

Research on the Transformation of Engineering Cost Management Driven by Information Technology

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Abstract: Given the large scale and complexity of the modern construction engineering system today, good management of engineering costs can directly affect the economic benefits for investors and the efficiency of using society's resources. For a long time, the calculation of domestic engineering costs has been done manually based on empirical estimation and decentralized spreadsheet processing. The traditional way is not only slow and labour-intensive, but it is also very prone to human error; therefore, there is poor information sharing and serious data isolation, and it cannot meet the high demand for dynamic cost control in modern engineering projects. With the development of the new round of the technological revolution, big data, artificial intelligence, Building Information Modelling (BIM) and cloud computing, etc., have all developed rapidly and provided new ways to solve the persistent problems in cost management. With the addition of digital technology, the cost data will be collected in real time, analysed in detail, and the results of the study will be shared with everyone. Therefore, in order to learn how far information technology has been applied in the management of engineering costs, this paper will investigate the current application conditions and existing problems, and put forward corresponding countermeasures to promote the transformation and upgrading of the industry. This is not only the introduction of new technology but also a change in the basic ideas of management and operation; therefore, the engineering-cost industry has moved from a "labour-intensive" mode to a "technology-intensive" mode with intelligent decision-making.

Keywords: Digital Technology and Engineering Cost Control: Problems in Transformation and Implementation Paths

Introduction

With the continuous development and expansion of the modern construction engineering system, good management of engineering costs is needed to ensure that investors can obtain economic benefits and that socialized resources are used efficiently. For a long time, the management of domestic engineering costs has been carried out by manual quantity calculation, empirical estimation and decentralized spreadsheet processing. The old way is not only slow and labour-intensive, but it is also very prone to human error; thus, there is a poor flow of information and a serious problem of data silos, and it cannot meet the high demand for dynamic cost control in modern engineering projects. With the development of the new round of the technological revolution, big data and artificial intelligence have advanced rapidly in recent years, and now new tools have been introduced to solve the problem of cost control. Build an online cost data collection and analysis system to promptly obtain new cost information and then spread this data to all relevant parties so that they can make informed decisions. Therefore, by studying the deep links between information technology and engineering cost management, investigating the current situation and problems of their application, many practical ideas can be obtained to promote the transformation and upgrading of the industry. It is not only the introduction of new technology but also a change in the style of management and operation.

1. Main Application Scenarios of Information Technology in Cost Control

The addition of information technology is not just the addition of some tools; rather, it is a comprehensive renovation of all stages in engineering cost management. The following sections will introduce some representative cases of intelligent cost management in the four areas of Big Data, artificial intelligence, Building Information Modelling (BIM) technology and cloud computing.

1.1 Big Data Promotes Data Integration and Prediction

There is a large amount of various data for engineering cost management in old project records, market changes, etc. ETL tools in Big Data technology are used to clean and organise the data before it is written to the distributed storage system called HDFS.

1.1.1 Data Warehouse Construction

ETL tools are employed to extract, transform and load all kinds of data from various sources, such as old project files in the company, external information on material prices in the market, policy and regulation databases, supply chain data, macro-economic indicators, etc., into one place. HDFS will be used to organise and distribute the data of the large-scale storage system in an ordered way. Therefore, a cost data warehouse for the whole company will be built to break down the silos of departmental and project information. Data mining can find some hidden patterns in the data, and then the manager will make an informed decision. For example, one can collect the cost per unit area index of projects in different areas and various types of buildings, and then build a multi-dimensional cost index library. Thus, we can obtain very accurate investment estimates in a short time, keep up with changes in market prices and government policies in real time, and improve the decision-making process from the old way of relying on experience to a new data-driven one.

1.1.2 Application of Predictive Models

Some Machine Learning Models for Cost Prediction have also been created. Based on the data of some similar past projects, cluster analysis and regression analysis have been used to determine that the required quantities of materials, labour hours and machinery shifts for new projects can be scientifically estimated. Based on historical data and changes in the market, we can predict the price fluctuations of the materials for this project in the future and choose a good time to purchase; thus, we can reduce inventory and free up funds for other investments. Big Data can be applied to conduct sensitivity analysis and determine how various factors will affect the total cost of a project; for example, we can find out how much the cost will increase if raw material prices rise by 10% or if the project schedule is delayed by a month, and then develop an effective cost-control plan.

1.2 Artificial intelligence technology can process unstructured data and automate workflows

Thus, human errors will be reduced, the speed of response will be increased, and the cost management staff will be freed from other work.

1.2.1 Intelligent Quantity Takeoff and Pricing

Intelligent Quantity Take-off Software can find parts in a picture, quickly gather the corresponding information, and then calculate the quantity for engineering. Based on the attributes of your project, the intelligent pricing system will select a suitable quota library and immediately give you a quote.

1.2.2 Early Warning of Risks

Build a Risk Assessment Model with AI. According to the history of risks, it will automatically check whether the cost documents meet the requirements of the regulations and find any increase in cost or delay in the schedule. AI will let us know if the cost is too high or too low at that time. If the amount of expenditure exceeds the upper limit, a warning will be issued at that time to prevent any problems from arising in the first place.

1.3 Full-Life Cycle Coordination of BIM Technology

BIM technology collects all kinds of information in the form of a three-dimensional digital model of the construction at different times and organises all this data from various sources.

1.3.1 Design and Construction Collaboration

BIM can be used to organise all the different disciplines in advance, and any clashes in the design and decision-making stage can be discovered early to avoid design conflicts and extra costs from construction modifications.

1.3.2 Dynamic Monitoring and Adjustment

A 5D model of the project will be built during the construction period by adding schedule and cost data, and the costs will be updated in real time. At the end of the construction, all the necessary data for

the settlement adjustment will have been obtained from the BIM model, and the cost information can be traced back at any time. From the above, we can see that the cost control staff will be better acquainted with which physical part corresponds to which item in the cost control.

1.4 Cloud Computing Supports Platform-Based Cooperation

Cloud computing can help to solve the problem of small local storage and lack of cooperation by offering cross-region management technical support.

1.4.1 Real-Time Data Sharing

All parties will be able to access the cloud data in the cloud service platform at any time and from anywhere, so there will be no further delay in distributing the tender documents, Bills of Quantities and schedules due to time or distance.

1.4.2 SaaS-Based Software

The development direction of Software as a Service (SaaS) for cost management is that the new features do not need to be installed locally. It is a multi-user online collaborative work platform that can improve the efficiency of team communication and data security, reduce enterprise IT operation and maintenance costs, etc. A cloud platform can be employed to collect real-time data on the cost situation of large-scale, multi-region projects and carry out central management of all related areas.

2. Current Issues and Solutions

2.1 The Contradiction of Technological Iteration and Cost Pressure, and Its Solution

Given that the life cycle of information technology is short, companies need to continuously increase investment in new software and hardware. Small and medium-sized cost consulting companies have high costs for introducing and maintaining technology, so they are slow to adopt new technologies and thus fail to realise the benefits of digitalisation; this will worsen the Matthew effect in the industry. Many enterprises are in a difficult situation: either they have fallen behind because they have not introduced the new technology, or they have introduced it but have found it unfeasible and thus ineffective.

Countermeasures: Build an information-age development plan for the company, set up an independent research and development fund, or work with technology companies to develop personalised services. The government will offer tax deductions and other subsidies to help enterprises purchase new technological equipment and promote the development of the digital economy. Set up a technology trial-and-error system in the company to find out how to apply the new technology in a particular area and avoid blindly pursuing the trend.

2.2 Insufficient Data Normalisation and System Construction

The industry does not have a standard for data exchange, and the various software programs have different data formats; therefore, it is not easy to share data. If the basic standards are not uniform, for example, different rules will be used to calculate engineering quantities and various material coding systems will have been established; otherwise, it will be impossible to carry out big data analysis and cross-project comparison. Uneven quality of the data will also affect the reliability of the analysis results (garbage in, garbage out).

Countermeasures: The industry association should take the initiative to develop a common data code, exchange form and storage standard, etc., and break down information silos. Build a data quality monitoring system to ensure that the source data is accurate and consistent; thus, it will be a good foundation for big data analysis and promote the circulation of value in data elements. The first problem with the current norm is that it does not consider the future development of technology and will thus be outdated in time.

2.3 Regulatory Policies Lag Behind the Development of Technology and Corrections

Most of the current regulations on engineering costs are still based on the old model, and they do not cover the legal validity and regulatory requirements of new forms, such as electronic bidding and

cloud-based data storage. The company has compliance risks with the new technology and is unwilling to try it out boldly because it is not legally clear. For example, some places do not know the legal consequences of electronic signatures, so cloud-based settlement has not been used widely.

Countermeasures: The relevant government department should promptly revise the relevant price standards and bidding regulations, clarify the legal nature of electronic data, and correct any deficiencies in the regulations. At the same time, we need to improve the dissemination of policies, guide enterprises to use information technology in accordance with the law, build a healthy digital ecosystem, and ensure the orderly development of the industry. Digitise the regulatory system and, with the help of big data, strengthen the supervision of market behaviour to improve the effectiveness of regulation.

2.4 Shortage of Versatile Talents and Talent Development

The people doing digital cost management need to have both engineering knowledge and IT skills. At present, there is a serious shortage of such all-round talents in the industry; the traditional practitioners cannot adapt, and a training system has not been established. Therefore, we have been unable to fully realise the potential of the technology and achieve the goals of innovation. Senior cost engineers have a large amount of experience but are not very good at software; young employees are good with technology but lack field experience. The two are in conflict and will not be reconciled anytime soon.

Countermeasures: Regularly train the staff on how to use the software and how to interpret the data better. Universities should strengthen their curriculum, improve industry-university-research cooperation, and foster all-round development of students in technology and management. Increase the salaries and other benefits of the company's top employees to motivate them to stay with the company longer and drive the development of the industry. Drive the development of the company's mentorship program to spread knowledge and skills among staff, address the lack of talent, etc.

3. Current Main Problems and Bottlenecks

3.1 The Contradiction Between Technological Iteration and Cost Pressure

With the development of information technology, the company should regularly increase its investment in new software and hardware. Small and medium-sized cost consulting companies have high costs for introducing and maintaining technology; thus, it is difficult for them to adopt new technologies in time, and as a result, they cannot enjoy the benefits of digitalisation and will be left behind in the industry. Many enterprises are in a bad way; either they are left out because they do not use the technology, or they cannot use it effectively because it is not suitable.

3.2 Not Normalised Data

The industry has not set up a standard for data exchange, so the data in different software programs are in various formats and cannot be shared. There is no uniform standard for the rules of calculation of engineering quantities and material codes, so big data analysis and cross-project comparison have not been carried out, and a new "digital silo" has thus been formed. If the quality of the data is poor, then the analysis results will not be reliable (garbage in, garbage out).

3.3 Regulatory Policies are Behind the Times

Most of the current regulations on engineering costs are still based on the old model, and they do not cover all the aspects of legal validity and regulatory requirements for new forms, such as electronic bidding and cloud-based data storage. The company plans to use new technology, but it does not know whether this will violate the law, so it has not done so yet. For example, the legal effect of electronic signatures is not uniformly recognised in all parts of the law, so they have not been widely used in cloud-based settlement.

3.4 Shortage of All-round Talent

In fact, people need to know engineering and IT to carry out digital cost management. Now there is

a severe shortage of such all-around talents in the industry, and the traditional practitioners find it difficult to adapt, nor has the training system done so. Therefore, we cannot fully realise the advantages of technology and achieve the aim of innovation. Senior cost engineers have a large amount of experience but are not very good at using software, and young employees are good with technology but lack field experience. The two problems will not be resolved in the near future.

4. Strategies for Promoting Deep Integration

4.1 Increase Research and Development Investment and Financial Support

Develop an Information Optimisation Development Plan, set up a special fund for research and development, or work with a technology company to build a customised solution. The government will provide tax deductions and other subsidies to help enterprises purchase new technology and equipment for digitalisation, thus promoting the development of the digital economy. A trial-and-error system will be established in the company to develop its own technology and explore the application range of new technologies to some extent.

4.2 Building an Industry Data Standard System

The industry association should take the initiative to build a common data code, exchange format and storage specification system and break down information silos. A Data Quality Monitoring Mechanism should be established to guarantee that the original data is accurate and consistent; otherwise, it will not be a reliable foundation for big data analysis and will block the flow of value among data elements. The old norm should be set slightly before the change in technology.

4.3 Strengthen Laws, Regulations and Supervisory Institutions

With the changes in electronic data and addresses and the lack of regulations, the government should promptly strengthen the system of price and bid regulation. At the same time, they should also spread the policy, guide enterprises in using information technology in accordance with the law, foster a healthy digital ecosystem, and ensure the orderly development of the industry. Digitise the Regulatory Approach and Use Big Data for Supervision of Market Behaviour.

4.4 Improve Talent Training and Ladder Construction

The company will organise training for staff on the use of software and data analysis periodically. Universities should revise their curricula, strengthen cooperation with enterprises, and foster all-round development of students in both technical knowledge and broad general knowledge. Raise the remuneration for key staff to help the company attract and retain excellent leaders who can drive the development of the industry. Motivate more people in the company to become mentors and share their knowledge and skills with others.

Conclusion

With the development of information technology, the system of engineering cost control has been modified and is now more effective and efficient. There are still some problems in the areas of technical standards, supporting regulations and talent cultivation, but with the joint efforts of all parties, a good digital ecosystem will be built and technology-oriented management will be achieved. With the continuous development of technology in the future, engineering cost management will be more intelligent and transparent, providing strong support for the sustainable development of the construction industry and achieving the goal of improving both economic and social benefits. It will not happen overnight; professionals in the industry need to have a strong sense of mission, continue to explore and try, and work together to raise the level of engineering cost control.

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