Application of Data Mining Algorithm in Value Engineering in the Selection of Highway Engineering Design Scheme

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Abstract. The paper analyzes and compares the rationality, scientificity and engineering value of highway engineering design scheme by combining technology and economy with value engineering, considering and analyzing two factors of function and cost. Through the calculation flow and algorithm, taking the multi scheme design comparison of Expressway isolation facilities as an example, the paper elaborates the algorithm and application of value engineering in highway engineering design scheme selection.

Keywords: Value engineering · Highway engineering · Design scheme

1 Introduction

According to the national capital construction procedure, the feasibility study stage of the project feasibility study project can be carried out after the project proposal is approved. On the basis of the road network status for the regional social and economic development, the necessary economic rationality of the project construction shall be fully investigated, evaluated, predicted and necessary investigation The feasibility of technology implementation possibility puts forward comprehensive research and demonstration results to determine whether the project is approved or not. Because highway engineering has the characteristics of large-scale, complex and complex capital consumption, long-term use after long-term operation, the feasibility study of the project is particularly important. Its quality is related to whether it can provide scientific basis for investment decision-making and whether to guarantee the project to play an investment effect and the choice of construction projects is a particularly important link in the engineering [1].

Highway engineering design mainly considers two factors: function and cost to meet the driving demand. However, no matter how attentive the designer is, due to the influence of time, cost, experience, habit and other factors, unnecessary or unnecessary functions and costs may still exist in the design scheme. If the function design of highway engineering is too high and complete, it will inevitably lead to the increase of cost, and the part of users who exceed the necessary functions do not need it, which will cause the excess of functions; On the contrary, it will cause the function insufficiency. Because

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highway construction cost is concentrated in short term (2-4a) and reflected in cost, it is easy to be recognized by people. However, the operating cost of service life (decades) is often many times of construction cost, but it is easy to be ignored due to scattered expenditure. This paper uses value analysis technology to control the function cost, and compares and selects the multi design scheme comprehensively, and selects the most reasonable scheme.

2 Concept and Principle of Value Engineering

2.1 Concept

The so-called value engineering refers to the functional analysis of products or services through collective wisdom and organized activities, so as to achieve the necessary functions of products or services reliably with the lowest total cost (life cycle cost), so as to improve the value of products or services. The main idea of value engineering is to improve the value of the object by analyzing the function and cost of the selected research object. The value here refers to the proportion between expense and acquisition, expressed in mathematical proportion as follows:

Value = total function/total cost.

where: the total function refers to the function of use;

Total cost = production cost + use cost.

As a method of technology economy analysis, value engineering has achieved the close combination of technology and economy. In addition, the unique feature of value engineering is that it pays attention to and improves the value of products, pays attention to the work in design stage, and takes function analysis as its own unique analysis method. Because value engineering expands the scope of cost control and involves the cost of life cycle of the project, it is necessary to analyze and study the rationality, scientificity and engineering value of the technical economy of engineering design carefully, explore the possibility of improvement in each construction stage, analyze the relationship between function and cost, and improve the value coefficient of the project; At the same time, the unnecessary functions in engineering design are found and eliminated through value analysis, so as to reduce cost and investment [2].

2.2 Principle

Only when the total production cost and the use cost are the minimum, the product value can reach the maximum and the better economic benefits can be obtained. The relationship between product function and cost is shown in Fig. 1.

In the figure: C_1 is the production cost. With the increase of product function, the production cost will rise; C_2 is the use cost. With the increase of product functions, users can use it easily, and the use cost will decrease; $C = C_1 + C_2$, which refers to the life cycle cost of the product. When the function is P_0, C reaches the lowest point.

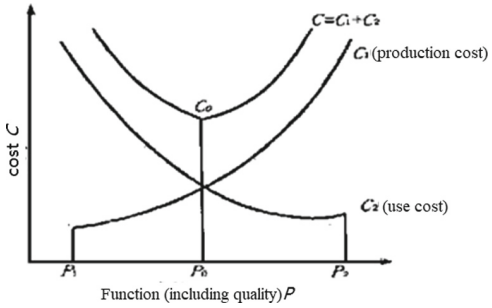

Fig. 1. The relationship between product function and cost

At this time, the value of the product is the highest. When the function is P_1, although the production cost of the product is relatively low, the function of the product is also less, which can not meet the needs of users, resulting in the use cost of C_2 is too high. When the function is P_2, the production cost of the product is too high, which leads to the increase of the product price and the inability of consumers to bear, which will also affect the efficiency.

The purpose of value engineering is to eliminate redundant functions, so that the total function can be reduced to the level required by users. At the same time, the cost can also be reduced to C_0. For highway engineering, the unification of function and cost should be achieved when the scheme is compared and selected, and the minimum investment should be used to meet the use function. The project cost in the construction period is the production cost, while the investment in the operation period is the use cost. If the road grade standard is set too high, the investment in the construction period will be large, that is, the production cost will be high. Although the road use function standard is high and the large and medium-sized maintenance cost is low, it is difficult for investors to raise funds in the construction period under the condition of tight funds. If it is a toll road, the toll standard will be relatively high, which is hard for road users to bear and the overall benefit is not good; If the grade and standard are set too low, the investment in the construction period will be less, that is, the production cost will be lower, the use cost such as large and medium-sized maintenance cost will be increased, the road user cost (such as the increase of fuel consumption due to low grade, the increase of accident rate, etc.) will also be increased, and the overall benefit will not be good. By using the principle of value engineering to compare and select schemes, the cost of the selected scheme can be the lowest and the functional requirements can be met [3].

3 Calculation Flow and Algorithm

3.1 Calculation Process

There are three indexes in the formula of value analysis. In order to get the value V, we must first calculate the function coefficient F and cost coefficient C. The calculation process is shown in Fig. 2.

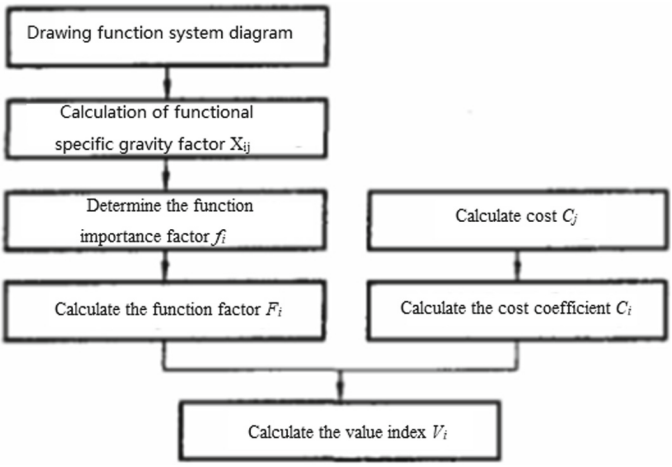

Fig. 2. V_i calculation process

3.2 Function Coefficient Algorithm

The core of value analysis is function analysis. Obviously, f in the formula; It is the key index of the formula, and its determination is complicated. The determination method usually adopts the forced scoring method. Firstly, according to the function of each function in the analysis object, the proportion of each function in the analysis object is calculated. Usually, the 0–10 forced scoring method is used to obtain a function proportion factor matrix

$$x_{ij} = \begin{pmatrix} x_{11} & x_{12} & \ldots & x_{1n} \\ x_{21} & x_{22} & \ldots & x_{2n} \\ \ldots & \ldots & \ldots & \ldots \\ x_{m1} & x_{m2} & \ldots & x_{mn} \end{pmatrix} \tag{1}$$

Then compare each function in pairs, using the 0–4 compulsory scoring method for comparison, the score grades are divided as follows: F_1 is more important than F_2, F_1 gets 4 points, F_2 gets 0 points; F_1 is more important than F_2, F_1 gets 3 points, F_2 gets 1 point; F_1 is equally important than F_2, F_1 gets 2 points, F_2 gets 2 points; F_1 is less important than F_2, F_1 gets 1 point, F_2 gets 3 points; F_1 is far less important than F_2. F_1 scores 0 and F_2 scores 4.

The column matrix of $\sum_{i,j=1}^{n} Y_{ij}$ is obtained by summing each row of the matrix

$$\sum_{i,j=1}^{n} Y_{ij} = \begin{pmatrix} \sum_{j=1}^{n} Y_{1j} \\ \cdots \\ \cdots \\ \sum_{j=1}^{n} Y_{nj} \end{pmatrix} \tag{2}$$

Finally, according to the above calculation results, it is easy to get the functional index coefficient F_i:

$$F_i = \frac{f_i}{\sum_{i=1}^{n} F_i} \tag{3}$$

3.3 Cost Coefficient and Value Calculation

For the function coefficient, the calculation of cost coefficient is relatively simple. Firstly, the construction cost of each design scheme in the construction period should be determined, including the construction cost of feasibility study start, design and construction; The maintenance operation cost and its life cycle cost during the operation period should also include all the costs during this period. The total life cycle cost of the scheme is obtained by adding the two [4].

$$C_j = C_{j1} + C_{j2} \tag{4}$$

Finally, divide the function coefficient by the cost coefficient to get the value

$$V_i = \frac{F_i}{C_j} \tag{5}$$

4 Design Scheme Comparison and Application

Expressway is a fully enclosed belt type civil engineering project. There are many traffic safety facilities along the highway, among which the isolation facilities (usually as a part project) have the largest investment. The unit price of various forms of isolation facilities varies greatly. Therefore, the isolation facilities with different quality index requirements for different highway sections can reasonably and effectively control the cost. In different road sections, isolation facilities have different quality indicators. For example, in sparsely populated embankment, isolation facilities usually only serve to isolate animals and people; The road section near the urban entrance and exit has higher requirements for aesthetics and certain sound insulation function. The following case is the use of value analysis technology to compare and select the isolation facilities design scheme of the sparsely populated general section of expressway.

(1) Draw the functional system diagram.
According to the characteristics of highway isolation facilities, the functional objectives are determined and the functional system chart is drawn. Obviously, the main quality requirements of customers for highway isolation facilities include isolation effect, sound insulation effect, durability, function, structure, beauty, convenience, etc.

(2) Calculate the functional specific gravity factor.
According to the role of the above functions in the divisional project (the original data is provided by the technical department), the proportion of various functions in the divisional project is calculated. In this case, 0–10 compulsory scoring method is adopted, that is, the score is based on the degree that each comparison scheme meets various quality indicators, and the full score is 10 points.
(3) Determine the functional importance coefficient.
Function importance coefficient, also known as function evaluation coefficient or function index, is expressed by F, which is the proportion of each function of the evaluation object in the overall function. This case uses 0–4 mandatory scoring method.
(4) Calculate the cost factor.
According to the relevant information and budget cost, the cost coefficient of each divisional project is calculated.
Cost coefficient = the sum of LCC of each alternative/LCC of each alternative.
The calculated data are shown in Table 1.

Table 1. Cost factor calculation table

Comparison scheme	Construction cost	Maintenance cost	Life cycle	Cost coefficient
Barbed wire wall	80	160	240	0.1765
Barrier	140	140	280	0.2059
Reinforced concrete isolation wall	300	40	340	0.2500
Reinforced concrete art wall	400	100	500	0.3676
total	-	-	1360	1.0000

Through the above analysis, the barbed wire fence wall is the most suitable design scheme for the isolation facilities in the sparsely populated highway section. It basically meets the basic requirements of road users for the isolation facilities in this section, such as stable structure, convenient maintenance, isolation and durability. Compared with other schemes, it reduces the redundant functional requirements such as sound insulation and beauty, thus reducing the unnecessary cost of redundant functions.

5 Conclusion

As a mature management method, value engineering has been widely used in engineering construction in many countries. It can be used for scheme comparison, scheme optimization and many other aspects. The emphasis of value engineering should be in the stage of product research and design. For highway engineering, the application of value engineering can optimize the scheme in the project feasibility study stage, so as to improve the investment efficiency.

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