Tech Science Press

# Research on the Development of Project Cost Informatization in the Era of Big Data

## Huiyu Long[1], Yan Ma[1], Xiang Mao[1] and Xinyuerong Sun[2,*]

[1]Hunan University of Finance and Economics, Changsha, 410205, China
[2]Yunnan University, Kunming, 650091, China
*Corresponding Author: Xinyuerong Sun. Email: Simon5115@163.com

**Abstract:** Under the background of big data, Informatization plays an important role in the development of the engineering cost industry. The rapid development of the industry and the increasing complexity of construction projects require higher standards of informatization. The current information processing methods and models have been difficultly to meet new requirements. Based on this, this study deeply analyzes the key factors that impede the informatization of engineering cost development, and tries to find corresponding solutions through theoretical analysis and empirical research to break these constraints. This will play a guiding role in the development of informatization in China's engineering cost industry.

**Keywords:** Big data; project cost; engineering costs; cost informatization

## 1 Introduction

In the '21st Century Business Herald', Ouyang [1] pointed out that the 21st century is an era of collision of all kinds of information based on the background of big data. At present, the engineering cost industry is 'difficult to accumulate data and share together'. In terms of data management, technology and security, there is a lack of systematic and comprehensive research. At the macro level, there is no data covering CCMIS (Construction Cost Management Information System) across the country [2]. At the micro level of the enterprise, SMEs (Small Middle Enterprises) still rely on professional software management to assist in engineering cost work. In practical applications, although information technology has been introduced and corresponding databases have been constructed, the use of databases exists some problems. For example, Zhang et al. raised the problem of insufficient deep processing of engineering cost information and insufficient data mining based on the background of the era of big data [3].

Muhammad et al. asserted that informatization is a popular trend in today's era [4], and it is the benchmark for industries or enterprises to take the lead in taking advantages. Robotics and Vision pointed out that the US engineering cost industry is good at using completed project information [5–6]. In the half century since the development of 'informatization', it has stimulated the innovation driving force of various industries; it has promoted the process of economic globalization [7]. How to dig deep into its data value and better promote the integration of China's engineering cost industry towards global informatization development is the focus of the engineering cost industry. It is also a positive response to the '13th Five-Year Plan' [8] for the development of the informatization in engineering cost.

## 2 Restrictions Identification Methods

### 2.1 Principal Component Analysis Method

PCA (Principal component analysis) was first introduced by British mathematician Karl Pearson for

nonrandom variables. It is used to explore the common characteristics of multivariate variables, and to find new and independent comprehensive variables through dimensionality reduction. Generally speaking, multivariate variables require a close relationship between the variables, and the ratio of the number of samples of the observed variable to the number of extracted comprehensive factors is at least 4.

The basic principle of this method is based on a statistical theory. Using orthogonal transformation, the variables related to classification in a given sample are converted into independent variables corresponding to the change of matrix in linear algebra. The basic idea of this method is to use the correlation of different variables to classify different, usually the results are divided into different categories, formed a set of different variables, representing different basic structure, has the characteristics of the structure, called the common factor or principal components, namely finally extract comprehensive index is deduced, as shown in Fig. 1. Finally, a few common factors are linearly combined to obtain the main factors that explain the research content.
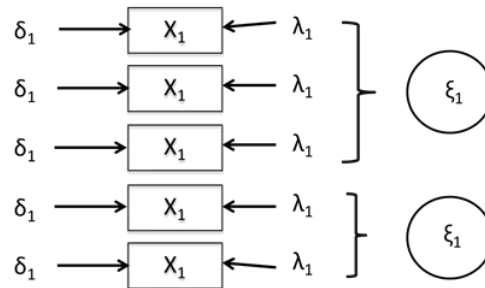


**Figure 1:** Principal component analysis

## 2.2 Comparative Analysis Method

The comparative analysis method originates from the development of the education industry in the former Soviet Union. Different comparative analysis methods can be adopted for different subject areas. Among them, the superior order comparison method and the inductive comparison method are more common.

|        | $X_1$    | $X_2$    | …   | $X_n$    | Index Point                        |
|--------|----------|----------|-----|----------|------------------------------------|
| $X_1$  | $a_{11}$ | $a_{12}$ |     | $a_{1n}$ | $\sum_{k=1}^{n} a_{1k} = A_1$      |
| $X_2$  | $a_{21}$ | $a_{22}$ |     | $a_{2n}$ | $\sum_{k=1}^{n} a_{2k} = A_2$      |
| $\vdots$ |        |          |     |          |                                    |
| $X_n$  | $a_{n1}$ | $a_{n2}$ |     | $a_{nn}$ | $\sum_{k=1}^{n} a_{nk} = A_n$      |

**Figure 2:** Utopian chess board

The comparative analysis method is to calculate the final weight by using the selected quantitative criteria, which reflects the comparison between the two factors and reflects their mutual relations. The ranking index of each evaluation index was optimized using Yan and Zhang's method [9], as shown in Fig. 2. The idea of this method is to compare the multi-objective decision-making factors in pairs and

divide them into three kinds of advantages and disadvantages: (1) When the factor Xi is better than Xj, the Xi score is 1. (2) When the factor Xi is worse than Xj, the Xi score is 0. (3) When the factor Xi and Xj are equal, the Xi score is 0.5. Finally, the weight of each factor is calculated, and the ranks can be obtained in order.

| Category | Sequence Number | Influencing Factors |
|---|---|---|
| Enterprise | $X_1$ | Enterprise management has insufficient awareness of informatization |
| | $X_2$ | It is difficult for enterprises to carry out comprehensive information management and control |
| | $X_3$ | Weak foundation of enterprise information management |
| | $X_4$ | Low corporate information processing |
| | $X_5$ | Fewer IT staff in the company |
| | $X_6$ | Inadequate use of completed project data within the enterprise |
| | $X_7$ | The use of pricing methods by enterprises is not applicable to information processing |
| | $X_8$ | High cost of informatization in the enterprise |
| | $X_9$ | The quality of enterprise engineering information is not high |
| | $X_{10}$ | Insufficient funds invested by enterprises |
| Industry | $X_{11}$ | Slow update of information data in the industry |
| | $X_{12}$ | Information released by the industry is not timely |
| | $X_{13}$ | Insufficient comprehensive information in the industry |
| | $X_{14}$ | Inadequate management system in the industry |
| | $X_{15}$ | Industry indicator system has not yet been formed |
| Government | $X_{16}$ | Inadequate security system of government system |
| | $X_{17}$ | Incomplete laws and regulations issued by the government |
| | $X_{18}$ | Government does not provide accurate and uniform standards |
| | $X_{19}$ | Insufficient government support |
| | $X_{20}$ | Limited government funding |

**Figure 3:** Identification of obstacles to the development of project cost informatization

## 3 Restrictions Identification

Based on this, this study will use the inductive contrast method to analyze the differences in informatization of engineering costs between China and other countries. Then we will integrate existing references to find out 20 influencing factors. Based on the relevant opinions given by professionals, we use the comparative analysis method and rank the top 12 influencing factors according to the weight from high to low. Using the idea of principal component analysis method, the 12 influencing factors are classified into 4 categories according to the government, industry and enterprise. Finally, we can extract four independent obstacles and analyze the corresponding solutions.

According to the three major sectors of government, industry and enterprise, which are summarized as shown in Fig. 3. After consulting relevant professionals, using the best-order comparison method, the results are shown in Fig. 4.

Sort according to the weights from high to low, exclude the 8 with lower weights, and take the first 12 as analysis factors, as shown in Fig. 5.

Using the principal component analysis method, the interrelated factors are classified into one category, and the irrelevant factors in each category are extracted. The results are shown in Fig. 6.

## 4 Factors Restricting the Development of Engineering Cost Informatization

### 4.1 Government Policies and Regulations

The construction of engineering cost informatization is a market economic activity. Because of this, the engineering cost industry needs government management. At this stage, our government's control and control ability is still relatively limited, which is specifically reflected in the following three aspects: First, the failure to make full use of various information and data resources to formulate efficient rules and regulations; The second point is that the government has not done enough to optimize social allocation and ensure lasting fairness in the society [10]. The third point is that as a macro regulator and a cost industry manager, the government should release reasonable industry information, policies and regulations and related standards.

| | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10}$ | $X_{11}$ | $X_{12}$ | $X_{13}$ | $X_{14}$ | $X_{15}$ | $X_{16}$ | $X_{17}$ | $X_{18}$ | $X_{19}$ | $X_{20}$ | Total | Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_1$ | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 16.5 | 5.95% |
| $X_2$ | 1 | 0.5 | 1 | 1 | 0 | 1 | 1 | 0.5 | 1 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 17 | 6.13% |
| $X_3$ | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 | 18 | 6.49% |
| $X_4$ | 1 | 0.5 | 1 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 | 0 | 16.5 | 5.95% |
| $X_5$ | 1 | 0.5 | 1 | 1 | 0.5 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 17 | 6.13% |
| $X_6$ | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 0 | 1 | 1 | 1 | 0.5 | 1 | 1 | 17 | 6.13% |
| $X_7$ | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0 | 0.5 | 10 | 3.60% |
| $X_8$ | 0.5 | 0.5 | 1 | 0.5 | 0 | 0.5 | 1 | 0.5 | 0.5 | 0.5 | 0 | 0.5 | 0 | 1 | 0.5 | 0 | 0.5 | 0.5 | 1 | 0.5 | 10 | 3.60% |
| $X_9$ | 0.5 | 0 | 0.5 | 0 | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 9 | 3.24% |
| $X_{10}$ | 0 | 0.5 | 0.5 | 1 | 0.5 | 1 | 0.5 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 0 | 10.5 | 3.78% |
| $X_{11}$ | 1 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0.5 | 1 | 17 | 6.13% |
| $X_{12}$ | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 0 | 16.5 | 5.95% |
| $X_{13}$ | 1 | 1 | 0.5 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 17 | 6.13% |
| $X_{14}$ | 0.5 | 0 | 1 | 0.5 | 0.5 | 0 | 0.5 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 0 | 0.5 | 8 | 2.88% |
| $X_{15}$ | 1 | 0.5 | 0 | 0.5 | 1 | 0.5 | 0 | 0.5 | 1 | 0.5 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 0.5 | 9.5 | 3.42% |
| $X_{16}$ | 1 | 0.5 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 16 | 5.77% |
| $X_{17}$ | 1 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 17.5 | 6.31% |
| $X_{18}$ | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 0.5 | 1 | 1 | 1 | 1 | 1 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 | 17.5 | 6.31% |
| $X_{19}$ | 0.5 | 0 | 0.5 | 0.5 | 0 | 0.5 | 0 | 0.5 | 0.5 | 0 | 0.5 | 0 | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 6.5 | 2.34% |
| $X_{20}$ | 0.5 | 1 | 0.5 | 1 | 0.5 | 0.5 | 1 | 0.5 | 0 | 0.5 | 0 | 0.5 | 0 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0.5 | 0.5 | 10.5 | 3.78% |
| Totalize | | | | | | | | | | | | | | | | | | | | | 277.5 | |

**Figure 4:** The proportion of different influence factors

### 4.2 Limitation of Industry Information Release

China's construction cost informatization level is still in the initial stages, coupled with China's vast land resources, regional cost information systems have their own characteristics and differences, and mutual communication is not enough. The data collecting, processing, and managing ability are weak, and there is a time lag in the release time in different regions. The ability to supply the latest information and data required by construction companies is insufficient. In addition, there are differences in the release of industry index [11]. Market prices change rapidly, and the trend of labor and machinery prices is relatively stable. Plus

differences in various regions, the latest information may lag another two to three months. Obviously, the issue of delay in the release time is more serious, and more efforts are needed [12].

| Category | Sequence | Influencing Factors |
|---|---|---|
| Enterprise | $X_1$ | Enterprise management has insufficient awareness of informatization |
| | $X_2$ | It is difficult for enterprises to carry out comprehensive information |
| | $X_3$ | Weak foundation of enterprise information management |
| | $X_4$ | Low corporate information processing |
| | $X_5$ | Fewer IT staff in the company |
| | $X_6$ | Inadequate use of completed project data within the enterprise |
| Industry | $X_{11}$ | Slow update of information data in the industry |
| | $X_{12}$ | Information released by the industry is not timely |
| | $X_{13}$ | Insufficient comprehensive information in the industry |
| Government | $X_{16}$ | Inadequate security system of government system |
| | $X_{17}$ | Incomplete laws and regulations issued by the government |
| | $X_{18}$ | Government does not provide accurate and uniform standards |

**Figure 5:** Re-extraction of obstacles to the development of project cost informatization

### 4.3 Enterprise Information Data Processing

The informatization of China's construction enterprises is mainly reflected in the construction of internal databases, information platforms and the development of cost management software. The direction is instructive, but there are still more outstanding problems in data processing. On the one hand, the awareness of information and data collection is relatively weak. Even after collecting and analyzing data, resources are not fully utilized, to some extent, valuable information and data are wasted. On the other hand, there is no uniform criteria for information and data processing and its specific scope is not clearly defined [13], so that the accuracy of the information and data obtained needs further analysis [14].

| Category | Influencing Factors |
|---|---|
| Enterprise | Enterprise information management is inefficient |
| | Enterprise information technology processing capacity is weak |
| Industry | Industry information and data aging issues |
| Government | The policies and regulations promulgated by the government are not complete |

**Figure 6:** Determinant factors

### 4.4 Enterprise Information Management

At present, the internal information management level of China's construction enterprises is not high

[15]. First of all, the management system is not perfect, and it is more likely to be theoretical and impractical during the informatization process. Moreover, the management level and sense of responsibility of construction enterprise managers also need to be raised. Although we can adopt the latest science and technology as an assistive tool for the development of engineering cost [16], after all, we still need to rely on people to organize and arrange; Finally, with the progress of the times, science and technology are changing with each passing day. As a member of the engineering cost industry, they should take responsibility, obey the organization and arrangement in the construction enterprise. They should also learn more new knowledge about informatization, and do not remain stagnant or be afraid to explore [17].

**5 Solutions for the Development of Engineering Cost Informatization**

*5.1 Promulgate and Improve the Policies and Regulations*

To make substantial progress in the whole industry, it is necessary for the government to promulgate and improve high-quality policies, laws and regulations which will provide a good environment for the development of engineering cost informatization. Specifically, we can start from the following two points: First, according to the macroscopic frame for the development of big data, improving the working mechanism of informatization is a breakthrough, promulgation the policies and regulations similar with 'General Measures for the Informatization of Engineering Costs' can better clarify the work responsibilities of the engineering industry and different construction enterprises; Second, on the basis of 'Thirteenth Five-Year Plan' for the development of engineering cost, the government needs to clarify the current difficulties and stage targets during the process of engineering cost informatization, and ensure that the relevant policies and regulations are complete enough. Only in this way can it help promote the development of informatization.

*5.2 Strengthen Industry Management Capabilities*

China Construction Engineering Cost Management Association, as the coordination manager of the entire engineering cost industry, must take the responsibility of cost informatization construction. The association can follow the two suggestions: The first point is the legal documents promulgated by the government should be fully interpreted and truly implemented. The second point is to formulate standards for the informatization of the engineering cost industry and release to the public regularly. In addition, the industry has a strong ability to integrate information and data [18], and has a leadership advantage in informatization. It should make full use of its leadership role, and coordinate the relationship between the government and construction enterprises on the basis of ensuring releasing relative information and data of high-quality on time.

*5.3 Construction of Cost Information Platform*

According to the different needs of construction enterprises, there are two solutions to note when constructing a cost information platform: Firstly, in order to meet the needs of self-development within the construction enterprise, integrates informatization, strengthens the internal operational capabilities of the enterprise and builds a complete information database, it is essential to ensures the reliability of information data sources; Secondly, although data standards provide a direction for the development of engineering cost informatization, they are not fixed [19]. On the basis of standards, it is necessary to flexibly deal with the problems and actively strengthen information exchange.

*5.4 Enhance Practitioners' Awareness of Informatization*

Managers need to be aware of the importance and inevitability of project cost informatization. In practical management work, they can benefit from the following opinions: First of all, information construction is a method, a process, and not a result. The final result cannot be overemphasized, while the relationship between management and informatization is more important to keep balance in the management process, and finally ensure the quality of cost management tasks; Besides, managers are supposed to unite the various departments within the construction enterprise. In this process, different

departments provide different kinds of knowledge, make full use of the resources of each department, and build the information system together.

## 6 Conclusion

Through the principal component analysis method and comparative analysis method, most of the influence factors can be extracted, after further screening, the final four determinant factors are obtained. It is exactly based on these experimental results, a specific analysis about the limitation in the development of engineering cost informationization can be carried out. But to some extent, both methods have their own shortcomings. Comparative analysis method will contain some subjective opinions from the evaluator, while the principal component analysis method produces variable results when analyzing variables. Furthermore, when using these methods, our survey target samples have certain limitations, and the data resources collected from them are not comprehensive. Therefore, the accuracy of the final conclusion is limited.

As big data technology becomes increasingly important, accelerating the progress of construction engineering cost informationization plays a very important role in the development of engineering cost industry. At present, the most important task is to build a better engineering cost information system. This is not only an urgent need for engineering industry to follow the trend of informatization, but also an important way to improve the level of China's economic development. At the same time, we should introduce advanced management methods, develop and create scientific processing systems, carry out professional training, and gradually increase the awareness of informationization among employees in the whole engineering cost industry. Based on that, a professional engineering cost information technology team will be established, and then meet the higher information demand of the engineering cost industry in the future.

**Conflicts of Interest:** The authors declare that they have no conflicts of interest to report regarding the present study.

## References

[1] M. Ouyang, "Grow up with China with high quality development," *21st Century Business Herald*, vol. 1, no. 2, pp. 1–2, 2019.

[2] Z. Zhang, "Problems and countermeasures in the construction of engineering cost informationization," *Economic Research Guide*, vol. 1, no. 31, pp. 133–134, 2019.

[3] W. Li, "Analysis of engineering cost management countermeasures in big data environment," *Modern Real Estate (Mid-term)*, vol. 1, no. 7, pp. 152–153, 2019.

[4] B. Muhammad, O. O. Lukumon, Q. Junaid, M. Kamran, O. A. Saheed et al., "Big data in the construction industry: A review of present status, opportunities, and future trends," *Elsevier*, vol. 30, no. 3, pp. 500–521, 2016.

[5] H. Y. Zeng, Y. F. Quan and G. Ning, "The study of cost management and control based on knowledge management for process industry MES," *ICARCV 2004 8th Control, Automation, Robotics and Vision Conference*, vol. 1, no. 1, pp. 568–573, 2004.

[6] D. C. Grant and R. W. Gallant, "Computer-based electric energy cost management," *IEEE Transactions on Industry Applications*," vol. 24, no. 1, pp. 70–74, 1988.

[7] A. Lin, "Introduction of the 13th five-year plan for the development of engineering cost industry," *Employment and Security*, vol. 1, no. 22, pp. 3–4, 2017.

[8] G. L. Yan and N. Zhang, *System Engineering*. Mechanical Industry Press, Beijing, 2008.

[9] M. Ge, H. Bangui and B. Buhnova, "Big data for internet of things: A survey," *Future Generation Computer Systems*, vol. 87, no. 1, pp. 601–614, 2018.

[10] Y. G. Diao, "Existing problems and countermeasures of project cost information construction," *Housing and Real Estate*, vol. 1, no. 3, pp. 20–21, 2020.

[11] S. T. GAO, "Research on application of engineering cost management informatization: Take a project as an example," *Value Engineering*, vol. 39, no. 7, pp. 282–283, 2020.

[12] Y. Li, "Influence of information technology development on engineering cost management," *Modern Economic Information*, vol. 7, no. 13, pp. 361–362, 2019.

[13] L. Y. Wang, "Obstacles and system guarantee system of project cost information construction," *Intelligent City*, vol. 4, no. 6, pp. 43–44, 2018.

[14] Y. Q. Liao, "Thinking on how to accelerate the process of engineering cost informatization under the new situation," *Technology Innovation and Application*, vol. 1, no. 3, pp. 83–84, 2017.

[15] X. S. Zhu and J. P. Peng, "Barriers and institutional security system of china's project cost information construction," *Journal of Engineering Management,* vol. 29, no. 2, pp. 22–26, 2015.

[16] Q. Y.  Zou, "Construction of the project cost," *Friend of Science Amateurs*, vol. 1, no. 4, pp. 67–68, 2012.

[17] R. Shao and J. G. Zhang, "The problems and trend study of engineering cost information management," *Shanxi Architecture,* vol. 35, no. 5, pp. 232–233, 2009.

[18] Y. H. He, "Considerations on construction of informatization of engineering cost," *Shanxi Architecture*, vol. 25, no. 22, pp. 240–241, 2008.

[19] W. D. Jiang, T. A. Yang, G. Sun, Y. C. Li, Y. X. Tang *et al.,* "The analysis of china's integrity situation based on big data," *Journal on Big Data,* vol. 1, no. 3, pp. 117–134, 2019.