i2}, \ldots, y_{iy} \end{bmatrix} \tag{2}$$

Then normalise the construction cost data of different assembled building to obtain the standard Cx_{ij}:

$$Cx_{ij} = \frac{x_{ij} - x_{\min}}{x_{\max} - x_{\min}} \tag{3}$$

In the formula, $x_{\max}$ and $x_{\min}$ represent the maximum cost data value and the minimum cost data value of the assembled building, respectively. The final normalisation matrix is obtained by combining the results of formula (3):

$$\Delta Y = \frac{Cx_{ij}}{X_{ij}\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{4}$$

According to the normalised matrix ΔY and standard indicator X_{ij} obtained, the information entropy value K_i of the construction cost data of each assembled building can be calculated by calculating the proportion E_{ij} of the i cost type of the j sub cost. The information entropy can reflect the uncertainty and randomness between the data caused by different assembled buildings. Specifically, as follows:

$$E_{ij} = \frac{X_{ij}(\Delta Y)}{\sum_{j=1}^{n} X_{ij}} \tag{5}$$

$$K_i = -k\sum_{j=1}^{n}\left(E_{ij}\ln E_{ij}\right),\ k = \frac{1}{\ln n} \tag{6}$$

When $E_{ij} = 0$, $E_{ij}\ln E_{ij} = 0$.

The large volume of cost data leads to a certain degree of redundancy in the obtained information entropy. Excessive redundant values can compromise the accuracy of assembled building construction cost prediction and subsequently impact the construction cost control results. Therefore, it is crucial to eliminate redundant data and perform preprocessing on the construction cost data of assembled buildings. This can be achieved using formula (7) as shown below:

$$D = 1 - \frac{E_{ij}\left(1 - k_j\right)}{\sum_{j=1}^{n} k_j} \tag{7}$$

2.3 Construction cost estimation model of assembled building based on SVM

In binary classification problems, SVM attempts to find a hyperplane that maximises the separation of sample points from two categories. This hyperplane is determined based on all vectors in the training sample that meet the 'interval' condition. Therefore, the assembled building construction cost data that has been preprocessed can be used as training samples, input into the Euclidean space and mapped to the feature space. Then, this mapping can be applied to the input data to construct a sample dataset, with the expression:

$$D_m = \left\{D_1, D_2, \ldots, D_n\right\} \tag{8}$$

Set φ to represent the construction time dimension, and extract the construction cost data characteristics β of assembled building according to the construction sample dataset:

$$\beta = \varphi\left(D_m\right) \times \frac{X_{ij}\left(\Delta Y\right)}{E_{ij}} \tag{9}$$

Input the acquired characteristics of assembled building construction cost data into the SVM to determine a set of training sets $\left\{u_i, p_i\right\}^N$ with the same size, where u_i and p_i represent input and output respectively. In the feature space, SVM finds a separating hyperplane, which is determined based on the support vectors in the training samples. Let this separation hyperplane be represented by $\aleph$, which can be obtained by multiplying the normal vector ϵ and the constant term τ. The normal vector is a vector perpendicular to the hyperplane, and the constant term is the distance between the hyperplane and the nearest support vector. After obtaining GGG, based on the nonlinear regression equation, to build a construction cost estimation model for assembled buildings, the following calculation formula can be used:

$$p\left(u\right) = \aleph\left[\varpi^T \sigma\left(\beta\right) + \mu + \theta\right] \tag{10}$$

In the formula, ϖ represents the weight vector; σ represents a nonlinear function; T represents transpose; μ represents the amount of deviation; θ represents fitting error.

Use this model to estimate the construction cost of assembled building. Suppose that there are H sub projects in assembled building construction project, and the cost per unit area of each sub project is r. Combining the Lange coefficient method (Wu and Qi, 2020), the construction cost of the project is calculated by multiplying the total construction value per unit area by the construction cost of the assembled building, the process of calculating the construction cost of assembled buildings G is as follows:

$$C = L\left(1 + \sum_{i=1}^{H} R_{ij}\right) \times p\left(u\right) e \tag{11}$$

$$G = \sum_{i=1}^{H} C\left(t \times r \times z\right) D_m \tag{12}$$

In the formula, L represents the Lange coefficient; R_{ij} represents the estimated coefficient of the j sub cost in the i cost type; e represents estimated redundant data; t refers to the construction time adjustment coefficient of assembled building; z refers to the construction quality adjustment coefficient of assembled building.

To prevent external factors from reducing the accuracy of the estimation model during the construction of assembled buildings, it is essential to calculate the sensitivity coefficient affected during construction.

Within the change range of external influencing factors, the change range method (Chen et al., 2019) is used to calculate the change rate of the output results of the assembled building construction cost estimation model when the influencing factors change by a certain range. The formula for calculating the rate of change is as follows:

$$W = \frac{v_{\max}}{v_{\min}} \times \frac{1-\left(f_0\right)}{v_{\max} - v_{\min}} \tag{13}$$

In the formula, W refers to the change rate of the output results of the assembled building construction cost estimation model; $v_{\max}$ and $v_{\min}$ represent the upper and lower limits of influencing factor changes; f_0 represents the magnitude of changes in influencing factors.

The sensitivity coefficient affected during the construction of assembled buildings is calculated based on the change rate of the output result of the assembled building construction cost estimation model. The calculation formula is as follows:

$$\alpha = \frac{\Delta\delta}{\Delta\vartheta} \times G \frac{F\left(f_0\right)}{W \times R_{ij}} \tag{14}$$

In the formula, $\Delta\delta$ represents the change value of the dependent variable; $\Delta\vartheta$ represents the change value of the independent variable; F represents the factors that affect the construction of assembled buildings.

2.4 Construction cost control of assembled building based on radial basis function (RFB)

After developing the construction cost estimation model for assembled buildings using SVM, it is essential to implement cost control measures for the construction of assembled buildings. To enhance the effectiveness of these controls, it is necessary to consider various factors that can impact the construction cost, such as project scale, design requirements, and geographical location, combined with the sensitivity coefficient α, the penalty coefficient γ is used as the complexity of SVM model for constraint optimisation to balance the SVM model and training error. The output results of the optimised model are as follows:

$$\gamma = \alpha \times \frac{1}{2}\varpi^{T}\sigma(\beta) + \Upsilon\frac{1}{2}\sum_{i=1}^{H}\mu \text{ , } i = 1, 2, ..., N \tag{15}$$

In the formula, $\Upsilon\frac{1}{2}\sum_{i=1}^{H}\mu$ represents the error in the training process of assembled building construction cost estimation model.

Radial basis functions (RBFs) have some other advantages. Its parameters are flexible and adjustable, and can adapt to different types of data and problems by adjusting the parameters. In addition, the calculation of RBFs is straightforward and efficient, making it suitable for handling large-scale datasets. Utilising RBF as the kernel function in SVM is beneficial for cost estimation models as it enhances the flexibility, accuracy, and predictive capability of the model, especially suitable for handling nonlinear cost estimation relationships. Because RFB has a significant effect in dealing with nonlinear parameters (Gong et al., 2020), by minimising the deviation in cost control and enhancing the precision of cost control, the kernel function $Q(d_h, d_o)$ can effectively control the construction cost of assembled buildings. The control result of the construction cost of assembled buildings can be obtained using the following calculation formula:

$$\partial = \sum_{i=1}^{H}\gamma Q(d_h, d_o) + \varpi, \qquad h, o = 1, 2, ..., H \tag{16}$$

$$\varepsilon = \partial(J) - \sum_{i=1}^{H}\frac{(\sigma)}{2}\gamma\left\{\varpi^{T}\sigma(\beta) + \mu\right\} \tag{17}$$

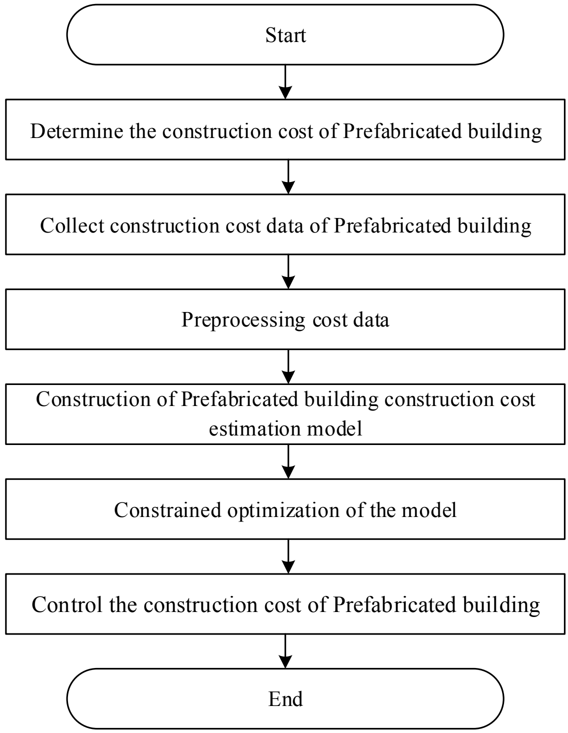
In the formula, ∂ represents the control threshold based on the RFB equation; J represents the kernel parameter of RBF; ε represents the result of construction cost control of assembled buildings.

Based on the above information, we can complete the cost control of the assembled building. With the aid of digital technology, the cost control process of the assembled building is outlined in Figure 2.

3 Experimental results and analysis

This study utilises a construction project of a prefabricated residential quarter in this city as the experimental subject, encompassing a total construction area of approximately 235,000 square metres. It plans to select five high-rise residential buildings of about 63545 square metres as the pilot assembled building. With reference to the national "Evaluation Standard for Industrial Buildings", prefabricated construction is carried out according to the prefabricated rate of 30% and the assembly rate of 60%. The construction period of the five assembled building is 15 days, and a total of 10 construction periods are planned to be completed. Among them, the design cost planned in the early stage is 9.15 million yuan, material cost is 100.65 million yuan, construction cost is 64.05 million yuan, transportation and installation cost is 9.26 million yuan, and initial investment is 18.311 million yuan.

Figure 2 Cost control process of assembled building



3.1 Experimental environment

For this experiment, the Windows 11 system equipped with the 10th generation intelligent Intel Core i7-1065G7 processor was chosen as the operating platform, with a running memory of 32GB and a SS743-G GPU workstation using a real sub cluster ultra silent server, including 3 PCl-E3.0×16 slots. The learning rate of the generative network is set to 0.003, the learning rate of the discriminative network is set to 0.0005, and the algorithm update frequency is set to 6 times. Divide the sample data of 22 past assembled building construction projects into two groups, divided into a training set and a testing set, in a ratio of 18 : 4. The experimental setup is shown in Table 1.

Table 1 System software working environment

Software name	*Edition*
Operating system	Ubuntu 16.04.6 LTS
Python	Python 3.7.1
PyTorch	PyTorch 1.4.6

3.2 Experimental plan

To evaluate the effectiveness of the proposed method in this paper, cost performance indicators are utilised. Additionally, the cost control deviation is employed as an indicator. For comparison purposes, this experiment employs two comparison methods: the cost control method of assembled buildings based on BIM technology and neural networks, and the cost control method of assembled buildings based on the DEMATEL-ISM model. The proposed cost control method for assembled buildings is then tested through experimental analysis.

Cost performance index: The CPI is a metric that assesses whether the project procurement expenditure has been allocated efficiently and fairly, i.e., CPI = EV/AC. Among them, EV is earned value, which is the budgeted cost of actually completing the work, that is, the predicted cost before cost control; AC is the actual cost, which is the actual cost spent on completing the work within the specified time, that is, the actual cost after cost control. If the CPI value falls below 1, it indicates that the actual cost exceeds the budget; whereas if the CPI value surpasses 1, it signifies that the actual cost is lower than the budget, indicating a positive cost control performance for the assembled building construction project. This serves as evidence that the cost control method is effective.

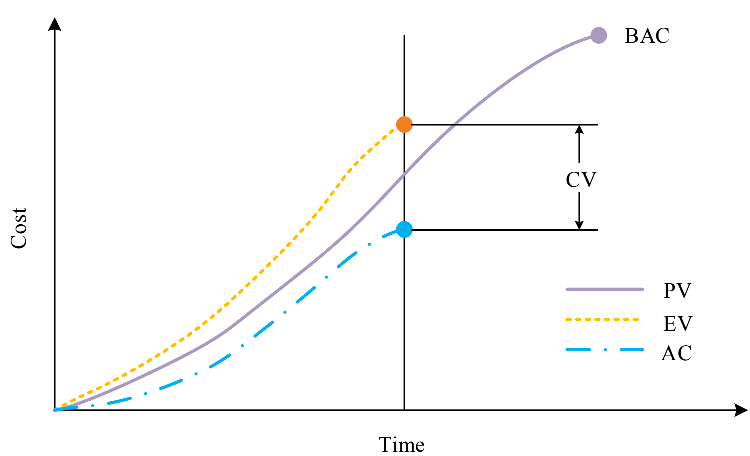
Cost control deviation: Cost control deviation refers to the difference between actual costs and budgeted costs. By analysing cost control deviation, managers can gain timely insights into the cost status of the project or enterprise, and thus formulate corresponding adjustment plans and decisions to maintain the effectiveness of cost control.

3.3 Comparative experiment

3.3.1 Cost performance index

To assess the efficacy of the proposed assembled building construction cost control method, the CPI is utilised as a test metric. The CPI of the assembled building construction project is determined using the cost control method proposed in this paper. The results of the CPI are presented in Figure 3.

Figure 3 Cost performance index (see online version for colours)



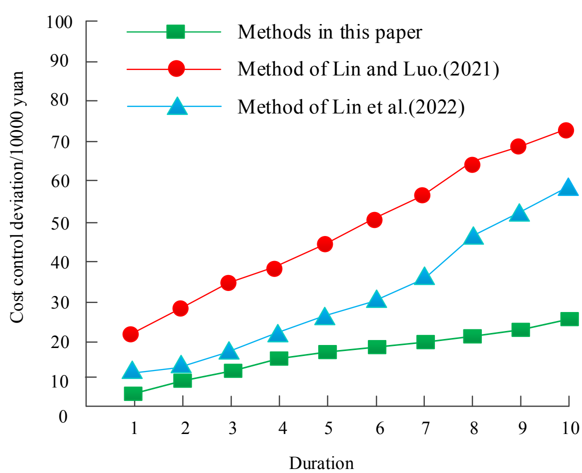
In Figure 3, budget at completion (BAC) refers to the completion budget of the project, which is the total budget from the beginning to the end of the project. It represents the total cost required for the project after completing all work. Cost variance (CV) represents the cost deviation, CV represents the difference between actual cost and earned value, calculated as CV = EV – AC. A positive CV value indicates that the project cost is lower than expected, while a negative CV value indicates that the project cost is higher than expected.

The analysis of Figure 3 reveals that implementing this method to control the construction cost of the assembled building construction project results in positive outcomes. Specifically, EV exceeds AC, CPI surpasses 1, and CV demonstrates positivity. These findings indicate the effectiveness of the cost control approach, as they suggest that the actual construction cost of the project is lower than originally predicted.

3.3.2 Cost control deviation

When evaluating the effectiveness of different cost control methods for assembled building construction projects, it is crucial to consider the extent of cost deviation. A lower cost deviation signifies a higher level of efficacy in the cost control approach. In this context, the cost control deviation of this particular assembled building construction project is compared using three different methods: the assembled building construction cost control method, the assembled building cost control method based on BIM technology and neural network, and the assembled building cost control method based on the DEMATEL-ISM model. The comparative results of cost control deviation for these methods are illustrated in Figure 4.

Figure 4 Cost control bias of different methods (see online version for colours)



According to the findings presented in Figure 4, the cost control deviation increases as the project progresses for all examined cost control methods. Notably, there is a positive correlation between the project progress and the cost control deviation. Upon completion of all projects, it was observed that the Lin and Luo method exhibited the highest cost control deviation of 720,000 yuan, making it the method with the most significant deviation. In contrast, the cost control method proposed by Lin et al. (2022) demonstrated an initial smaller deviation, but its later stages yielded relatively larger deviations, totalling 580,000 yuan. On the other hand, the cost control method proposed in this paper consistently achieved a lower cost control deviation of 260,000 yuan throughout the comparison, outperforming the two methods. Additionally, the growth of the cost control deviation showed a gradual and consistent upward trend, underscoring the effective cost control achieved by the method put forth in this paper over the entire construction period.

4 Conclusion

To address the limitations present in current cost control approaches for assembled building construction, this paper takes advantage of digital technology to devise a novel cost control method.

1. Key steps involved in developing a cost control method for assembled building construction are as follows: firstly, the cost breakdown of assembled building construction is determined. Next, past data is collected and preprocessed. Subsequently, the sensitivity coefficient influenced during the construction process and the rate of change in output results are calculated. Based on these calculations, a cost estimation model for assembled building construction is built utilising SVM. To further enhance the method, it is combined with a RBF. This comprehensive approach aims to effectively control the construction cost of assembled buildings.

2. Experimental findings confirm the effectiveness of the cost control method proposed in this paper for assembled building construction. The method demonstrates an earned value (EV) greater than actual cost (AC), a CPI value exceeding 1, and a final cost control deviation of 260,000 yuan, indicating a minimal deviation. Consequently, the implementation of this method leads to actual construction costs that are lower than the initially projected costs, highlighting its efficacy in cost control. These results serve as evidence that the proposed design methods can significantly enhance the level of cost control in assembled building construction. Furthermore, they contribute to the promotion of a healthy development of the assembled building industry, and hold practical implications for achieving the transformation and upgrading of the construction industry while bolstering overall competitiveness.

References

Chen, F. and Wang, N. (2023) 'Simulation of incremental control of energy consumption cost in the whole life cycle of prefabricated buildings', *Computer Simulation*, Vol. 40, No. 01, pp.373–377.

Chen, W., Wu, Y., Zou, S., He, K. and Qin, G.K. (2019) 'Construction cost factor analysis of prefabricated building based on structural equation model', *Journal of Civil Engineering and Management*, Vol. 36, No. 05, pp.50–55.

Gong, P., Zhang, J., Xiong, F. and Liu, F. (2020) 'The whole process cost determination of fabricated building based on component splitting scheme', *Construction Economy*, Vol. 41, No. 01, pp.76–83.

Li, H., Chen, X. and Gao, Y. (2022) 'Research on difficulties and countermeasures of prefabricated building cost control', *Construction Economy*, Vol. 43, No. S1, pp.109–111.

Liang, X., Wang, D., Dai, J., Guo, J. and Du, M.T. (2021) 'Research on cost control of prefabricated construction project under EPC model: taking a affordable housing project as an example', *Construction Economy*, Vol. 42, No. 11, pp.56–60.

Lin, S. and Luo, H. (2021) 'Research on cost control of prefabricated building based on BIM technology and neural network', *Construction Economy*, Vol. 42, No. 02, pp.86–89.

Lin, Y., Hao, M. and Wang, Y. (2022) 'Research on cost control of prefabricated steel structure building based on DEMATEL-ISM model', *Construction Economy*, Vol. 43, No. 09, pp.54–60.

Liu, G., Qi, Y., Ji, Y., Feng, J. and Zahng, K.M. (2019) 'Research on the identification of influencing factors of prefabricated building cost under EPC model and formulation of evaluation criteria', *Construction Economy*, Vol. 40, No. 05, pp.86–92.

Liu, Z. and Guo, J. (2022) 'Research on construction cost control of prefabricated building based on BIM', *Construction Economy*, Vol. 43, No. 03, pp.40–46.

Luo, L., Wu, X. and Huang, W. (2020) 'Analysis of the factors influencing the cost of prefabricated buildings based on fuzzy cognitive map', *Construction Economy*, Vol. 41, No. S2, pp.77–82.

Luo, X. and Huang, X. (2021) 'Research on cost control of prefabricated building based on interpretative structural modeling method', *Construction Economy*, Vol. 42, No. 11, pp.73–77.

Lv, Z., Sun, H., Wen, D., Hu, G. and Xu, Y. (2022) 'Research on the influencing factors of the cost of prefabricated building in Jilin under the perspective of life cycle cost', *Construction Economy*, Vol. 43, No. S1, pp.120–125.

Wei, H., Niu, C., Liu, F., Chen, K. and Ren, Z.F. (2021) 'Research on factors influencing the cost of prefabricated building components based on DEMATEL-AISM method', *Construction Economy*, Vol. 42, No. 10, pp.83–88.

Wei, R. and Liu, X. (2022) 'A life cycle cost analysis for pre-fabricated steel structure buildings', *Building Structure*, Vol. 52, No. S2, pp.1539–1542.

Wu, Z. and Qi, A. (2020) 'Research on cost evaluation method of prefabricated building based on fuzzy TOPSIS', *Journal of Fuzhou University (Natural Science Edition)*, Vol. 48, No. 05, pp.618–624.

Xun, Z., Zhang, L., Zhao, Z., and Niu, B. (2020) 'Cost risk evaluation of prefabricated buildings based on combined weighted cloud model', *Journal of Civil Engineering and Management*, Vol. 37, No. 06, pp.8–13.

Yu, H., Shang, Z., Liu, Q., Peng, P. and Huang, F. (2021) 'Research on cost accounting model of prefabricated building components based on time-driven activity-based costing', *Construction Economy*, Vol. 42, No. S2, pp.35–39.

Zhang, J., Wei, W. and Chen, K. (2023) 'Research on the evaluation of the control level of prefabricated building's implicit cost based on SEM-MEA', *Building Science*, Vol. 39, No. 05, pp.202–210.

Zhao, L., Li, S. and Teng, J. (2022) 'Influencing factors and control countermeasures of cost analysis of prefabricated buildings based on the whole life cycle', *Construction Economy*, Vol. 43, No. 11, pp.98–104.

Zhao, Y., Zhang, C. and Liu, Y. (2020) 'Research on the composition and optimized direction of prefabricated construction cost chain: based on the perspective of real estate enterprises', *Construction Economy*, Vol. 41, No. 11, pp.57–62.