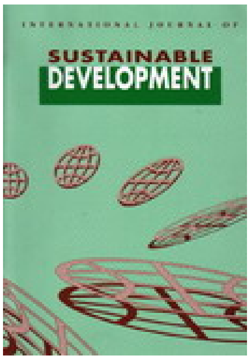


International Journal of Sustainable Development

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

Accurate estimation of prefabricated building construction cost based on support vector machine regression

Min Jiang, Boda Li

DOI: 10.1504/IJSD.2024.10062173

Article History:

Received:	01 August 2023
Last revised:	18 October 2023
Accepted:	11 December 2023
Published online:	15 July 2024

Accurate estimation of prefabricated building construction cost based on support vector machine regression

Min Jiang*

Department of Civil Engineering,
Hunan City University,
YiYang, 413000, China
Email: 16013998@qq.com
*Corresponding author

Boda Li

Department of Finance,
Hunan University of Finance and Economics,
ChangSha, 410205, China
Email: liboda@hufe.edu.cn

Abstract: In order to overcome the low accuracy and assembly rate of the traditional construction cost estimation methods for prefabricated building, an accurate estimation method of prefabricated building construction cost based on support vector machine regression is proposed. The cost estimation indicators for prefabricated building construction are selected, and the indicators are preprocessed. The input vector for accurate cost estimation models for prefabricated building construction is determined, including prefabrication cost, assembly cost, direct cost, and indirect cost. A cost estimation model based on support vector machine regression is constructed, and Lagrange transformation is introduced for model training. The trained model is used to obtain accurate cost estimates for prefabricated building construction. The test results show that the cost estimation accuracy of the proposed method is basically maintained at around 99%, and the assembly rate is above 95%, which can ensure the cost estimation accuracy and has strong applicability.

Keywords: support vector machine regression; prefabricated building; construction cost; accurate estimation method; cost estimation model; Lagrange transformation.

Reference to this paper should be made as follows: Jiang, M. and Li, B. (2024) ‘Accurate estimation of prefabricated building construction cost based on support vector machine regression’, *Int. J. Sustainable Development*, Vol. 27, No. 3, pp.246–261.

Biographical notes: Min Jiang received her Master’s degree in Engineering Management from Central South University of Forestry and Technology in 2013. Currently she is a Lecturer in the Department of Civil Engineering of HunanCity University. Her research interests include engineering management and cost management.

Boda Li received her Master's degree in Finance Economics from Katholieke Universiteit Leuven in 2003. Currently she is a Lecturer in the Department of Finance of Hunan University of Finance and Economics. Her research interests include finance engineering and investment portfolio management.

1 Introduction

With the continuous deepening of social urbanisation, the number of urban buildings has increased on a large scale. The construction industry plays a crucial role in it. In recent years, with the continuous development of construction technology, a large number of buildings have been built quickly in a relatively short time and cost (Zhao et al., 2021). Among them, the emergence of prefabricated building has become a more eye-catching construction project in the construction industry. Prefabricated building is a common building casting method in which building parts are transferred to the factory for direct processing, manufactured according to the size and demand of building parts, and then assembled according to a certain connection method (Zhao and Chen, 2022). Prefabricated building adopts information technology and other technologies, which has become a popular construction method in architecture. This building form has been widely used due to its advantages of saving manpower, significantly shortening construction period, and high-quality environmental protection (Li et al., 2021). Although prefabricated buildings are relatively easy to realise the rapid construction of buildings, the cost of prefabricated building continues to rise due to the limitations of raw materials, geographical location, etc. And because the size of prefabricated building components is easily limited by production equipment, it cannot fully meet consumer needs. From this point of view, the development of prefabricated building also has certain limitations. If prefabricated building want to develop stably, they need to pay more attention to their construction costs (Vassiliades et al., 2022). For this reason, people in this field have designed many estimation algorithms for the construction cost of prefabricated building, and have made certain achievements.

Wang et al. (2022) proposed to study the use of deep neural networks to estimate construction project costs. In this study, it was pointed out that many construction cost estimation methods overlook external economic factors, resulting in inaccurate estimation of construction project costs. In order to quantitatively study these impacts, this study uses the deep neural network as the Estimator, and the Shapley additive expansion planning as the model interpreter. This analysis is also verified by using the comparative analysis of several popular machine learning models in building cost estimation. The results indicate that economic factors play an important role in reducing engineering cost estimation errors. The research results will help stakeholders in the construction and management fields make appropriate decisions, and help researchers reveal the actual impact of other influencing factors on construction cost estimation. This algorithm has good theoretical performance, but the corresponding influencing factors in estimation are not detailed, and further refinement and improvement are needed. (Wu and Huang, 2021) designed a cost estimation method for construction projects based on artificial intelligence technology. Based on the theory of artificial neural network, genetic algorithm and engineering cost, a radial basis function optimisation model based on genetic algorithm is proposed. This search feature combines the width, centre, and hidden layer weights of the RBF network with genetic algorithm for self correction, greatly improving the accuracy of model calculation results. In this method, four test samples were tested based on the model's error (actual output expected output), reducing the estimated error value and improving the estimation effect. However, this method has limited parameter selection in the model input, weak persuasiveness, and certain shortcomings. Jiang et al. (2022) proposed an engineering cost estimation method based on time series data. This method points out that investments in building materials, labour, and other miscellaneous items should consider their significant costs. Based on these reasons, this study focuses on analysing the construction cost from the perspective of using a multivariate cost prediction model to predict the construction cost index and other independent variables, and predicts the selected variables using social science statistical package software and R program design application. Pearson correlation is used to compare these predicted values with CCI to evaluate influencing factors. The ARIMA model has the highest model fitting correlation and is the best predictive model.

In order to improve the accurate estimation of the construction cost of prefabricated building, this paper designs a new accurate estimation method of prefabricated building construction cost based on support vector machine regression. The main research contents of this paper are as follows:

1 Analyse the construction cost composition of prefabricated building and screen the construction cost estimation indicators of prefabricated building, obtain multiple cost estimation indicators such as prefabricated cost, assembly cost, direct cost and indirect cost, and use these indicators as the input vector of the accurate estimation model of the construction cost of prefabricated building.

2 Based on the cost estimation indicators obtained, the indicator data with less impact are removed, and the indicator data are normalised and checked for consistency, so as to achieve the pretreatment of prefabricated building construction cost estimation indicators.

3 On the basis of pretreatment of cost estimation indicators, build a cost accurate estimation model based on support vector machine regression, introduce Lagrange transform to train the model, and use the trained model to obtain accurate construction cost value of prefabricated building.

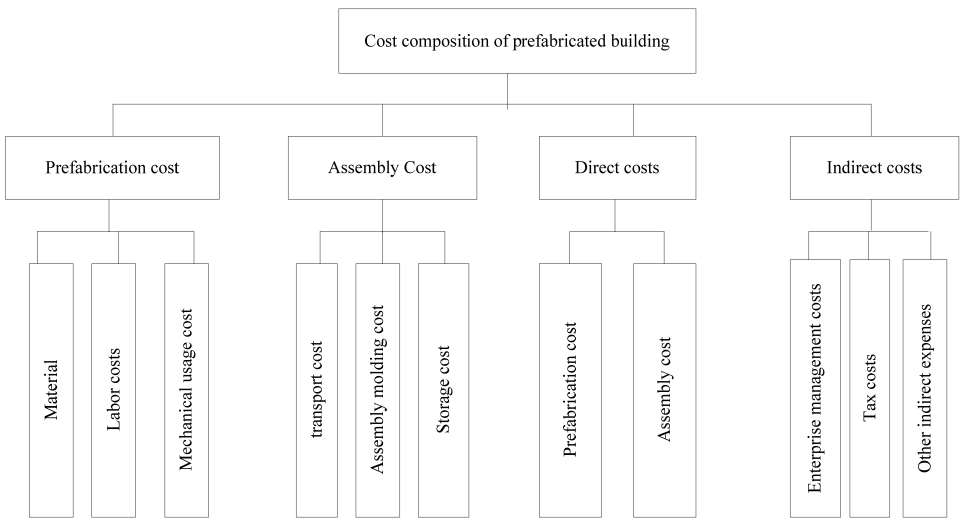
4 Design of experimental plans and analysis of experimental methods.

2 Screening and pretreatment of prefabricated building construction cost estimation indexes

2.1 Selection of construction cost estimation indicators for prefabricated building

In order to realise the construction cost estimation of prefabricated building, it is necessary to clarify the construction cost composition of prefabricated building before index screening. There are significant differences between prefabricated building and traditional buildings. It is necessary to understand the cost composition of the building before estimating its cost (Akanbi and Zhang, 2021). Prefabricated building mainly refers to the type of building that some or all of the prefabricated parts are processed in the factory and connected through a certain degree. It can be seen from its production process that the cost of prefabricated building includes labour costs, site costs and transportation costs. In the prefabricated building project, the cost of the building components in the early stage is consistent with that of the traditional building structure, which is mainly the cost of materials. However, due to the change of construction methods, the proportion of various costs has also changed significantly (Chen, 2022). In addition to traditional building costs, this building model also increases the production cost, transportation cost, and construction site prefabrication cost of prefabricated components. The specific composition is shown in Figure 1.

Figure 1 Schematic diagram of construction cost composition of prefabricated building



As shown in Figure 1, the construction cost of prefabricated building is complicated, including many cost types of major and minor items. In order to effectively estimate the construction cost of prefabricated building, on the basis of analysing the construction cost composition of prefabricated building, it is also necessary to further analyse the relationship between costs to reduce the difficulty of estimation.

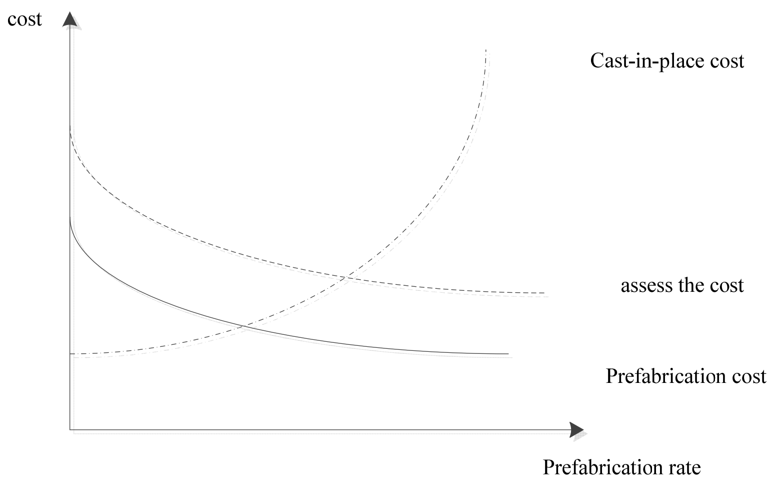
Based on the analysis of the construction cost composition of prefabricated building, the index system of this estimation is constructed, which is the key parameter of this estimation. Most of the costs in the construction cost of prefabricated building are the prefabrication costs and assembly costs (Daud and Malik, 2022). The prefabrication cost of prefabricated building in this indicator is reflected by the prefabrication rate (Bettinger, 2021), namely:

$$y_i = \frac{b^3}{c^3 + b^3} \times 100\% \tag{1}$$

In formula (1), y_i represents the prefabrication rate, b^3 represents the volume of prefabricated materials, and c^3 represents the volume of cast-in-place materials.

The influence of the prefabrication rate of prefabricated building on the total cost is shown in Figure 2.

Figure 2 Schematic diagram of the influence of prefabrication rate of prefabricated building on total cost



The assembly cost is composed of the proportion of prefabricated parts, commodity quantity and other products. The assembly cost in the construction cost of prefabricated building is reflected by the assembly rate (Bodendorf et al., 2021), namely:

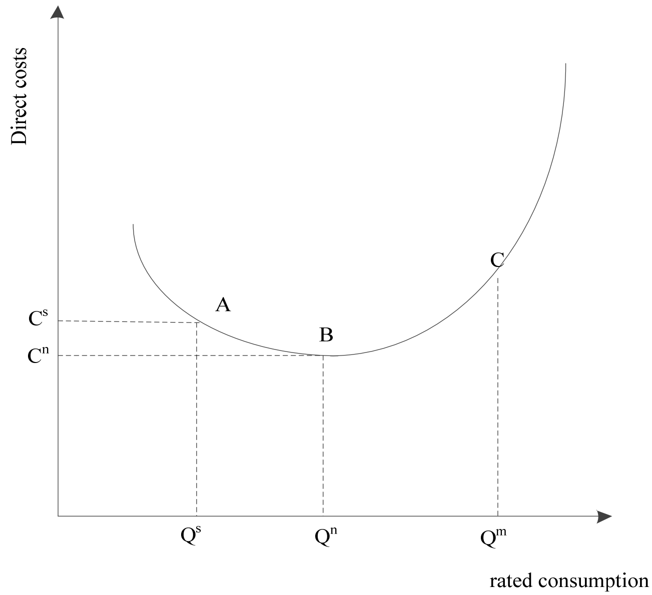
$$P = \frac{p_1 + p_2 + p_3}{100 - p_4} \times 100\% \tag{2}$$

In formula (2), p_1 represents the cost of the main assembly structure, p_2 represents the cost of walls and interior walls, p_3 and p_4 represent the cost of decoration and equipment installation, and P represents the total cost.

According to the different rated consumption, the construction cost of prefabricated building can also be divided into direct cost and indirect cost, which are also key estimation indicators. The rated consumption of prefabricated parts in prefabricated building refers to the amount of materials needed to make prefabricated parts, and the amount of this parameter is directly related to the construction cost (Aguirre et al., 2021). There is a linear relationship between rated consumption and direct cost, as shown in Figure 3.

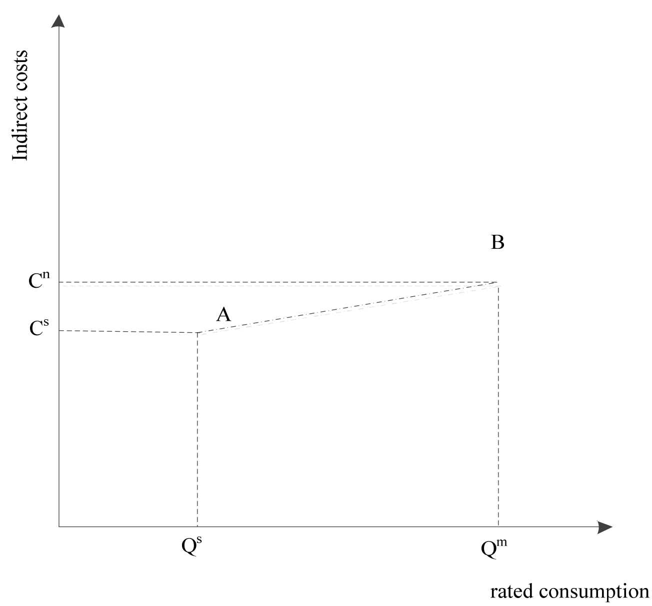
As can be seen from Figure 3, the direct cost of prefabricated building construction increases with the increase of rated consumption. At the beginning, the rated consumption is less, but the construction cost is higher. This is because there are more machinery, labour and materials invested in the initial construction, which is more stable in the middle stage. Point B becomes an extreme point of rated consumption in this stage (Gauch et al., 2023), and its rated consumption corresponds to point Q^n, This value can be regarded as a normal consumption, where C^n is the critical cost among direct costs; As the construction stages vary and the amount of materials invested increases, the direct cost continues to rise.

Figure 3 Schematic diagram of the linear relationship between rated consumption and direct cost



The indirect cost in the construction cost of prefabricated building is included in the project cost in the mode of apportionment, which has a positive proportion relationship with the quota consumption. As the quota consumption increases, the more the indirect cost apportioned, the greater the proportion relationship between them (Mahmoodzadeh et al., 2022a). The positive proportion relationship between fixed consumption and indirect costs is shown in Figure 4.

Figure 4 Positive proportional relationship between quota consumption and indirect costs



As shown in Figure 4, point A in the figure represents the minimum fixed consumption, denoted by Q^s, and its indirect cost is C^s, point B represents the corresponding consumption of Q^n, and point C^n represents the corresponding indirect cost. Assuming that the indirect cost between point A and point B is an indirect rate, the relationship between the two can be expressed as:

$$c(x) = \frac{C^n - C^s}{Q^n - Q^s} \tag{3}$$

In formula (3), $c(x)$ represents the indirect rate.

In the screening of prefabricated building construction cost estimation indicators, analyse the construction cost composition of prefabricated building, and screen the prefabricated building construction cost estimation indicators as prefabrication cost, assembly cost, direct cost and indirect cost. Then analyse the proportional relationship between cost indicators and between quota consumption and indicators, and complete the screening of prefabricated building construction cost estimation indicators.

2.2 Pretreatment of prefabricated building construction cost estimation indicators

Based on the cost estimation indicators for prefabricated building construction selected in Section 2.1, some indicators are preprocessed to ensure the accuracy of subsequent analysis. In the screening of prefabricated building construction cost estimation indicators, there are many other branch indicators in the four key indicators of prefabricated cost, assembly cost, direct cost and indirect cost, and there are also indicators with less impact in these indicators. Such indicators are bound to affect the accuracy of estimation (Ye, 2021). For this reason, this paper further preprocesses the selected estimation indicators.

In this preprocessing study, a multi-level structural model was constructed to select key indicators for decision-making. The target layer includes three types: target indicator layer, intermediate indicator layer, and indicator layer (Zhang et al., 2021). Among them, the first layer is the key indicator, and the intermediate indicator layer and target layer need to determine the important indicators based on specific cost estimates. Set the intermediate indicator layer set representation as:

$$D = (D_1, D_2, ..., D_m) \tag{4}$$

Set the indicator set of the target layer as:

$$F = (F_{11}, F_{12}, ..., F_{mn}) \tag{5}$$

At this point, it is necessary to construct a judgement matrix to distinguish the criticality of indicators in the intermediate indicator layer and the target layer, namely:

$$H = (h_{ij})_{m \times n} \tag{6}$$

In formula (6), H represents the judgement matrix, and h_{ij} represents the judgement rules of the judgement matrix.

According to the constructed judgement matrix (Dasovi and Klanek, 2021), the importance of cost indicators in formulas (4) and (5) is determined. Among the results obtained, the key indicators in the middle indicator layer are:

$$H(D) = (h_{ij})_{m\times n} = \begin{bmatrix} h(D_1), h(D_2), \ldots h(D_{1m}) \\ h(D_2), h(D_3), \ldots h(D_{2m}) \\ \cdots \\ h(D_{n1}), h(D_{n2}), \ldots h(D_{nm}) \end{bmatrix} \tag{7}$$

In formula (7), $H(D)$ represents the judgement matrix for key indicators in the intermediate indicator layer.

The key indicators in the target layer are:

$$H(F) = (h_{ij})_{m\times n} = \begin{bmatrix} h(F_{11}), h(F_{12}), \ldots h(F_{1m}) \\ h(F_{21}), h(F_{22}), \ldots h(F_{2m}) \\ \cdots \\ h(F_{11}), h(F_{12}), \ldots h(F_{mn}) \end{bmatrix} \tag{8}$$

In formula (8), $H(F)$ represents the key indicator judgement matrix of the target layer.

After processing the indicators in the intermediate indicator layer and the target layer, it is necessary to further determine the criticality of the construction cost indicators in the target indicator layer. This processing is completed by calculating weights (Jarndal et al., 2021), and the results obtained are:

$$\beta_{max} = \sum_{i=1}^{n} \frac{(r)_i}{nv_i} \tag{9}$$

In formula (9), β_{max} represents the maximum weight value of the construction cost indicator in the target indicator layer, v_i represents the indicator entropy value, and $(r)_i$ represents the initial indicator data sample value.

After determining the criticality of all the construction cost indicator data mentioned above, in order to facilitate subsequent estimation research, it is necessary to normalise and verify the consistency of all indicator data. The normalised result is represented as:

$$g_i(x) = \frac{u_i}{\sum_{i=1}^{n} u_i} \tag{10}$$

In formula (10), $g_i(x)$ represents the normalisation model of construction cost indicator data, and u_i represents the number of all required normalisation indicators.

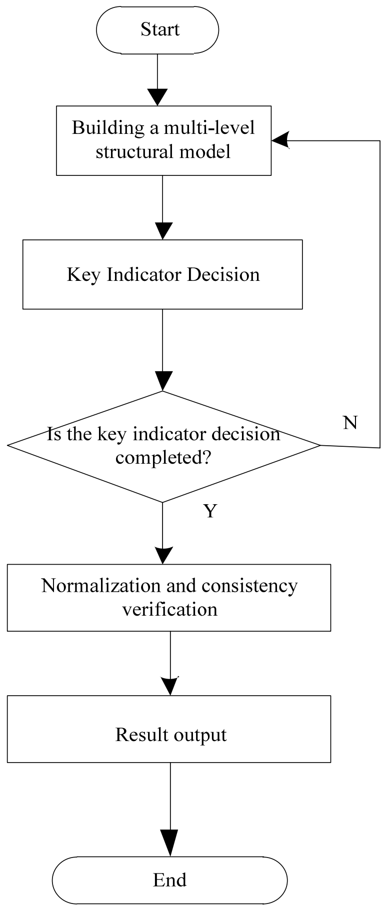
The verification result of the consistency of construction cost indicators is expressed as:

$$CI = \frac{\delta_{\max} - n}{n-1} \tag{11}$$

In formula (11), δ_{max} represents the maximum eigenvalue of the indicator, and CI represents the consistency check result.

The pre-processing realisation process of prefabricated building construction cost estimation indicators is shown in Figure 5.

Figure 5 Pre-processing implementation process of prefabricated building construction cost estimation indicators



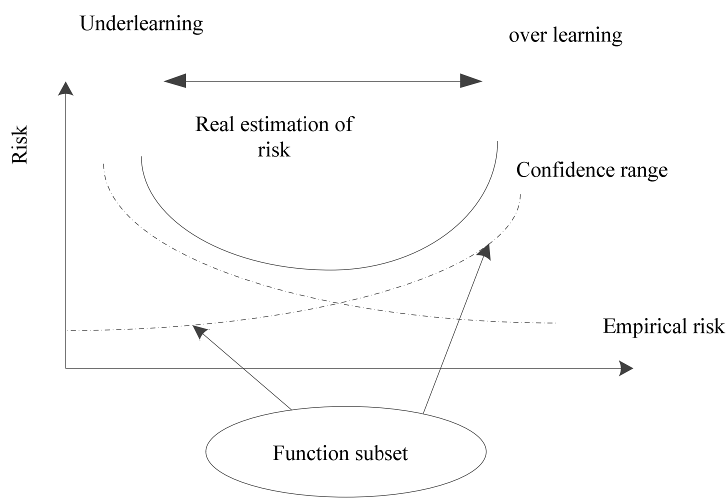
In the pretreatment of construction cost estimation indicators for prefabricated building, the decision-making and selection of key indicators are carried out by building a multi-level structure model, the key degree of indicators in different levels is calculated to remove the indicator data with less impact, and the indicator data is normalised and checked for consistency, so as to achieve the pretreatment of construction cost estimation indicators for prefabricated building.

2.3 Accurate cost estimation based on support vector machine regression

Using the preprocessed results of the indicators in Section 2.2 as the input vector for the precise cost estimation model of prefabricated building construction, which mainly includes prefabricated costs, assembly costs, direct costs, and indirect costs, a cost estimation model based on support vector machine regression is constructed. The

Lagrangian transform is introduced to train the model, and the trained model is used to obtain accurate cost values of prefabricated building construction. On the basis of the above analysis, in order to achieve accurate cost estimation of prefabricated building, this paper introduces support vector machine regression algorithm to design the final cost estimation algorithm. Support vector machine regression algorithm is developed on the basis of support vector machine. This algorithm can not only perform effective classification, but also perform nonlinear regression fitting (Mahmoodzadeh et al., 2022b). The principle of this algorithm is to map low dimensional nonlinear problems to high-dimensional spaces for transformation, and then perform linear processing to obtain the optimal solution. In the design of this algorithm, steps such as selecting input variables, kernel functions, model training, and parameter optimisation are required. This algorithm can reduce the estimation error and improve the estimation accuracy in the construction cost estimation of prefabricated building. This algorithm can improve the accuracy of cost estimation based on its own experience and machine learning. The basic empirical structure diagram of this algorithm is shown in Figure 6.

Figure 6 Schematic diagram of support vector machine regression algorithm



The design and implementation process of a cost accurate estimation algorithm based on support vector machine regression is as follows:

Process 1: Determine the input sample set of prefabricated building construction cost estimation indicators, and map the indicators to a high-dimensional space by establishing a regression function. The sample set of prefabricated building construction cost estimation indicators is expressed as:

$$\{(x_i, x_j), i = 1, 2, ..., n\} \tag{12}$$

The results of establishing a regression function mapping to high-dimensional space are represented as:

$$f(x) = w^T \gamma(x) + b \tag{13}$$

In formula (13), $f(x)$ represents the regression function model, $\gamma(x)$ represents the nonlinear mapping function, b represents the offset value, and w^T represents the multidimensional space of the mapping.

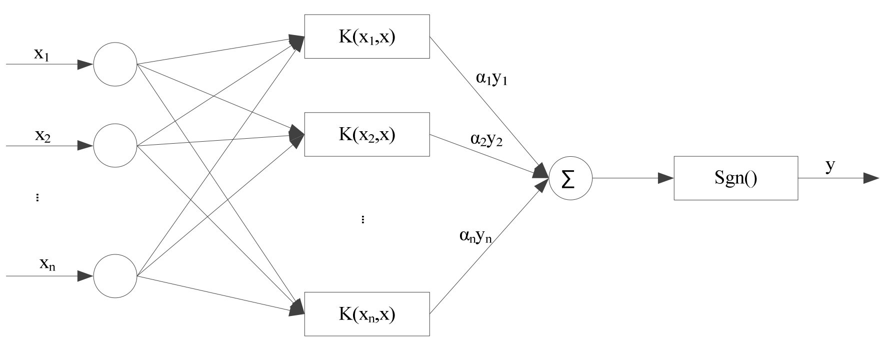
Process 2: Selection of kernel functions. When using support vector machine regression, the choice of kernel function has a greater impact on the estimation of the construction cost of prefabricated building. There are many types of kernel functions, but the radial basis function has better performance. The expression of this function is:

$$K\left(x_i, x_j\right) = \exp\left\{-\frac{\left|x_i - x_j\right|^2}{2\vartheta^2}\right\} \tag{14}$$

In formula (14), $K\left(x_i, x_j\right)$ represents the radial basis kernel function model, and ϑ represents the kernel parameter. If the function is too small, it will result in poor generalisation ability of the estimation. Therefore, the selection of this value should be more appropriate.

Process 3: Build a cost accurate estimation model based on support vector machine regression. The cost index data of prefabricated building are screened through the input of the model, and further optimised according to the output results, so as to improve the accuracy of the algorithm. The topology structure of the cost accurate estimation model based on support vector machine regression is shown in Figure 7.

Figure 7 Topological structure of cost accurate estimation model based on support vector machine regression



It can be seen from the analysis of Figure 7 that the input vector of the cost accurate estimation model based on support vector machine regression is the prefabrication cost, assembly cost, direct cost and indirect cost, and the output vector is the construction cost value of accurate prefabricated building.

The constructed model is represented as:

$$y = \sum_{x=1}^{n}\left(t\left(x_n, x\right)\right)\int K\left(x_n, x\right)\alpha_n y_n \tag{15}$$

In formula (15), $K\left(x_n, x\right)$ represents the nonlinear transformation function, α_n represents the weight, y_n represents the expected output value, and t represents the threshold.

Process 4: On the basis of the above initial output of prefabricated building construction cost estimation output results, due to the constant changes of indicator variables, such as the fluctuation of material costs, the cost estimation will have some errors. Therefore, optimisation is still needed in this process. Lagrange transformation is introduced to realise model training, namely:

$$y(x) = MAX\left[-\frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{m} t\left(x_i, x_j\right) - \alpha_n \sum_{i=1,\, j=1}^{m,n} z(x)\right] \tag{16}$$

In formula (16), $z(x)$ represents the estimation error function.

To sum up, this paper mainly determines the input sample set of prefabricated building construction cost estimation indicators, maps the indicators to a high-dimensional space by establishing a regression function, selects the radial basis function kernel function to reduce the generalisation of the estimation, builds a precise cost estimation model based on support vector machine regression, introduces Lagrange transformation optimisation to train the model, and realises the research on prefabricated building construction cost estimation.

3 Experimental analysis

3.1 Experimental plan

To verify the feasibility of the proposed estimation method, an experimental analysis was conducted. In the experiment, a prefabricated building that is being installed in a certain place is selected as the estimation object. In this study, the cost of prefabricated components is fixed, and there are certain changes in their pre assembly costs and assembly costs. The prefabricated building consists of prefabricated components such as block building, plank building, skeleton plank building, exterior wall panels, stairs, etc. Parameters such as component cost of prefabricated building in this experiment are shown in Table 1.

Table 1 Experimental parameters

Parameter	*Content*	*Content*
Rebar/kg/yuan	5	135
Concrete (C30)/m^3/yuan	450	1.0
Hardware accessories/items/yuan	100	1.0
Production labour/m^3/yuan	750	1.0
Transportation of prefabricated parts/m^3/yuan	300	1.0
PC components/m^2/yuan	305	1.0
Rough assembly/m^2/yuan	405	1.0
Iterations	100	–
Data processing software	Spss10.0	–

Utilise multiple channels to obtain cost data for supporting buildings, and clean the data collected at the location to ensure the reliability of experimental data. Not so, in order to ensure that the experimental data can be input into the simulation software, it is necessary to normalise the experimental data to ensure that the data length is consistent and can be smoothly input into the computer. The types of experimental data used in this experiment are as follows:

1 *Prefabrication cost*: during the construction of prefabricated building, the prefabrication cost refers to the cost related to the production and transportation of prefabricated components, mainly including the production cost of prefabricated components, transportation cost, loading and unloading cost, infrastructure cost, equipment and facilities cost, etc.

2 *Assembly cost*: during the construction of prefabricated building, assembly cost refers to the costs related to the assembly and installation of components, mainly including labour costs, tools and equipment costs, construction site preparation costs, safety measures costs, quality control costs, management costs, etc.

3 *Direct costs*: the direct costs during the construction of prefabricated building mainly refer to those costs directly related to specific components and materials. Direct costs are an important part of the construction of prefabricated building and are crucial to the cost control and funding of the project, mainly including material costs, infrastructure costs, auxiliary materials and small tools costs.

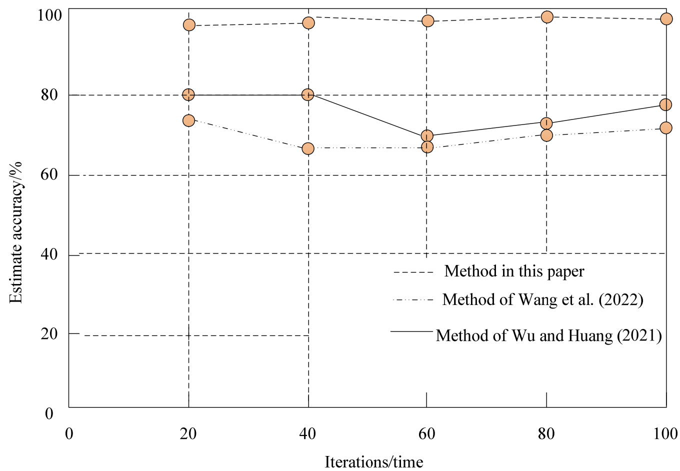
4 *Indirect costs*: Indirect costs in the construction process of a modular building refer to costs that are not directly related to specific components and materials, but have an impact on the entire construction project. They mainly include design costs, engineering management costs, building permits and approval costs, project insurance costs, quality control and testing costs, building site rental costs, office equipment and personnel costs, legal and compliance costs Management software and technical support costs, etc.

Based on the above designed experimental scheme, the experimental test indicators selected in this test are the construction cost estimation accuracy of prefabricated building and the assembly rate after cost estimation among them. The accuracy of construction cost estimation is mainly based on the estimation of the prefabrication cost, assembly cost, etc. of prefabricated building, and the accuracy after comparing the result with the actual cost of the actual assembly cost; The assembly rate after cost estimation refers to the ratio of prefabricated components to all components within the scope of single building after cost estimation of prefabricated building. This indicator indirectly reflects the reliability of cost estimation. The higher the assembly rate, the more realistic the estimated cost is. In order to ensure the effectiveness of the experiment, multiple experimental verifications were conducted on the data obtained in the experimental study, ensuring that the obtained data meets the experimental requirements and can verify the effectiveness of the proposed method.

3.2 Analysis of experimental results

The method adopted in this paper, method of Wang et al. (2022) and method of Wu and Huang (2021) were compared. For the selected sample prefabricated building, 100 cost estimates were made, mainly for prefabrication costs, assembly costs, etc. The estimated accuracy results are shown in Figure 8.

Figure 8 Accuracy results of prefabricated building construction cost estimation (see online version for colours)



From the analysis of the test results in Figure 8, it can be seen that there are significant differences in the accuracy of the construction cost estimates for the selected sample prefabricated building using the three methods. Among them, from the bar chart results, the estimation accuracy of the method in this paper is basically maintained at about 99%, and the estimation accuracy of his two methods is far lower than that of the method. Compared with one of the three methods, the accuracy of the method in this paper is better, which verifies the feasibility of the proposed method in the three methods.

After estimating the cost, the experiment further used three methods to analyse the assembly rate of the sample prefabricated building after evaluation, and the results obtained can indirectly reflect the rationality of the method. The assembly rate results of the three methods are shown in Table 2.

Table 2 Results of assembly rate of prefabricated building with different method samples (%)

Iterations	*Method in this paper*	*Method of Wang et al. (2022)*	*Method of Wu and Huang (2021)*
20	96	87	85
40	96	85	83
60	96	85	82
80	95	83	80
100	95	82	80

Analysing the experimental data in Table 2, it can be seen that as the number of iterations continues to change, method in this paper, method of Wang et al. (2022) and method of Wu and Huang (2021) after estimation, the assembly rate of prefabricated building has a certain change. Among them, the method with the highest assembly rate is method in this paper, which remains above 95%, followed by method of Wang et al. (2022), and finally method of Wu and Huang (2021). Comparing the results of assembly rate, it can be seen that the method in this paper performs better.

4 Conclusion

As a rapid, efficient and sustainable construction method, prefabricated building has attracted more and more people's attention. Accurately estimating the construction cost of prefabricated building is of great significance for budget planning and project decision-making. Therefore, this paper proposes to design an accurate estimation method of prefabricated building construction cost based on support vector machine regression. Select the prefabricated building construction cost estimation indicators as prefabrication cost, assembly cost, direct cost and indirect cost, input the processed indicator data into the trained accurate cost estimation model based on support vector machine regression, and obtain the prefabricated building construction cost estimation results. The test results show that the accuracy of the proposed method in estimating the construction cost of prefabricated buildings is basically around 99%, and the assembly rate is above 95%. Therefore, this method has the characteristics of high accuracy in estimating the construction cost of prefabricated buildings and assembly rate, and has certain feasibility. This paper accurately estimates the construction cost of prefabricated building, which can provide important reference information for decision makers and promote the application and development of prefabricated building. Future research will further improve the cost estimation model and further explore the advantages of prefabricated building in terms of sustainability and economy.

References

Aguirre, H., Vogt, D., Eyre, M. and Valerio, S. (2021) 'Understanding the key risks affecting cost and schedule performance of modular construction projects', *Journal of Management in Engineering*, Vol. 37, No. 4, pp.1–16.

Akanbi, T. and Zhang, J. (2021) 'Design information extraction from construction specifications to support cost estimation', *Automation in Construction*, Vol. 131, No. 11, pp.1–14.

Bettinger, P. (2021) 'Machine learning modeling of forest road construction costs', *Forests*, Vol. 12, No. 9, pp.1169–1178.

Bodendorf, F., Merkl, P. and Franke, J. (2021) 'Intelligent cost estimation by machine learning in supply management: a structured literature review', *Computers and Industrial Engineering*, Vol. 160, No. 15, p.107601.

Chen, S. (2022) 'Construction project cost management and control system based on big data', *Mobile Information Systems*, Vol. 2022, No. 11, pp.1–7.

Dasovi, B. and Klanek, U. (2021) 'Integration of mixed-integer nonlinear program and project management tool to support sustainable cost-optimal construction scheduling', *Sustainability*, Vol. 13, No. 21, pp.1–10.

Daud, M. and Malik, A.A. (2022) 'Construction and validation of early software size estimation models based on ADAF-adjusted ACD metrics', *The Computer Journal*, Vol. 12, No. 10, pp.1093–1099.

Gauch, H.L., Dunant, C.F., Hawkins, W. and Serrenho, A.C. (2023) 'What really matters in multi-storey building design? A simultaneous sensitivity study of embodied carbon, construction cost, and operational energy', *Applied Energy*, Vol. 333, No. 11, pp.100–111.

Jarndal, A., Husain, S. and Hashmi, M. (2021) 'On temperature-dependent small-signal modelling of GaN HEMTs using artificial neural networks and support vector regression', *IET Microwaves Antennas and Propagation*, Vol. 15, No. 3, pp.1211–1222.

Jiang, F., Awaitey, J. and Xie, H. (2022) 'Analysis of construction cost and investment planning using time series data', *Sustainability*, Vol. 14, No. 3, pp.1–10.

Li, X.J., Xie, W.J., Jim, C.Y., Chen, K.L. and Hu, Y. (2021) 'Holistic LCA evaluation of the carbon footprint of prefabricated concrete stairs', *Journal of Cleaner Production*, Vol. 329, No. 20, pp.1–11.

Mahmoodzadeh, A., Nejati, H.R. and Mohammadi, M. (2022a) 'Optimized machine learning modelling for predicting the construction cost and duration of tunnelling projects', *Automation in Construction*, Vol. 139, No. 7, pp.1–23.

Mahmoodzadeh, A., Nejati, H.R., Mohammadi, M., Ibrahim, H.H., Khishe, M., Rashidi, S. and Ali, H.F.H. (2022b) 'Prediction of Mode-I rock fracture toughness using support vector regression with metaheuristic optimization algorithms', *Engineering Fracture Mechanics*, Vol. 2021, No. 264, pp.1–16.

Vassiliades, C., Barone, G., Buonomano, A., Forzano, C., Giuzio, G.F. and Palombo, A. (2022) 'Assessment of an innovative plug and play PV/T system integrated in a prefabricated house unit: active and passive behaviour and life cycle cost analysis', *Renewable Energy*, Vol. 186, No. 5, pp.845–863.

Wang, R., Asghari, V., Cheung, C.M., Hsu, S.C. and Lee, C.J. (2022) 'Assessing effects of economic factors on construction cost estimation using deep neural networks', *Automation in Construction*, Vol. 134, No. 2, pp.1–10.

Wu, W. and Huang, H. (2021) 'Construction engineering cost estimation based on artificial intelligence technology', *Journal of Intelligent and Fuzzy Systems*, Vol. 19, No. 2, pp.1–9.

Ye, D. (2021) 'An algorithm for construction project cost forecast based on particle swarm optimization-guided BP neural network', *Scientific Programming*, Vol. 2021, No. 9, pp.1–8.

Zhang, W., Kang, K. and Zhong, R.Y. (2021) 'A cost evaluation model for IoT-enabled prefabricated construction supply chain management', *Industrial Management and Data Systems*, Vol. 121, No. 12, pp.2738–2759.

Zhao, Q., Li, J., Fediuk, R. and Nemova, D. (2021) 'Benefit evaluation model of prefabricated buildings in seasonally frozen regions', *Energies*, Vol. 14, No. 21, pp.1–10.

Zhao, W. and Chen, Y. (2022) 'Study on large-scale promotion of prefabricated buildings in Anhui province based on SEM and IoT', *Scientific Programming*, Vol. 2022, No. 4, pp.1–13.