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Research on Intelligent Control of Engineering Project based on Case-based Reasoning

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Abstract: With the increasingly fierce market competition, the demand for effective project cost estimation methods is increasingly urgent. In this paper, the author analyse the intelligent control of engineering project based on case-based reasoning. The use of traditional methods to estimate the cost of the project has exposed many problems. The application of case-based reasoning based on the experience of the past data to calculate the cost of the current process, which can ensure the timeliness and accuracy of data, is a more effective method of estimation. This study provides a scientific basis for the investment decision of the project, and has great practical value.

Key words: Intelligent control, Engineering project, Case-based reasoning, Estimation system

1. INTRODUCTION

The construction project is out of control is an important problem of China's fixed asset investment, its reason is in many aspects, which is one of the important aspects of cost control in construction stage there is a heavy and light investment decision problems(Gan, 2012). The project mainly includes the investment decision-making stage, the design stage, the construction stage, the guarantee stage. From the aspects of investment and cost control, although the actual investment projects mainly in the construction phase, but the possibility to control and save the project investment is mainly in the pre construction stage, and with the progress of the project, will be gradually reduced(Hong, 2014). Among them, the investment decision-making stage is the goal of the construction project is expected to be the highest level of the whole process of project cost control is the most basic basis. Therefore, how to accurately estimate the cost of the project has become a problem that can not be ignored.

With the popularization and application of computer, the construction cost estimation system based on artificial intelligence technology has become the development direction of engineering cost estimation. At present, the engineering cost estimation system based on rules and neural network(Liu, 2005). Because of these systems have some shortcomings, such as knowledge acquisition is very difficult, the system can not solve the problem beyond the scope of the problem, the cost of reasoning is more abstract, not easy to understand. Based on the engineering cost of case reasoning retrieval needs is the construction case, 'greatly reduces the knowledge necessary from the experts, are easier to build similar solutions of reasoning results of specific cases are not perfectly matched between to solve engineering problems and cases, more vivid, can reflect the general situation engineering, easy to understand and accept (Liu, 2001; Li, 2006). Based on this, this paper presents the study of engineering cost estimation based on CBR, which has important theoretical significance and practical value. Based on the engineering cost estimation and case based reasoning research and in-depth understanding, to find a meeting point of the two, the project cost estimation problems with case based reasoning combined with case-based reasoning process as the main line, according to the problems, research methods used in CBR, compensate for the lack of common reasoning mechanism, and improve the speed and accuracy of case-based reasoning, at the same time, also expand the application of case based reasoning, provides a new and effective method for solving the engineering cost estimation the problem.

2. THEORETICAL ANALYSIS OF ENGINEERING COST ESTIMATION

2.1. Engineering cost estimation

The cost of construction, that is, the construction price of the project, refers to the construction of a project is expected to spend or the actual expenditure of the total investment in fixed assets. The project cost is large, which has a great impact on the national economy. The price structure is a comprehensive reflection of the market price of a number of industries(Sun, 2001). Project cost management is to reasonably determine and effectively control the project cost. Namely, reasonable investment estimation, cost budget, cost budget, contract price, the settlement price and completion price based on the optimization of construction scheme, design scheme, in the various stages of construction procedures, the use of certain methods and measures to control the cost limit within reasonable scope and approved the project cost. In order to obtain better investment returns and

social benefits. With the progress of construction projects, effectively reduce the possibility of project investment will decrease gradually, that is to say, although the project entered the construction period after the funds is the peak, but the control and save the project investment potential is more and more small. According to relevant statistics, in the various stages of construction, investment decision-making stage of the impact of the project cost of up to 80%-90%. Therefore, the decision-making phase of the project is to determine the cost of the project based on a direct impact on the decision-making phase of the construction phase of the project cost control and control. It is an important content of project cost management to do well in the project decision-making stage.

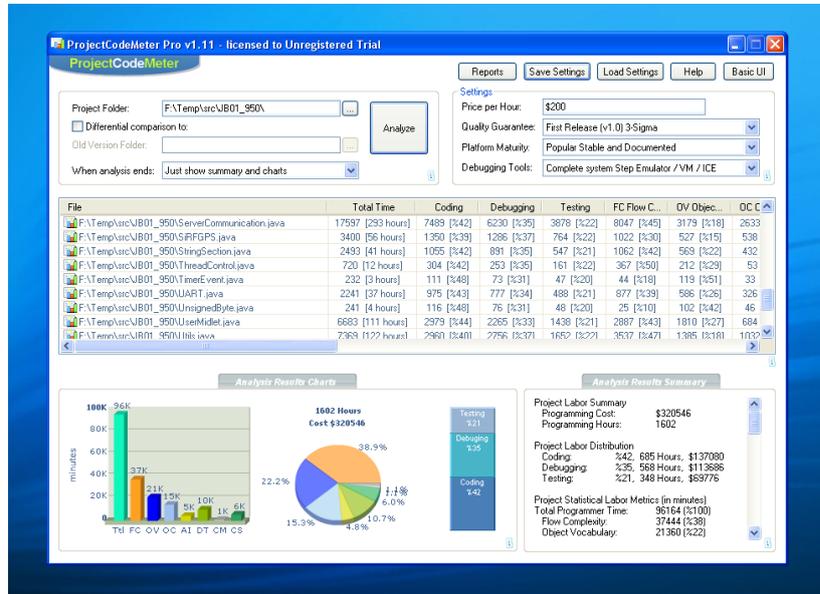


Figure 1. Engineering cost estimation

The estimation of the project cost is to estimate the investment of the project in the investment decision stage, according to the information and the investment estimate index, the experience and the method. Investment decision-making is the process of selection and investment decisions of the programme of action, is the technical and economic necessity and feasibility of the proposed project, the different construction scheme for technical and economic comparison, selection and judgment and decision process. Whether the investment decision is right or not is directly related to the success or failure of the project construction. With the gradual deepening of the investment decision-making, mastery of the material gradually rich, investment estimation work is correspondingly divided into four stages to estimate the planning phase of the investment estimation of the project proposal stage of investment, investment estimation in feasibility study, investment estimating review stage.

Item	Design Estimate Effort	Project Contingency Range (%) ^a	Design Information Required	Cost Estimate Basis		
				Major Equipment ^b	Other Materials ^b	Labor
Class I (Similar to AACE Class 5/4)	Simplified	30-50	General site conditions, geographic location and plant layout; Process flow/operation diagram; Product output capacities	By overall project or section-by-section based on capacity/cost graphs, ration methods, and comparison with similar work completed by the contractor, with material adjusted to current cost indices and labor adjusted to site conditions.		
Class II (Similar to AACE Class 3)	Preliminary	15-30	As for Type Class I plus engineering specifics, e.g., Major equipment specifications; Preliminary P&I (piping and instrumentation) flow diagrams	Recent purchase costs (including freight) adjusted to current cost index	By ratio to major equipment cost on plant parameters	Labor/material ratios for similar work, adjusted for site conditions and using expected labor rates
Class III (Similar to AACE Class 3/2)	Detailed	10-20	A complete process design; Engineering design usually 20-40% complete; Project construction schedule; Contractual conditions and local labor conditions	Firm quotations adjusted for possible price escalation with some critical items committed	Firm unit cost quotes (or current billing costs) based on detailed quantity take-off	Estimated man-hour units (including assessment) using expected labor rate for each job classification
Class IV (Similar to AACE Class 1)	Finalized	5-10	As for Class III, with engineering essentially complete	As for Class III, with most items committed	As for Class III, with material on approx. 100% firm basis	As for Class III, some actual field labor productivity may be available

Figure 2. Different levels of project cost estimation

2.2. Influencing factors of value estimation

Project cost estimation is affected by many factors, not only related to the investment environment, but also with the technical program, but also by the impact of the estimation method.

2.2.1. Project investment environment

- **Engineering condition:** In the investment decision-making stage, the project of knowledge is limited to the needs of the investigation, to grasp the information is very limited, so it is necessary according to the construction needs of deep mining engineering information, as far as possible to accurately understand the engineering requirements, ensure good use of construction funds, streamlining project overhead, improve the effective use of resources.
- **Peripheral factors:** Peripheral factors are policy factors, fuel power supply, transportation and communication conditions, environmental protection. To strive for a comprehensive and detailed understanding of the details of these factors, to avoid unnecessary loss of project expenditures, as far as possible to achieve the best value of the project.
- **Technical supporting factors:** Advanced production technology and equipment is the basis of project scale benefit, and the corresponding management technology level is the guarantee of realizing the scale benefit. If the high cost of acquiring technology or the current technology and equipment have reached advanced level commensurate with the scale economy, will bring the crisis to the development of the project on the project led to the low efficiency of investment, project cost expenditure serious waste.
- **Market factors:** The market supply and demand and cost fluctuation quantity, the requirements of the project, combined with the construction period, to do thoroughly work in advance, and in accordance with the laws of the market, as accurately as possible for exchange rate projections, charts, understand the possible range of project cost, so as to do there, to ensure sufficient supply of funds. In view of the factors affecting the project cost estimation, need to master enough data, and fully understand the connotation of the two only in this way, in order to better complete the design work of technical scheme, which directly affect the size and composition of the project cost.

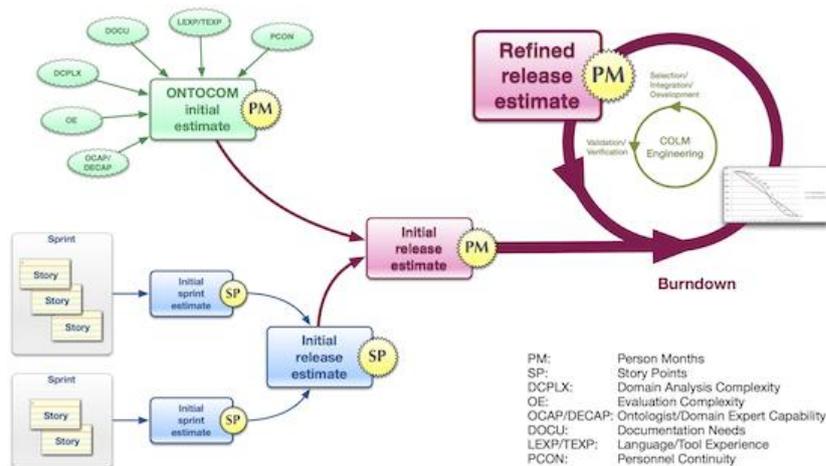


Figure 3. Cost estimation model

2.2.2. Project construction scheme

The advantages and disadvantages of the project directly affect the size of the construction cost and the length of the construction time, the impact of the construction of the target and the input of human resources, determine the long-term use value and economic effect of the construction project. In the decision-making phase of the construction project, the design of the program is mainly to grasp its depth, in the premise of ensuring a reasonable period of time, a more detailed and comprehensive program planning.

- **Establishment of construction standards:** The main content of the construction standard is the scale, the area, the technical equipment, the construction standard, the supporting project, the labor quota and so on. The construction standard is the important basis for compiling, evaluating and approving the feasibility study of the project. It is an objective measure of whether the project cost is reasonable and the construction of the supervision and inspection project.
- **Selection of construction area and construction site:** The choice of the construction area refers to the choice of the suitable area or scope of the proposed project in several different areas. The choice of the construction area is reasonable or not, to a large extent determines the fate of the proposed project, affecting the cost of the project. The choice of the construction area shall follow the following two principles: the principle of appropriate aggregation of the principles of industrial production of raw materials, fuel supply and consumption.

- Determination of production process plan and layout plan: The determination of the production process makes the construction of the current project possible, and achieves the maximum economic effect with the minimum consumption. To determine the feasible scheme to be adopted in the light of advanced application and economic rationality.
- Equipment selection: The selection of the equipments is determined according to the production scale, product plan and process requirements, in accordance with the application of advanced, economic and reasonable, safe and reliable principle, equipment selection and mechanical loading, high efficiency and low energy consumption structure. The selection of equipment directly constitutes the evaluation of equipment, which affects the total investment of the project and the technical and economic evaluation of the project.

3. CASE BASED REASONING

3.1. CBR basic principle

Rule based reasoning is the domain expert knowledge and experience based reasoning, the expert knowledge and experience for some abstract reasoning process, it is widely used in the mode of reasoning in expert system, knowledge system development tools are using this reasoning mechanism, and it is more intuitive, the inference process is easy to understand at the same time, the rules are independent of each other, with modular characteristics of strong, easy to implement interpretation function, reasoning efficiency is relatively high but the RBR expert knowledge and experience is very hard to get, especially for more complex rules and conditions of multiple solutions, comprehensive collection of experts in the field of knowledge and experience, more difficult. And can not directly transfer information between rules and rely on context rules, when the rules number, according to the context, and retrieve usable rules can be expensive, push Reduced efficiency. Therefore, the reasoning mechanism of RBR is mainly adapted to the knowledge and experience of experts in the field, which is easy to collect, and the problem structure is good.

Case based reasoning is a new reasoning method developed with the research of cognitive psychology. The basic principle is that people can use the previous experience of similar problems, that is, to solve the problem. In this method of solving problems in the past, people will solve problems according to the case of a certain organization is stored in the case base, when the new problems to be solved when the user input, the system first case database search, find the problem to be solved or similar to the problems to be solved in the case. If you find the case is consistent with the description of the problem to be solved, otherwise the output solution problem is found in the case, according to the description of the problem solving, to modify the retrieved case, to produce a solution for the problem to be solved and the output requirements. At the same time, the problem and its solution are stored as a new case in the case base. Therefore, in the future system solution process, you can use the case library of all known cases, without having to start from scratch.

3.2. CBR inference process

Case based reasoning accords with people's cognitive psychological process, and reflects the characteristics of human cognitive process, which is based on the past experience and method. When encountered new problems, they are often faced with new problems to identify the previous question similarity queries "some related problems apt to identify new problems, which should be similar to the experience or previous experience what adjustment conclusion. Similarly, the process of case based reasoning is a new problem when the problem comes, to describe its old case retrieval of similar cases from the library, to compare the differences between the new problem and the old case, making adjustments to the old case, to seek a solution to the object problem. The solution adjusted by program evaluation to determine the quality of the solution, if satisfied, then get the solution of the problem, the formation of the case, also use case studies to determine whether the technique can be stored in the case base or by deleting the lack of representative cases, in order to eliminate the inconsistency between the case and to prevent the case outdated. The reasoning process of CBR consists of 5 steps: (1) problem description; (2) case retrieval; (3) program adjustment; (4) program evaluation; (5) case study.

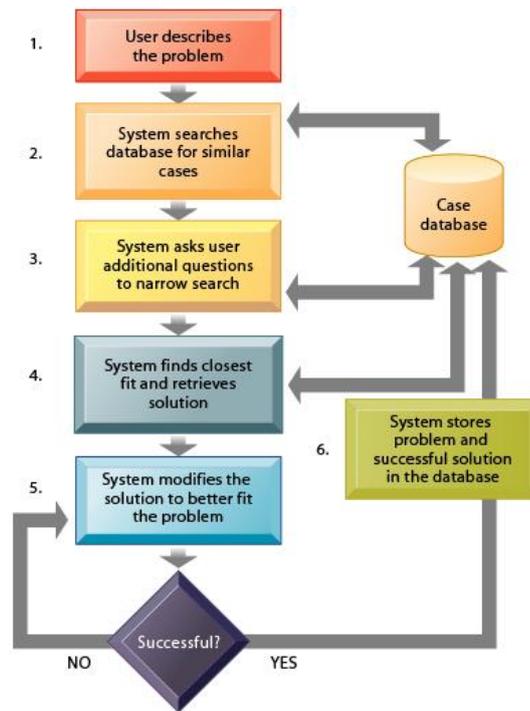


Figure 4. Case reasoning process

4. PROJECT COST ESTIMATION BASED ON CASE BASED REASONING

4.1. Engineering cost estimation system

Estimated by the traditional method of project cost, has exposed many problems in the traditional project cost estimation method weakens the concept of the market, just to meet the expansion of infrastructure investment demand as the center to determine the project cost, the country could have passed the reasonable price of construction product by the construction of centralized tax dollars are freely distributed to the thousands of households. Loss caused by the national construction industry, and therefore have no self development ability, not the development of the traditional methods can not play a very good control of the project cost management of engineering cost estimation, leading to the construction process of the "super three" phenomenon, is not conducive to the advancement of technology, high quality production, the development will be serious if things go on like this. Hinder social productivity. Project cost estimation is carried out in the investment decision-making stage, the restriction of master of engineering degree determine the detailed information, many engineering information is sketchy, the project cost estimation of the general valuation method of engineering cost is not feasible, and the application method of case based reasoning, with the help of the experience of the past data, calculation the current process cost, can provide the basis for ensuring the timeliness and accuracy of data, is a good choice. At the same time, in the actual work, the project cost estimate also mostly uses the past engineering experience to complete, and the method based on case reasoning. In order to improve the timeliness and accuracy of the project cost estimation, it is necessary to study the cost estimation based on case based reasoning.

The method of engineering cost estimation, with interoperability can be put into the corresponding quantity and price breakdown between the case based reasoning method and the commonly used methods, the engineering required quantity of investment estimate, combined with the corresponding market price to get the total cost of the project, reflect the real law principle of separation of quantity and price, reflect the personality characteristics of concrete the project can use fuzzy mathematics method to estimate the similarity between engineering and typical engineering to do the quantitative calculation, the similarity between the building structure and construction of the project to reflect the similarity with the quantity, the fuzzy features reflect the problems of the construction cost, the impact of the project cost to reduce the time value of capital factors and neural network method similar, also suitable for processing of unstructured information, and in the case reasoning process can be better considered practical needs, the effect is not very in reasoning To a large extent subject to the selection of sample information. Case based reasoning method can be used to estimate the engineering cost. With the popularization and application of case based reasoning method based on some research achievements in the field of engineering cost, the successful use of the method of main quantity residential building consumption were estimated, provide a reference basis for the engineering cost estimation

decision is of great value. This study confirms the idea that case-based reasoning can be a powerful tool for engineering cost estimation.

4.2. CBR implementation technology

In the CBR system, the case base is an important part of the whole process of reasoning, which is the basis of other modules. Therefore, the construction of cost estimation system based on case based reasoning, first of all, is to study how to express the past engineering examples into the form of cases, and how to organize the case to form a case base.

Case representation: Because of the understanding or judgment of things is often manifested as a comprehensive grasp of the various aspects of the property or judgment, with the value of the property to reflect the value of things, that is, of course. Therefore, the extraction and use of attributes is the basis of the case. According to the engineering information, select the investment decision-making stage to determine the main factors influencing the construction cost of the construction standards, construction area and construction site selection, determine the production process and layout, equipment selection etc.. Case representation refers to the use of a certain data structure, the formal description of historical experience, the completion of the transformation of human experience to the case. At present, the common methods of case representation include logical representation, frame representation, production representation, semantic network representation and so on. Among them, the framework representation is a generalization of the semantic network structure, but also the source of the idea of object-oriented framework representation to a certain extent, to meet the needs of engineering knowledge and expression based on the need of case-based reasoning, the system is conducive to conveniently and smoothly reasoning. Frame representation method.

Case organization: Case organization is to better represent the case, according to the characteristics of the case and the need to retrieve, organize the case, sort out, the formation of case base. Case organization provides the necessary premise for case-based reasoning, which directly affects the efficiency of case retrieval. According to the engineering case representation method, the application of relational database technology to organize cases. In fact, relational database technology is a data structure model, which is based on the data structure of the conceptual model. The collected project case framework is stored in a series of interrelated data tables. Each attribute of the engineering case is used as the field and the case number is used as the primary key to construct the table structure, and the corresponding index in each table is created. By using the technology of relational database, we can use the language to retrieve the project case, and manage and maintain the project case base.

Case retrieval: Case retrieval is the key of case reasoning and the core of case-based reasoning system,. The efficiency of the system is largely determined by the ability to quickly and accurately retrieve the appropriate case from the case base. Therefore, how to retrieve the case quickly and efficiently is the key to the success or failure of the project cost estimation system based on case reasoning. Therefore, it is necessary to set up appropriate search strategy and search algorithm. On the macro level, the case retrieval strategy is divided into two types: serial and parallel. In the case of multiple serial retrieval according to the hierarchical structure of Lin organization, retrieval using a top-down layer refinement, the farther down, the higher the degree of similarity of parallel retrieval can weaken the hierarchy characteristic between the case at the same time, a plurality of case retrieval, which returns the highest level of similar cases.

Plan adjustment: When the case retrieval result is not empty, just get a collection of case base to solve the problem is the guiding role of the case, but usually, the proposed solution and the current problems there are still some differences, is difficult to achieve complete matching, therefore, the need for adjustment. In the project cost estimation system based on case reasoning, another reasoning difficult engineering case retrieval after is how to use the suggested solutions to compensation, and similar cases, inconsistencies in the correction of the current problems, in order to get the solution to solve the engineering problems. Adjust the way directly affect the success of the program adjustment, even if the case is similar, if the adjustment is not appropriate, the adjustment results will be very poor or even failure. Therefore, it is necessary to choose appropriate adjustment methods to ensure the effectiveness of the adjustment results. According to the characteristics of the engineering cases, the automatic adjustment and the combination of man machine and man machine are selected. The basic idea is to compare the similarities and differences between the engineering problems and the engineering cases to be solved.

Project evaluation: After the solution of current problems of Engineering adjustment is not correct, therefore, after the adjustment scheme, need timely evaluation of the effectiveness, in order to determine the feasibility and intensity adjustment scheme of the strength, so as to judge the success of reasoning. In the project cost estimation system based on case reasoning, users usually propose multiple targets to take into account the requirements of project evaluation control effect on the whole project cost, often hope project total valuation minimum but considering the reality construction, and of every project put forward different requirements of the corresponding valuation. Project evaluation is to check the existing solutions to the problem of the requirements of the situation, given the corresponding conclusions, the current program is sufficient to optimize. This process can be done by the evaluation mechanism of the system itself, or by the user's own evaluation. In order to ensure

the objectivity, accuracy and intelligence of the project evaluation, this paper uses the method of system evaluation and user evaluation to evaluate the project.

Project Cost Summary							
Project Title:		TECHOLAC STORAGE EXPANSION-TANK, WAREHOUSE, FIRE PREVENTION					
Project Name:		Sample Projects		Scenario Name:		Refit	
Proj. Location:		HEAD OFFICE		Job No:		000010	
Estimate Date:		25JAN13 10:01:04		Est. Class:		1	
Account		MH	Wage Rate	Labor Cost	Matl Cost	Total Cost	Percentages
(2) Equipment	59	15.00	878	113,400	114,278	34.2% of TDC	
(3) Piping	1,714	15.00	25,710	46,478	72,188	21.6% of TDC	
(4) Civil	2,007	15.00	30,098	57,724	87,822	26.3% of TDC	
(5) Steel	4	15.01	64	380	444	0.1% of TDC	
(6) Instruments	308	15.00	4,613	29,913	34,526	10.3% of TDC	
(8) Insulation	589	15.00	8,834	14,433	23,267	7.0% of TDC	
(9) Paint	67	15.00	1,003	744	1,747	0.5% of TDC	
Total Direct Field Costs	4,747		71,199	263,072	334,271	100.0% of TDC	
	(TDMH)		(TDL)	(TDM)	(TDC)		
Indirect Field Costs					73,560	103.3% of TDL	
	(IFMH)				(IFC)		
Total Field Costs	4,747				407,831	73.3% of TIC	
	(TFMH)				(TFC)		
Freight					7,892	3.0% of TDM	
Taxes and Permits					13,154	3.3% of TDC	
Engineering and HD					40,113	1.3% of TIC	
Other Project Costs					32,626	5.3% of TIC	
Contingency					50,152	3.1% of TIC	
Total Non-Field Costs					143,947	26.1% of TIC	
	(HOMH)						
Project Total Costs					551,778	165.1% of TDC	
					(TIC)		

Figure 5. Project cost evaluation

5. CONCLUSION

With the continuous deepening of reform, people gradually change the traditional concept of the past, the project cost control afterwards into prior control, realized the importance of project cost estimation, but the traditional project cost estimation method of misfits with the current market economic system, the contradiction between the two is more and more outstanding. As the market competition becomes more and more fierce, the demand for the effective method of estimating the cost of the project becomes more and more urgent. Therefore, the study of a rapid and accurate way to estimate the cost of the project is to promote the development of China's engineering construction to solve the problem of fish. The master of engineering cost estimation based on the related theory and case reasoning on the study of engineering cost estimation based on case reasoning, design the system of engineering cost estimation based on case reasoning, and through the application to the practicality of the system has been verified. This research has successfully explored the effective way to solve the problem of project cost estimation under the new situation, and provided scientific basis for the investment decision of the project. With the gradual popularization of the in-depth research and application and perfect, will realize the control of engineering cost, improve the enterprise's economic benefit and social benefit, actively promote the reform and development of engineering cost system in china.

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