# Intelligent Performance Evaluation Method of Assembly Construction Project Management Based on Cloud Computing Technology

Qiu-yi Li(✉)

Fuzhou University of International Studies and Trade, Fuzhou 350202, China
lqyl3799475957@163.com

**Abstract.** In order to better evaluate the performance of construction project management in Jinzhou, an intelligent evaluation method based on cloud computing technology is proposed. Combined with the practice of construction project management, the performance evaluation index system of construction project is established. Using the formula of relative membership degree to standardize the data, using linear programming to determine the weight of index factors, vector projection formula to find the approach degree between the actual evaluation value and the target evaluation value to evaluate the construction project management performance. Finally, it is proved by experiments that the performance intelligent evaluation method of assembly construction project management based on cloud computing technology has higher accuracy and timeliness in the practical application process, and fully meets the research requirements.

**Keywords:** Cloud computing · Construction engineering · Engineering management · Performance evaluation

## 1 Introduction

With the rapid development of China's infrastructure construction, in the process of urbanization, construction engineering has become the backbone of the steady development of national infrastructure. In the implementation of construction projects, engineering management has become the focus of attention of construction project practitioners, especially the audit of project cost budget and settlement, which has become an important link in the control of project cost in construction project management, and plays a decisive role in project risk, cost execution, management of project quality and guarantee of progress [1]. In such a new era of construction project management environment and management needs, to explore more application ways of project cost budget and settlement audit has become the key to ensure the efficient implementation of construction projects and the consensus of practitioners in the industry [2]. Construction engineering has the characteristics of large investment, long construction period, involving many subjects, many uncertain factors and high risk.


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Construction project performance evaluation is an important part of construction project management. The intelligent performance evaluation method of prefabricated construction project management based on cloud computing technology can not only provide theoretical guidance for the practice of construction enterprises, but also provide a good basis for managers to grasp the project operation in the process of the project, so as to provide real-time monitoring and control.

# 2 Intelligent Performance Evaluation Method of Assembly Construction Project Management

## 2.1 One Point One Weight Algorithm of Attribute Index in Assembly Building Engineering

In the process of project price budget and settlement audit, there are many methods applied, in order to fully deal with the long construction period and large construction period The impact of the amount of capital investment and the changeable market environment on the application of the cost budget and settlement audit, generally, the cost budget and settlement audit will be carried out in a variety of audit methods, such as screening audit, analogy audit, key audit, sub audit and so on [3]. Based on this need, the algorithm of attribute index weight is optimized.

There are two factors influencing the comprehensive evaluation of construction project performance:

The first level of evaluation index set is a = (asset growth rate $A_{21}$, project profit rate $A_{22}$, cost reduction rate, $B_3$ project funds in place rate is $B_5$) * agility + accounting. $B_4$ and further combined with operational profitability $A_{46}$, customer satisfaction $A_{31}$, cooperation unit closeness $A_{20}$;

The second level evaluation index set is table = (duration control capability $A_{ij}$, risk control capability $A_{12}$, contract performance rate $B_{13}$ and response time $B_4$),

If the project schedule completion rate is $A_{31}$, the project contracting capacity is $A_{32}$, the cash flow turnover time $A_{33}$, the inventory turnover rate is $A_{34}$, the current asset turnover rate is $B_5$, the labor productivity is $A_{36}$, the safety production control ability is $A_{37}$, the owner satisfaction rate $A_{40}$, the quality target compliance rate is $A_{42}$, the completion punctuality rate is $A_{44}$, the rework rate is $B_4$, the owner complaint rate $A_{45}$, the design change control ability is $B_6$, and the environmental protection control ability is $B_7$. Based on this, the evaluation index grades of construction project management are divided as follows (Table 1):

**Table 1.** Classification of construction project management evaluation indexes

| Division of primary and secondary factors of evaluation | Evaluation index of building materials | Evaluation criteria and equivalence division results |
|---|---|---|
| Main evaluation grade classification standard Classification standard of secondary evaluation grade Main evaluation grade classification standard Classification standard of secondary evaluation grade | Main sources | Subsidiary indicators affecting the evaluation results of the model |
| | Toughness | The key index influencing the evaluation results of the model is only second to the loss degree of building materials |
| | Management intensity | The key indicators influencing the evaluation results of the model are much more important than other factors |
| | Pressure bearing capacity | Subsidiary indicators affecting the evaluation results of the model |
| Main evaluation grade classification standard | Pricing range | Under the premise of the change of evaluation standard, the pricing range of building materials will also change |

Due to the different units of each evaluation index, the data will be incommensurable. If the calculation is conducted directly, the results will be unreasonable. Therefore, before the aggregation, the evaluation value and the target value provided by experts should be standardized respectively. The specific algorithm is as follows:

Benefit index weight algorithm:

$$B_{\mathrm{ij}} = \frac{A_{ij} - 1}{A_{\mathrm{ijmax}} - A_{ij\mathrm{min}}} \tag{1}$$

The index algorithm of construction project contracting is as follows:

$$\mathrm{S}_{ij} = \frac{B_{\mathrm{ij}}}{2\left(A_{\mathrm{ijmax}} - A_{ij\mathrm{min}}\right)} + 1 \tag{2}$$

Where I is the I first level indicator and j is the j second level indicator. Considering both subjectivity and objectivity, the two methods are integrated, that is, the weight is given by experts and owners in the form of interval range according to the industry characteristics and experience of construction engineering [4]. Obviously, the determination of a reasonable attribute weight vector $w_{\mathrm{ij}} = (w_{i1}, w_{i2}, w_{i3}, \ldots, w_{in})$ should make the total deviation between its performance evaluation result and the target value provided by the expert smaller, as well as the better. In this way, the expert's opinion is fully considered and the data itself information is fully utilized [5]. Therefore, in order to determine the weight of secondary evaluation indexes, the following linear programming model is established:

$$\min G = \sum \sum A_{ij}(\mathrm{w}_{ij} - B_{ij}) \tag{3}$$

Use formula (3) to calculate the weighted value of performance evaluation of actual data and target data respectively:

$$P_{ij} = \prod (\mathrm{B_{ij}} + w_{ij})k/\mathrm{Q_i} \quad (4)$$

There, $k$ are two vectors. The larger the projection value of vector $\mathrm{Q_i}$ coincidence on the vector, the closer the vector coincidence and A are, the closer the evaluation result of engineering practice is to the target value given by experts, the better [6]. Further, the numerical calculation table of each secondary index calculated by the directional principle is as follows (Table 2):

**Table 2.** Secondary index specification for construction project management

| $B_{10}$ | $B_{11}$ | $B_{12}$ | $B_{13}$ | $B_{14}$ |
|---|---|---|---|---|
| Actual evaluation value | 82 | 85 | 88 | 84 |
| Target evaluation value | 12 | 11 | 14 | 10 |
| Rights information provided by experts | [0, 12, 6, 24] | [3, 12, 8, 16] | [2, 16, 4, 20] | [5, 16, 2, 13] |
| Actual data specification value | 0.12 | 0.23 | 0.16 | 0.20 |
| Target data specification value | 12.16 | 13.41 | 16.46 | 15.42 |
| Secondary weight | 10.46 | 9.558 | 9.76 | 9.32 |
| Weighted comprehensive actual value | 0.13 | 0.46 | 0.35 | 0.28 |
| Weighted combined target value | 0.230 | 0.220 | 0.168 | 0.167 |
| Weighted marginal target value | 0.236 | 0.245 | 0.231 | 0.264 |

## 2.2 Evaluation Model of Construction Project Management

In order to strengthen the supervision of large-scale public buildings, indemnificatory housing, commercial housing and key projects of municipal Party committee and municipal government, and ensure the project quality. Strengthen the solid quality supervision of foundation and main structure engineering. Adhere to the supervision focus on the foundation, main structure and key parts affecting the use safety and use function, and implement the mandatory standards of engineering construction to ensure the safety of engineering structure [7]. Strengthen the management of completion acceptance of housing construction projects to prevent unqualified projects from flowing into the society. According to the relevant national and provincial regulations, supervise the organization form of completion acceptance, the implementation of acceptance procedures, the implementation of acceptance scheme, review the completion acceptance data, and supervise the implementation of national mandatory standards, specifications and quality evaluation results for the completion acceptance of the project, so as to ensure the quality of the completion acceptance.

Furthermore, the excessive dependence on the contract by the flexible management will not only weaken the mutual trust between the cooperative participants, but also lead to opportunistic behavior. The performance management evaluation model is a flexible project management model based on the contract signed and the agreement made by the cooperative participants through consultation as the basic code of conduct [8, 9]. Combined with the principle of cloud computing, based on the engineering management protocol, with management as the means and goal realization as the core, the management mechanism system includes cooperation mechanism, coordination mechanism, communication mechanism, trust mechanism and incentive mechanism. The specific management mechanism framework model is shown in the Fig. 1.

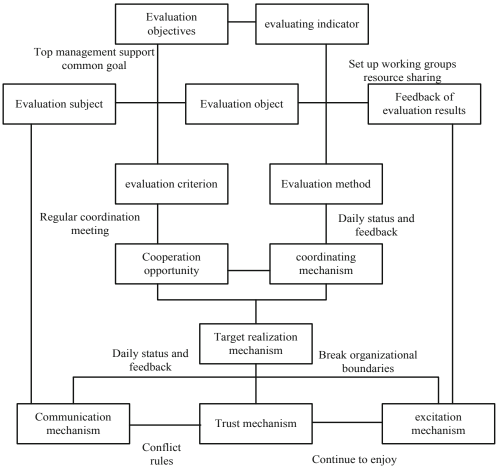


**Fig. 1.** Framework model of construction project management mechanism

In order to evaluate the core competitiveness of construction enterprises more objectively and effectively, and to provide reference for the cultivation of competitiveness of later construction enterprises, we should abide by the following principles when formulating the evaluation index system of core competitiveness of construction enterprises:

(1) Objective principle

The main purpose of building the index system is to analyze and evaluate the core competitiveness of construction enterprises, which needs to consider the industry characteristics and development background of construction enterprises as well as the relevant theories in the process of index selection.

(2) The principle of combining qualitative and quantitative analysis

From the concept point of view, the core competitiveness of construction enterprises is a more abstract concept. In order to reflect it more comprehensively, the qualitative and quantitative expression methods are used in the construction of index system. Quantitative analysis reflects the attributes of things through specific quantity, and qualitative analysis explores the essence of things through observation, experiment and analysis. The combination of qualitative analysis and quantitative analysis can ensure that the evaluation results of core competitiveness indicators of construction enterprises are more real and objective.

(3) Follow the principle of data authenticity

The construction of indicator system cannot be separated from the support of data. Scientific and authentic data can effectively reflect the rationality of each indicator and help the next analysis process. On the contrary, if the collected data is not authentic enough, it will lead to the appearance of unreasonable indicators and affect the final analysis results [10, 11]. In order to ensure the authenticity and reliability of the data, we must strictly comply with the relevant requirements when collecting the data.

(4) Follow the principle of representativeness

In the process of index construction, we should select those representative indicators that can reflect a certain characteristic of the research problem, and build a scientific index system according to the specific characteristics of the research [12, 13].

(5) Dynamic principle

The evaluation system of the core competitiveness of construction enterprises is a relatively complex evaluation system, because the core competitiveness of construction enterprises is realized in the real dynamic, with the change of regional, environmental, policy and other factors is a dynamic development variable, so the dynamic characteristics of the core competitiveness of construction enterprises should be considered in the selection of evaluation indexes. The dynamic principle requires that the evaluation index should be flexible, reflect the development trend of the enterprise, adapt to the changes of the market environment, and reflect the characteristics of the core competitiveness in a long period of time. The dynamic evaluation index can help the enterprise to respond to the changes of the market environment and make adjustments quickly [14, 15].

## 2.3 Implementation of Project Management Performance Evaluation

Combined with the previous research results, the knowledge management ability is divided into four dimensions: knowledge acquisition ability, knowledge integration ability, knowledge creation ability and knowledge application ability. Through reading the relevant literature at home and abroad, appropriate items are selected to measure it. In this study, several documents were collected for a brief introduction: Shi Jiangtao defined the concept of knowledge integration and put forward the factors that affect the ability of knowledge integration. The restrictive factors of enterprise knowledge creation ability are also a multi-level dynamic system, and the factors related to knowledge creation ability are numerous and complex. In order to better realize the transfer evaluation of project management performance, the evaluation system of project management performance is constructed as follows (Fig. 2):

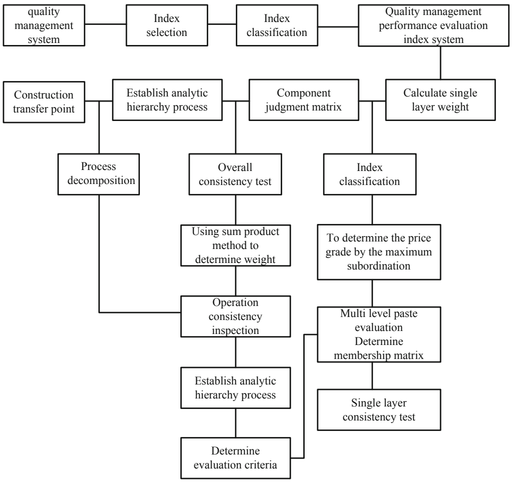


**Fig. 2.** Project management performance evaluation system

It plays an important role in the process of construction project management. The work content is closely related to the project contractor, the owner, the construction unit and the supervisor. Each relevant party must perform its own responsibilities, strengthen the project change management, and avoid problems in the change management caused by its own factors, which will affect the whole process The quality of individual projects results in the loss of economic interests of all parties. The initial index system is divided into three levels: the first level is the core competitiveness of the enterprise; the second level is the ability to acquire knowledge, the ability to integrate knowledge, the ability to create knowledge and the ability to apply knowledge; the third level is obtained by reading relevant literature and combining the collaborative innovation network of construction enterprises. The measurement indicators of the core competitiveness of construction enterprises are the quality rate of construction projects, the proportion of professional and technical personnel of enterprises and the brand awareness of enterprises. The impact indicators of the management system of construction enterprises are analyzed. The specific indicator system is shown in the Table 3:

**Table 3.** Impact indicators of construction enterprise management system

| First level indicators | Secondary index | Exponential property |
|---|---|---|
| Knowledge acquisition ability a Knowledge integration capability B Knowledge creation ability C Knowledge application ability D | Willingness to acquire knowledge A1 | qualitative |
| | Frequency of knowledge acquisition A2 | qualitative |
| | Access to knowledge A3 | ration |
| | Timeliness of network knowledge acquisition A4 | qualitative |
| Core competitiveness of construction enterprises x First level indicators Knowledge acquisition ability a Knowledge integration capability B | Knowledge preparation of construction enterprise B1 | ration |
| | Heterogeneity degree of knowledge acquired by construction enterprises from other subjects B2 | ration |
| | Construction of B3 knowledge management system in construction enterprises | directional |
| | Trust degree between construction enterprises and other network subjects B4 | qualitative |
| Knowledge creation ability C Knowledge application ability D Core competitiveness of construction enterprises x First level indicators | Incentive intensity of construction enterprises to knowledge creation C1 | ration |
| | Proportion of construction enterprises participating in knowledge creation C2 | qualitative |
| | The importance of construction enterprise to staff training | ration |
| | Cooperation degree between construction enterprises and other network entities C4 | ration |
| Knowledge acquisition ability a Knowledge integration capability B Knowledge creation ability C Knowledge application ability D | The degree of using collaborative innovation network to develop new products in construction enterprises D1 | qualitative |
| | Number of new patents of construction enterprises in recent years D2 | qualitative |
| | Number of new construction methods developed by construction enterprises and network members in recent years D3 | ration |
| | New technology adoption rate of construction enterprise D4 | directional |
| Core competitiveness of construction enterprises x | Proportion of technical personnel in No.1 industry x1 | qualitative |
| | Excellent rate of enterprise construction project x2 | directional |
| | Enterprise brand awareness x3 | qualitative |

(1) Willingness to acquire knowledge A1

Construction enterprises expand the channel of knowledge acquisition by building collaborative innovation network. For enterprises, the increase of knowledge source does not mean the increase of knowledge. Only when enterprises realize the importance of knowledge and have the desire to acquire knowledge urgently, the ability of knowledge acquisition of enterprises will be enhanced.

(2) Frequency of knowledge acquisition A2

The frequency of knowledge acquisition in the collaborative innovation network not only reflects the communication between the network subjects, but also reflects the rate of knowledge update of the network subjects. Generally, the higher the frequency of knowledge acquisition, the faster the knowledge flow in the collaborative innovation network, and the easier it is for enterprises to acquire the knowledge they want.

(3) Convenience of acquiring knowledge A3

The main purpose of enterprises to acquire knowledge is to hope that the acquired knowledge can bring economic effects to enterprises, and the purpose of enterprises is to pursue profits, which also determines that enterprises have various difficulties in acquiring key knowledge. The convenience of acquiring knowledge from network members determines the transfer efficiency of key knowledge between enterprises.

(4) Timeliness of knowledge acquisition A4

Through the construction of collaborative innovation network, the channels for enterprises to acquire knowledge are expanded. While acquiring knowledge, enterprises must ensure the timeliness of knowledge. Only in this way can knowledge have value. Knowledge with low timeliness may mislead enterprises to make wrong decisions and affect the development of enterprises.

(5) Reserve level of construction enterprise B1

To a certain extent, the knowledge reserve of an enterprise not only reflects the quality level of employees, but also reflects the degree of knowledge accumulation of an enterprise. Generally, the knowledge that an enterprise reserves is the knowledge that can bring actual benefits to the enterprise after being tested. At the same time, these knowledge can improve the efficiency of knowledge integration.

(6) Heterogeneity degree of construction enterprises B2

In the collaborative innovation network, different network subjects often have different organizational culture, which also determines that the knowledge owned by enterprises often has their own characteristics. Generally, the closer the enterprise nature and corporate culture are to knowledge integration, the easier it is.

(7) Completion degree of knowledge management system of construction enterprise B3

Knowledge management system is an information system that collects and processes all knowledge in an organization. Enterprises must classify and store the acquired knowledge information effectively for knowledge integration. A complete knowledge management system can help enterprises to call the information they need quickly and greatly promote knowledge integration.

(8) Trust degree of construction enterprises B4

The higher the degree of trust among the subjects in the collaborative innovation network, the faster the knowledge flows in the network, and the stronger the efficiency of knowledge integration. At the same time, the establishment of trust relationship strengthens the cooperation among network members, which is more conducive to the development of knowledge integration activities.

(9) Incentive strength of construction enterprises C1

By setting up various incentive mechanisms and incentive measures, enterprises can stimulate employees' enthusiasm for knowledge creation and promote the development of knowledge creation activities. At the same time, the greater the support of enterprises for knowledge creation, the more new knowledge they create.

(10) Proportion of construction enterprise participants C2

People are the main body of knowledge creation, and knowledge can produce value because of people's use. The higher the proportion of people who have knowledge creation, the easier it is for enterprises to create new knowledge.

(11) Importance of construction enterprises on management C3

Knowledge is constantly updated. The enterprise often trains its employees so that they can realize that only through continuous learning can they adapt to the development of the company and enhance their sense of crisis. At the same time, through training, they can increase the number of talents in the enterprise and lay the foundation for knowledge creation.

(12) Cooperation degree of construction enterprises C4

Knowledge creation needs the full cooperation between the network subjects, and the full communication can promote the production of new knowledge by gathering the advantageous resources of each subject together. In this process, the higher the degree of cooperation between the subjects, the stronger the efficiency of knowledge integration of enterprises.

## 3 Analysis of Experimental Results

In order to verify the actual application effect of the intelligent performance evaluation method of assembly construction project management based on cloud computing technology, this paper takes the general contractor of construction project as the core enterprise as a case to learn from the concept of supply chain, and expounds the establishment of the performance evaluation method and evaluation effect of construction project. Experiment on Windows platform. Establish database, input and organize through Excel 2003. SPSS13.0 is used for statistical analysis, mainly descriptive statistical analysis; in the use of analytic hierarchy process to determine the weight of the index system and the use of fuzzy comprehensive evaluation method to comprehensively evaluate the performance score, the algorithm of matrix operation is mainly used. The number of sample cases shall be determined according to the sampling proportion of 5%. A multi-stage, proportional sampling method is used to extract the target data of the survey case experts under the overall goal of the project planning. Based on the above experimental environment comparison detection, the specific detection results are as follows:

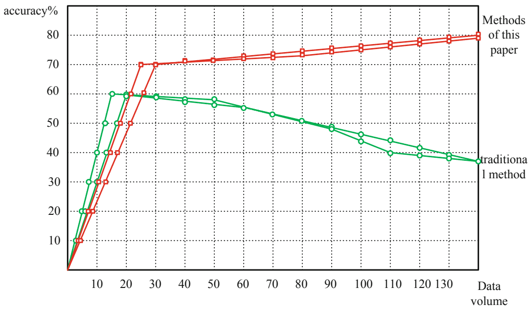


**Fig. 3.** Comparison of accuracy of project management performance evaluation

Further, in the same environment, the time-consuming situation of the two methods is compared and tested, and the test results are recorded, as follows:

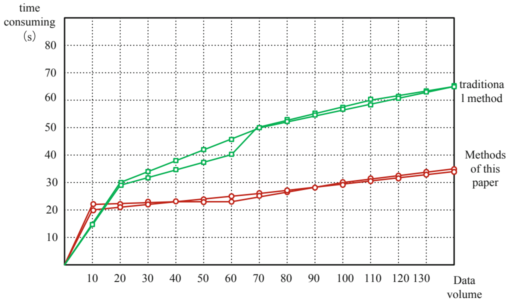


**Fig. 4.** Time consuming test of project management performance evaluation

It can be seen from the inspection results in Fig. 3 and Fig. 4 that, compared with the traditional evaluation methods, the intelligent evaluation method based on cloud computing technology proposed in this paper has higher evaluation accuracy in the practical application process, and the evaluation time of construction project management performance is significantly reduced in the same environment. It is proved that the performance intelligent evaluation method based on cloud computing technology is more effective and accurate, which fully meets the research requirements.

## 4 Conclusion

This paper constructs a performance evaluation model of construction project based on vector projection, quantifies the effect of construction project, and compares the effect of specific project management with the ideal target parameters, so as to help construction enterprises effectively classify key indicators and clarify the key points of performance management. The partial weight and information problem model proposed by the author can effectively avoid affecting subjective Human factors. The empirical study shows that the method is clear and can effectively avoid the shortcomings of other methods, and provides a new way for the research in this field. In the future research, we should strengthen the performance management of construction projects, innovate the sustainable development of construction projects, and improve their practical application performance.

**Fund Projects.** Research on the application of cloud computing technology in the construction project management system in the era of big data (Project No.: JAT190908).

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