ISSN 2616-5767 Vol.6, Issue 2: 50-53, DOI: 10.25236/AJETS.2023.060208

Research on Single Cost Estimation of Civil Engineering Based on Fuzzy Clustering Algorithm

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Abstract: *Project cost management is the main means to manage project construction investment, which plays a vital role in project quality, investment cost and even rational allocation of social resources. During the estimation period, the project is in the early stage of the project, with little information, so it is difficult to estimate quickly, effectively and accurately. If the cost of the project can be estimated accurately and quickly, it will play a very important role in the progress of the later work of the project. In the case of many built projects, typical projects with high similarity can be selected to improve the estimation accuracy. In order to improve the accuracy of investment estimation, the fuzzy clustering analysis principle is proposed to cluster the proposed project and the built project. In this paper, the fuzzy clustering algorithm (FCA) is used to estimate the unit cost of civil engineering, which provides an effective way to estimate the project cost quickly.*

Keywords: *Civil engineering; Cost estimation; Fuzzy clustering*

1. Introduction

Investment estimation is an important work link in the early stage of a project from investment decision-making to preliminary design, and it is a prerequisite for economic evaluation and fund raising of the project. Construction investment estimation is the basis of the project decision, and reasonable estimation is the basic guarantee for the smooth implementation of the whole project [1]. With the continuous development of market economy and construction industry, the project cost estimation of contemporary enterprises has not only provided data support for feasibility study, but also become the starting point of the whole project cost management, the basis of cost control, and the key indicator of dynamic cost control [2]. In the implementation stage of a construction project, the control focus of the project cost often focuses on the completion and settlement stage of the construction project, ignoring the importance of the accumulated cost-related information of the project, and failing to grasp the implementation status of the actual progress of the project in time, which leads to the uncontrollable state of the project cost [3].

With the establishment and development of the market economy, budget personnel are required to come up with more accurate budget or valuation results in the shortest possible time by simply familiarizing themselves with engineering drawings, so as to meet the needs of leaders' decision-making and relevant departments' management, and to improve work efficiency [4-5]. Controlling the project cost in the decision-making stage is the key to correctly determine the planned investment amount of the construction project, and it is of great significance for the project investors to reasonably control the investment objectives. Secondly, compared with other follow-up work of construction projects, controlling the cost in the investment decision-making stage has the greatest impact on the economic effect of construction projects [6]. Constructing a high standard cost control system, promoting the initiative of prior control, and avoiding passive post-control are not only related to the success or failure of project cost control, but also related to the survival and development of enterprises [7-8]. In this paper, the FCA-based unilateral cost estimation strategy of civil engineering is put forward, which provides an effective way for rapid estimation of engineering cost.

2. Construction cost estimation

2.1. The concept of construction cost estimation

Construction project cost estimation refers to the prediction of the total investment amount of a specific project according to the project proposal, feasibility study, architectural conceptual design and

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other materials in the feasibility study stage or investment decision-making process, according to a specific method. The construction cost is influenced by many factors, with complex composition, changeable situation and great uncertainty. Therefore, it is a very complicated task. However, the geological conditions of the construction site are similar to those of the projects with similar functions, and their architectural structure features are similar to some extent. When the price level is stable, the cost of projects with similar structural features is similar. In the stage of investment estimation, the sample data used to determine the cost is generally the accumulated cost data of the built project. Therefore, in order to ensure the accuracy of the investment estimation of the proposed project, it is necessary to sort out all kinds of cost data of the built project, classify them, and establish a database of similar project cost data of the proposed project. In the early stage of the project, the project cost estimation is not only related to the investment decision, but also directly affects the financing scheme and plan of the construction project.

In the implementation stage of the project, it also directly sets the target of quota design for architectural scheme design, and its function runs through all stages of scheme design, preliminary design, construction drawing design and project construction. Because of the uniqueness of construction projects, in essence, there are no two identical projects, but there are some similarities among many projects. The basic principle of dynamic cost control analysis is based on the similarity of construction projects. Because the biggest characteristic of buildings is inconsistency, there are no two identical buildings, and the similarity between them is somewhat fuzzy [9]. Therefore, fuzzy cluster analysis can be used to classify the historical data of previous project cost in a more detailed way. Then, using the cost data of these similar projects as the original data, make a preliminary calculation, and finally get the project cost and other relevant data.

2.2. Content of construction cost estimation

The project cost is dynamic, which means that the project value changes with the implementation of the project. The content, components and amount of the project cost are different in different construction stages of the project, which is affected by many dynamic factors. General civil engineering is composed of basic components such as foundation, wall, floor, roof, doors and windows. The engineering cost depends on the quantity, category and price level of the main engineering objects, and the quantity of the actual engineering objects is determined by the structural parameters of the engineering design. According to the principle of construction project budget estimate, the cost components and building structure parameters which have great influence on the project cost are selected as the main characteristic indexes [10]. Different mathematical theories show different abilities when solving the problem of project cost prediction, that is, different mathematical theories or models are selected to predict the project cost, and the accuracy and speed of the final predicted project cost are quite different.

It is of great significance to accurately and quickly predict the construction cost. The project cost in the implementation stage is formed on the basis of the investment of the project at this stage, and it is the stage of gradually forming the cost of the construction project, so the project cost control at this stage is dynamic. In the process of construction project implementation, due to some changes in environment and conditions, the project cost of the project will change, and the factors that change will be found. Project cost prediction is to predict the cost of the whole project. According to the different objects of project cost, the prediction of project cost is different. The project cost forecast refers to the process that in the early stage of project construction, the staff can calculate the cost data of a similar project at present or in the future by analyzing and counting the cost data of similar projects in the past, and then summarizing the laws and analyzing them in depth.

3. Single cost estimation of civil engineering based on FCA

Dynamic cost management in the construction stage is to study and compare the project cost during the implementation of the construction project, analyze and study the project cost management problems with the viewpoint of change, and correct the deviation at any time according to the progress of the project, so as to ensure the realization of the investment goal of the project management, and strive to make rational use of manpower, material resources and financial resources in each stage of the project construction, so as to control the project cost of the construction project within a scientific and reasonable range. When the concept and technology of big data flood into the engineering cost industry, it will inevitably bring a qualitative leap, and then provide strong technical support for the development

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of enterprises and even the whole construction industry. The emergence of the Internet project cost management platform in the era of big data not only changes the current cost management mode, but also shares the real data of various enterprises and construction markets. The dynamic management of engineering cost mainly refers to the management in the construction stage, that is, strictly taking the construction drawing budget, engineering contract price, etc. as the control basis, through controlling engineering measurement, engineering change and other methods, strictly measuring according to the approved actual completed engineering quantity, controlling the investment cost, and the construction unit cannot change it casually.

In order to achieve the purpose of reducing the project cost, a series of methods are sought for improvement, so as to achieve the expected goal. The basic principle of dynamic management of construction cost is to take the planned investment amount as the investment control target value. During the project implementation, the actual investment value is compared with the target value regularly. Through comparison, the deviation between the actual expenditure amount and the investment control target value is found out, and then the reasons for the deviation are analyzed, and effective measures are taken to control it, so as to ensure the minimum deviation between the target value of construction cost and the actual investment value. The principle of single cost estimation of civil engineering based on FCA is shown in the Figure 1.

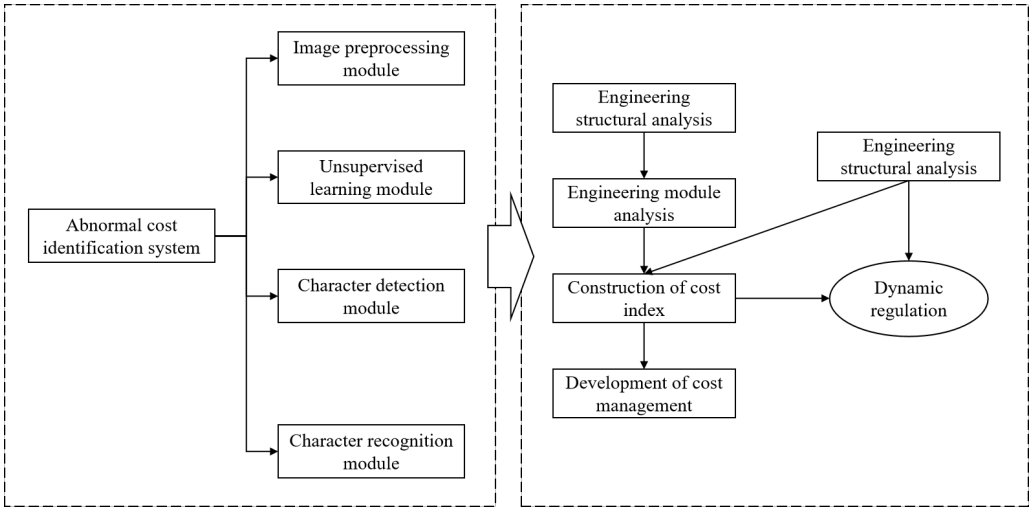

Figure 1: Single cost estimation of civil engineering based on FCA

Assuming S is a set of s data samples, there are m category attributes with different values: $C_i(i=1,2,\ldots,m)$. Let s_i be the quantity of samples in class C_i. For a given sample, its total information entropy is:

$$I(s_1,s_2,\ldots,s_m)=-\sum_{i=1}^{m} P_i \log_2(P_i) \tag{1}$$

Where P_i is the probability that any sample belongs to C_i, which can usually be expressed as s_i/s. Samples with attribute A value a_j in S are included in subset S_j. Let S_{ij} be the quantity of samples with the category C_i in the subset S_j. The information entropy value of the sample obtained by division is:

$$E(A)=\sum_{j=1}^{k} \frac{s_{1j}+s_{2j}+\ldots+s_{mj}}{s} I(s_{1j}+s_{2j}+\ldots+s_{mj}) \tag{2}$$

Among them:

$$I(s_{1j}+s_{2j}+\ldots+s_{mj})=-\sum_{i=1}^{m} p_{ij} \log_2(p_{ij}) \tag{3}$$

According to the implementation stage of the construction project, the input of the dynamic

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management model of the project cost is the characteristics of the building and structure and the factors that affect the project cost, such as labor cost, material cost, design change and so on.

To control the cost in the project implementation stage, we should further implement the project organization and optimize the content of construction organization design on the premise of ensuring the project quality and construction progress. If there are subcontracted projects, the principle of being scientific, reasonable and conducive to construction and controlling the total investment of the project should be followed, and the impact of different subcontracting schemes on investment should be analyzed. Actively carry out optimized design, popularize and apply new technologies, new materials and new processes that are beneficial to controlling project cost and reducing project cost. Suggestions or incentives for design optimization and rationalization should be formulated, the construction organization design should be actively optimized, and the construction scheme beneficial to reducing the project cost should be selected on the premise of meeting the requirements of safety, quality and construction period.

4. Conclusions

The project cost in the implementation stage of the project is a variable quantity. Both the constructor and the owner hope to pay attention to the change of the project quantity or control the change of the project cost. Construction cost estimation is an important part of project feasibility analysis, and the largest part of project economic analysis. It plays a key role in project decision-making and the promotion of follow-up work. Government departments that master the massive data of engineering cost should take the lead in opening up data, provide data source guarantee for research, and remove the obstacles of data scarcity. The data introduced into the model also needs to consider that the cost of the construction project will be affected by social and economic factors; We should also analyze the correlation among the factors influencing the cost. In addition, enough similar projects can be estimated as cases, which will be of great help to the estimation accuracy of future projects. With the advent of the era of big data, massive data will follow. Accordingly, the massive storage capacity, powerful parallel computing and distributed computing capacity of cloud computing can provide important technical support for engineering cost industry and research. Therefore, cloud computing can efficiently analyze data, which is also a future development direction.

References

[1] Alhendi H, Mahmoud M, Celikag M. Optimal depth selection of composite tubular-floor trusses based on cost estimation [J]. Advances in Structural Engineering, 2021, 24(13):2912-2926.
[2] Fan W, Liu R, Ang H S, et al. A new point estimation method for statistical moments based on dimension-reduction method and direct numerical integration [J]. Applied Mathematical Modelling, 2018, 62(10):664-679.
[3] Sime M, Bailey G, Hajj E Y, et al. Road Load Based Model for Vehicle Repair and Maintenance Cost Estimation: [J]. Transportation Research Record, 2020, 2674(11):490-497.
[4] Tajalli M, Mirheli A, Hajbabaie A, et al. Utilization and Cost Estimation Models for Highway Fleet Equipment: [J]. Transportation Research Record, 2021, 2675(12):1172-1186.
[5] Baki O T, Aras E. Estimation of BOD in wastewater treatment plant by using different ANN algorithms [J]. Membrane Water Treatment, 2018, 9(6):455-462.
[6] Elgayar A, Jrade A. Integrating 3D modeling, sustainability and cost estimating at the conceptual design stage of bridges [J]. Canadian Journal of Civil Engineering, 2021(12):48.
[7] Offenbacker D, Saidi A, Ali A, et al. Economic and Environmental Cost Analysis of Cold In-Place Recycling[J]. Journal of Materials in Civil Engineering, 2021, 33(3):1-8.
[8] Ozuysal M, Caliskanelli S P. Reliability estimation of public bus routes: Applicability of multivariate adaptive regression splines approach [J]. Canadian Journal of Civil Engineering, 2018(10): 45.
[9] Zahedi L, Lu M. Generating labour cost budget for a construction-oriented fabrication facility: simulation-based resource scheduling approach [J]. Canadian Journal of Civil Engineering, 2022(6): 49.
[10] Kirkey W D, Bonner J S, Fuller C B. Low-Cost Submersible Turbidity Sensors Using Low-Frequency Source Light Modulation[J]. IEEE Sensors Journal, 2018, (22):9151-9162.