Research on the Billing Standard of Highway and Water Transport Test and Inspection in Shandong Province

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Abstract: With the rapid development of China's economy, all sectors of society on the quality and safety of road and water transport projects have gradually increased the importance of road and water transport test, and inspection services market demand and cost share have also increased. Many test and inspection organizations have flooded the market, resulting in malicious competition and price confusion in the test and inspection market. Therefore, providing a set of scientific, reasonable, and standardized test and inspection billing standards is urgently needed to improve the test and inspection management of road and water transport projects and solve the existing problems. Based on this, the project will rely on Shandong Province highway and water transport engineering test and inspection billing standard research project, systematic analysis of Shandong Province highway and water transport engineering test and inspection factors. It is from the cost of scientific management and field research of the characteristics of the system research, for Shandong Province test and inspection charges to provide a more objective, accurate, scientific theoretical basis for calculating, for the further preparation of Shandong Province, highway and water transport engineering test and inspection Billing standards in Shandong Province to lay a solid theoretical foundation.

Keywords: Highway and Waterway Engineering; Testing and Inspection; Fees; Scientific Validity; Computational Modeling

1. Introduction

With the rapid development of China's highway engineering construction, ensuring the quality of the project is one of the joint efforts of all parties involved in the construction of one of the objectives of the test is not only an essential means of quality management of highway engineering but also to control, guide and assess the quality of the project is the necessary basis for managing and evaluating the acceptance of the critical aspects of the key links of the acceptance of the evaluation [1-3]. Test and inspection as a highway project quality management is essential for standardization, rationalization, and scientification. It impacts the monitoring effect of project quality and directly affects the test and inspection work [4,5].

At the same time, China's market economic system gradually improved, and the price mechanism has achieved a high reliance on a highly centralized government pricing to the market to convert prices. Because of the market's spontaneous regulation and market failure of the 'duality,' there is a need to rely on the government for the macro and micro aspects of monitoring and regulating. Therefore, government intervention has become a significant feature of today's market economy. The government's regulatory function of the price is mainly reflected in maintaining fair market competition to regulate the market and as a market service provider [6]. Currently, the highway engineering test and inspection cost standards can not meet the construction needs. There are still no scientific, reasonable, standardized methods to determine the test and inspection guide price rationally, provide relevant price information, and regulate the test and inspection market behavior, which is the urgent need to solve the problem of highway test and inspection.

Based on the above background research, this paper combines the current research results and billing characteristics of highway engineering test and inspection billing standard research

2. Components of Test and Inspection Billing

Highway engineering test and inspection billing refers to the act of charging for those test and inspection projects based on relevant construction norms, standards, and safety operation procedures, such as the quality and technical parameter indexes of materials, engineering products, constructions, and solid works used in highway engineering [7].

Highway engineering test and inspection cost refers to the highway testing unit in a highway engineering testing project as the object of accounting for the testing process consumed in the price of labor, materials, machinery, and testing unit for the organization and management of the testing project for the total sum of all the expenses incurred [8].

3. Testing Cost Components and Analysis Methods

3.1 Sources of Data

The establishment of the sample case base of this project mainly includes two aspects: the national sample and the sample in Shandong Province. This study conducts statistical research on the testing and inspection charges of 19 provinces in the country, such as Jiangsu, Anhui, Zhejiang, etc., and at the same time conducts inquiry and research on the testing and inspection charges of 10 testing units in the province to establish the sample case base.

3.2 Preprocessing of Data

The primary work of the initial selection of statistical data is following specific rules, unified test, and inspection projects, parameters and units, and a unified list of subheadings contained in the work content and workload so that it has uniformity in form, comparability at the same level, and is conducive to the accuracy of the model calculation. The steps to make the sample data comparable at the same level are shown in Figure 1.

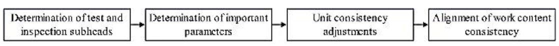

Figure 1. Flowchart for Making Sample Data Comparable at the Same Level

3.3 Removal of Abnormal Data

Due to the highway engineering test and inspection billing list subheading guide price determination in the use of inquiry method and measurement method, need to collect, measure, and analyze a large number of sample data, and in these data, it is impossible to avoid the appearance of some anomalous data. Suppose these data are not identified and eliminated. In that case, it will lead to a significant error between the final calculation of the guide price and the reality, so it is necessary to eliminate the anomalous data. Commonly used outlier testing methods include the Lajda criterion, the Schauweiler criterion, the Dixon test, the skewness-kurtosis test, and the Grubbs method. Still, the calculation of these methods is more complicated [9]. Grubbs criterion has been mathematically proven to test fewer data and give rigorous results. The Grubbs method is often recommended internationally for identifying anomalous data, and the Grubbs method is also used in this study [10]. The Crubbs criterion is described in detail below.

A prerequisite for the Groubus criterion to identify anomalous data is that the data samples must follow a normal distribution. Please assume that the sample data are X1, X2, X3, ..., Xn, and arrange them in descending order as X1 ≤ X2 ≤ X3 ≤ ... Xn..., with a sample variance of Sn-12.

$$S_n{}^2 = \frac{1}{n-1}\sum_{i=1}^{n}(X_i - \overline{X}_n)^2 \qquad (1)$$

Here $\overline{X}_n$ is the sample mean of n data, the sample variance $S_n{}^2$ can know the degree of dispersion of the sample and then estimate the overall variance σ^2 Assuming that X_i is anomalous data, then the $S_i{}^2$ will be particularly large or small, which should be excluded from X_i, and re-estimate the σ^2 by using the remaining n-1 data, and the sample variance of the sample is $S_{n-1}{}^2$ The sample variance is $S_{n-1}{}^2$.

$$S_{n-1}{}^2 = \frac{1}{n-2}\sum_{i=1}^{n}(X_i - \overline{X}_{n-1}{}^2)^2 \qquad (2)$$

Where $\overline{X}_{n-1}$ is the mean value of the remaining n-1 data after excluding X_i.Assuming that there is no anomalous data, $S_n{}^2/S_{n-1}{}^2$should be around 1: on the contrary, when the value of $S_n{}^2/S_{n-1}{}^2$ is too large, it is reasonable to suspect that X_n It is anomalous data. Calculate $g_n = [X_i - \overline{X}_n]/S_n$, if X_n is farther away from the mean, the greater the probability that X_n It is not from the same aggregate as the other data.

$$\frac{S_n{}^2}{S_{n-1}{}^2} = \left(\frac{n-2}{n-1}\right)/[1 - \frac{n}{(n-1)^2} g_n{}^2] \quad (3)$$

It can be seen from the formula that as long as g_n is more significant than a certain number, then $S_n{}^2/S_{n-1}{}^2$ is also greater than that number, and it is simpler to calculate g_n than to calculate $S_n{}^2/S_{n-1}{}^2 2$. Therefore, the basic idea of Grubbs criterion is to calculate g_n first, and according to the given significance level α to check the correspondence table between α_n and n to find out the critical value of α_n, if $g_{n>}$ α_n, it means that these n data are not all from the same overall, and it can be deduced that X is anomalous data. When using the Grubbs criterion to judge gross errors, if the residual error of the measured value exceeds the limit of several data, then only the data with the most considerable residual value can be eliminated (if there are two identical data exceeding the limit, only one can be eliminated), i.e., only one data can be eliminated at a time, and then recalculate the mean, residuals, and variance of the remaining n-1 data, and judge the following suspicious data, until there is no suspicious data left. The remaining n-1 data will be recalculated with mean, residuals, and variance. Then, the following suspicious data will be judged until there are no suspicious data because there is a possibility that the next largest (or equally prominent) data that were considered suspicious in the last calculation may not exceed the limit after the calculation.

4. Methodology Case Library Construction

The method library construction includes the description of the method classification, the complexity of the method, the availability of raw data, the requirements of the model on sample data, and the reliability of the calculation results. The structural framework of method library construction is shown in Figure 2.

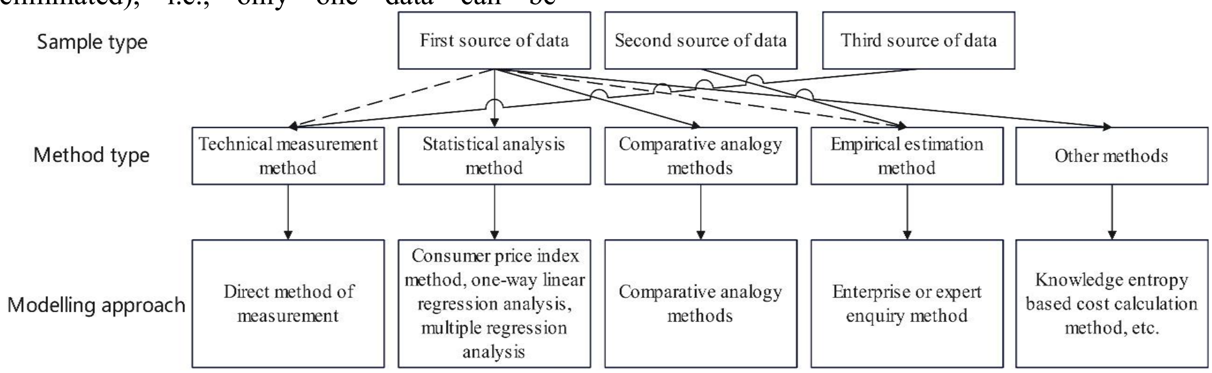

Figure 2. Framework Diagram of the Construction Structure of the Method Library

There are many methods for calculating the guideline price of the test and inspection list subheading: commonly used price index method (CPI method), comparative analogy method, regression analysis method, inquiry method, actual measurement method, and other widely used methods of calculation, etc. [11-13]. Because of the many factors affecting the cost of road engineering tests and inspection, and the statistical data are mostly small sample data and no sample data, the calculation of the cost of road engineering tests and inspection based on linear statistical data appears to be extremely difficult and is not suitable for the use of specific measurement methods that require multiple samples of the characteristics of the cost calculation method based on knowledge entropy is used in this study. The method uses a rough set of knowledge entropy to determine the weights of the factors influencing the test and inspection costs, and then the samples are corrected.

5. Method Selection and Evaluation of Theoretical Values

The selection of computational models based on data classification can be studied according to the sample data categories of the computational method selection and then in the full use of the sample data based on obtaining a reasonable theoretical value of the calculation at the same time, which is not only as a judgment criterion of the method of whether the process is sensible but also as a basis for whether it can meet the needs of real-world applications.

5.1 Calculation Method Selection Based on Sample Characteristics

According to the sample classification of the theoretical model selection study, used to calculate the need for billing provinces of the highway engineering test list of each subhead of the guide price theoretical value, all the theoretical values obtained through the model need to be adjusted through the Consumer Price Index method of the guide price to the guide price of the project in the year of the establishment of the guide price. Here, it does not consider the method selection process due to the need to verify the theoretical values through other methods.

The selection of the calculation model should not only take into account the complexity of the application of the model, the availability of raw data, the requirements of the model on the sample data, the reliability of the calculation results, and other five characteristics but also meet the principles of the selection of the calculation model. According to the idea that model selection should satisfy the applicability principle and the benefit principle, the model preference is divided into three steps. First, the model applicability selection is based on the sample size and the coefficient of variation characteristics of the classified samples, and the selection of the calculation model applicable to the samples; secondly, the selection of the samples with high relevance as the calculation samples according to the classification results of the cluster analysis; and lastly, the selection of the computational model according to the degree of complexity of the computation model The optimal calculation model; thus, according to the difficulty of the calculation of the model, the availability of data and the accuracy of the calculation of the theoretical value of the calculation method that meets a specific type of data is preferred.

5.2 Evaluation of Theoretical Values

Evaluation of theoretical value refers to checking and supervising the calculated value, which takes specific forms, processes, and methods to make preliminary and reasonable analyses and judgments on whether the computed value meets practical application needs. Determination of theoretical value refers to the reasonable calculated value is determined as the theoretical value, the unreasonable theoretical value in the evaluation of the basis to give adjustments, in the adjustments to modify the opinion, the cycle of the process, and will be the final determination of the results of the calculation of the theoretical value. The contents of the theoretical value evaluation include the form adopted for assessment, the evaluation procedure, and the evaluation method.

The theoretical value of the demonstration of the method mainly used in the expert meeting evaluation method, trial method, in which the expert meeting evaluation method follows specific procedures, the use of certain methods and theories, and combined with the experience of experts on the calculation of the value of the appropriate to make a judgment; trial method is the calculation of the theoretical value of the application of the road engineering test testing of the actual, through the collection of the user's opinion of the appropriateness of the judgment. In this study, the reasonableness of the theoretical value is mainly judged through expert discussion combined with the experts' own working experience, applying the methods of subhead cost decomposition and price analogy.

In this paper, the working process of the expert meeting review method is stipulated as follows: (1) check and explain whether the samples and calculation methods are selected appropriately; (2) experts describe the reasonableness or otherwise of the calculated values based on their experience, using methods such as comparing similar subheads and analyzing the composition of the costs; and (3) compare the existing guideline prices of provinces and autonomous regions, explaining the level at which they are located, and explaining the reasons that lead to their being high or low, and explaining their reasonableness. Its reasonableness. (4) Determine the theoretical value if it is reasonable; if it is not, explain the reasons that may cause it to be unreasonable or ask for verification through the actual measurement method.

Determining theoretical value is retaining the reasonably calculated value and modifying the unreasonable computed value. The process includes the evaluation of theoretical values. After completing the above evaluation steps, the expert opinions are summarised, collated and analysed, the degree of deviation of the calculated values is estimated, and the adjustment opinions and methods are proposed. The computed values that are considered reasonable are retained. At the same time, the unreasonable calculated values are adjusted, and the adjustment process needs to be combined with the expert opinions and appropriately adopt the expert estimation method, cost analysis method, actual measurement method, and other methods to obtain the theoretical value, repeat the above process and finally determine the theoretical value. After the theoretical value is determined, it is necessary to carry out systematic level measurement work and trial correction stage, gradually adjusting, perfecting, and improving the guide price, which is a long-term process.

6. Conclusion

This study proposes a set of scientific, reasonable, and standardized billing standards through systematic analysis and in-depth research on the billing standards for highway and water transport engineering tests and inspections in Shandong Province. During the research process, based on the actual situation of Shandong Province, the factors affecting the test and inspection cost were comprehensively sorted and analyzed, and the Gruppus method was used to eliminate abnormal data to ensure the accuracy and reliability of the data. At the same time, the weights of the factors affecting the cost were determined using the rough set knowledge entropy method, which further corrected the sample data and improved the scientificity and applicability of the billing standard.

The research results provide an objective and factual theoretical basis for Shandong Province highway and water transport engineering test and inspection charges and lay a solid theoretical foundation for developing unified billing standards. Through expert evaluation and practical application of the test, the reasonableness and operability of the developed standard were proved, and the current test and inspection market malicious competition and price confusion were effectively solved. Overall, this study not only improves the scientific management level of the test and inspection cost standard for highway and water transport projects but also provides other provinces in the country with experiences and methods that can be learned from, which is of great significance in promoting the quality management of highway and water transport projects and the standardized development of the market. Improving and optimizing this standard will further enhance the efficiency and fairness of the test and inspection work and escort the high-quality development of China's highway and water transport project construction.

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