

## Benefit Evaluation Research of BIM Application

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**Abstract:** With the development of technology, the traditional two-dimensional paper-document work mode and technological means can not tackle all the challenges in construction industry anymore. The application of Information technology especially BIM technology has great influence on the development of construction industry. This article analyzes the benefit of BIM application from several aspects, such as efficiency of decision-making, cost control, construction management and so on. And proposed a series of evaluation index system from financial, production, organization, management and strategy.

### 1. BIM Application Benefits Overview

#### 1.1 BIM application development

Construction projects are characterized by capital intensiveness, involving many parties, long construction period, and high risks. After the project information passes the owner, designer, construction party and operator, the information loss is large and the waste is large. The information loss is a very important problem that causes waste. Therefore, information construction is an important direction of the construction industry at this stage. The application of Building Information Modeling (BIM) solves the problems of difficult understanding and incomplete coverage of paper documents, and integrates the separated information with BIM technology, thus achieving cost savings and increasing benefits.

The measurement of BIM benefits can provide a scientific basis for project implementation, feasibility study, program comparison and post-implementation evaluation of project implementation of BIM technology, thus promoting the application and development of BIM technology; the benefit evaluation generated by the implementation of BIM technology is a Urgent problems.

#### 1.2 Benefits of BIM applications

(1) BIM applications can improve decision-making efficiency for organizations. By building a BIM model, engineering management tools can be provided to managers at different levels and levels to support scientific decision making. The visual and easy-to-understand 3D model is more conducive to the exchange and review of the construction plan between the project participants, and promotes project understanding and the consensus of all parties.

(2) BIM applications can help managers control costs. BIM-based cost management can carry out different grading of construction projects. Each level has corresponding cost information and bidding information; thus clarifying relevant cost indicators, facilitating bidding and dynamic cost monitoring. In the BIM5D model, the progress information and cost information of the project implementation process can be synchronized and changed, which can greatly help statistical cost information, progress payment review, change price review, and project settlement.

(3) BIM applications reduce engineering conflicts and reduce construction and design changes. Applying BIM technology can avoid human error in traditional 2D drawing design. Through the 3D model conflict detection, the space collision in the design drawings is eliminated, the design drawings and the pipeline arrangement scheme are optimized, and the change and rework caused by

the collision during the construction process are avoided, the work efficiency is improved, and the construction cost is saved.

(4) BIM applications enhance the sustainability of buildings and save resources. Various professional analysis models and tools are applied during the design phase to perform various building performance analysis on BIM, such as noise, ventilation, illumination, shading, comfort, visibility, and energy consumption analysis. By analyzing the results and combining relevant regulations, the sustainability of the building can be effectively guaranteed. At the same time, in the construction phase, the BIM-based low-carbon management model is adopted to establish a comparison method for low-carbon technology solutions, which can provide a basis for the selection of different technical solutions to meet the requirements of green construction.

In addition, the application of BIM technology can produce great benefits in improving project management efficiency, assembly construction and sustainability of building design.

## 2. BIM application benefit evaluation

### 2.1 Steps for BIM Benefit Evaluation

The BIM benefit measurement evaluation can use the comparison test between similar projects and projects to obtain evaluation data. For the same environment of the same project, compare and analyze the application of traditional process technology and application BIM technology, and evaluate the benefit of BIM application through actual measurement data. The implementation process is shown in Figure 1, which includes the following steps.

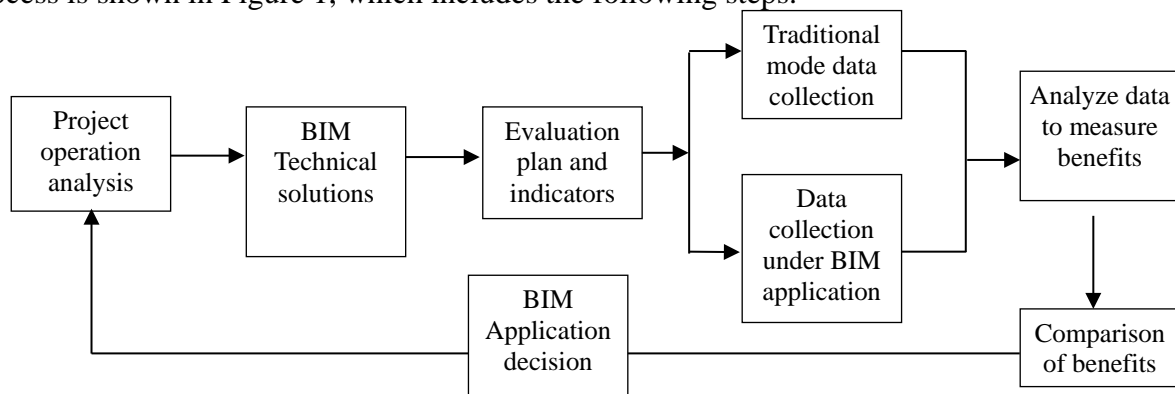


Figure 1 BIM benefit evaluation flow chart

(1) Analysis of the project situation. Collect project information, including data on projects without BIM technology, and technical indicators such as project design, cost management, and schedule management.

(2) Determine the BIM application technology solution. For the project situation, choose the BIM technology implementation plan.

(3) Select evaluation indicators and plans. Establish evaluation indicators and evaluation plans to prepare for measuring the benefits of BIM use.

(4) Collect corresponding data of evaluation indicators. In the BIM application process, for the selected evaluation indicators, field research, data collection, and collection of traditional model data according to the pre-project operation.

(5) Analyze data according to indicators. According to the evaluation indicators and programs, analyze the benefits of the application of BIM technology, and compare and analyze the benefit prediction in the BIM program to evaluate the benefits of BIM technology application.

(6) Evaluation of benefit calculation. According to the BIM benefit measurement results, the post-evaluation of the project BIM technology is applied, and the BIM technology implementation of the project is feed backed, and the BIM technology implementation is proposed according to the specific benefit situation, and the decision-making basis is provided for the follow-up project.

## 2.2 BIM Benefit Indicators

The economic evaluation method and parameters of the construction project (the third edition) pointed out that the financial benefits and cost estimation are important basis for the project economic benefit evaluation. According to the CIFE Integrated Facilities Engineering Center of Stanford University, the impact of information technology on the construction industry mainly includes three aspects: product, organization and process. That is, the product refers to the results of the organization to complete the project delivery, such as completed design, engineering; organization refers to the unit or individual involved in the project to complete the product; the process refers to the process that the organization has experienced in order to complete the product. In order to ensure the comprehensiveness of BIM benefit index system, comprehensive China's economic benefit evaluation regulations and existing domestic and international project benefit evaluation content, this paper divides BIM benefit indicators into five aspects: finance, product, organization, management and strategy. The BIM application benefit indicator system is constructed as shown in Table 1.

Table 1 BIM benefit evaluation index system

Benefit level	Benefit indicator	Sub-indicator	Indicator type	Measuring method
Financial level	Finance	Return on investment	Quantitative	Net income / investment
Product level	Duration	Saving period benefits	Quantitative	Saving time / total construction period
	quality	Qualified	Quantitative	Qualified product rate
	Safety	Accident rate	Quantitative	Reduced number of accidents
		Casualty rate	Quantitative	Casualties / total number of people
	product structure	Sustainability	Qualitative	Survey score
		Visualization	Qualitative	Survey score
Organizational level	Human organization	Human use efficiency	Qualitative	Survey score
		Staff development	Qualitative	Survey score
		Communication and cooperation	Qualitative	Survey score
	Business organization	Organizational structure improvement	Qualitative	Survey score
Management level	communication	Information flow benefit	Qualitative	Survey score
	Productivity	Rework reduction rate	Quantitative	Rework ratio
		Reduce change	Quantitative	Number of changes, amount
		Labor saving rate	Quantitative	Artificial consumption change
	risk	risk control	Qualitative	Survey score
Strategic level	Competitive advantages	Technology application growth and benefits	Qualitative	Technical re-application rating
	Contract party satisfaction	Contract performance rate	Qualitative	Project delivery rate

(1) Financial level benefit analysis. Financial efficiency measures are generally expressed in terms of return on investment (ROI), which is the total project revenue (cost savings, benefit output)

divided by the total investment of the project BIM, calculated as

$$ROI = \frac{\text{Project income}}{\text{Total investment}}$$

Among them, the income mainly refers to the measurable project benefits and profits brought by the application of BIM to the project, such as cost saving and the benefits of early completion conversion. The amount of investment is expressed as the cost of completing or operating BIM, and usually includes BIM technical consulting fees, operating costs, hardware costs, software fees, installation and configuration fees, training fees, model maintenance costs, and daily management fees.

(2) The product-level benefit indicators brought by BIM applications are mainly reflected in the construction period, quality, safety, and institutional benefits.

The main performance is the benefit brought by the BIM application to the project schedule, and the efficiency is saved by saving the construction period/period of construction period.

Quality benefits refer to the benefits of BIM applications to project quality, which can be expressed in terms of qualified product rates and superior products.

Safety benefits refer to the reduction in the safety accident rate and the reduction in the number of casualties caused by BIM applications.

The product structure refers to the benefits brought by the visual performance of the project after the BIM application for project sustainability and project implementation.

(3) The organizational-level benefits brought by BIM applications are mainly reflected in the optimization of BIM technology for enterprise human resources organizations and enterprise organizations; it can be expressed as the improvement of human use efficiency, the cultivation of employees, especially the training of BIM technicians, and the flow of information. The resulting increase in the efficiency of communication and cooperation, as well as the improvement of the organizational structure of the enterprise. The measurement of its indicators is generally qualitative.

(4) The management level benefits are mainly reflected in the improvement of production efficiency and the reduction of project risks.

Applying BIM technology can better avoid human error in traditional 2D drawing design. Through the conflict detection of 3D models, eliminating space collisions in design drawings, optimizing design drawings and pipeline layout schemes, thereby avoiding changes and rework caused by collisions during construction, and can reduce the proportion of rework, labor saving and number of changes. The reduction and the cost savings are used to evaluate the benefits of BIM use. The change reduction rate can be expressed by the change amount reduction ratio and the change fee reduction ratio. The rate of rework reduction can be expressed by the amount of rework and the cost of rework. The labor saving rate indicates the proportion of labor required to complete a certain job.

Since the use of BIM technology can effectively reduce some uncertainties in project implementation, the risk control of the project will be significantly improved. It can be measured by the improvement of the technical risks, security risks, and financial risks of the project implementation.

(5) The strategic level benefits of using BIM are mainly reflected in the improvement of customer satisfaction and the improvement of corporate competitiveness.

### 3. Conclusion

Based on the existing BIM benefit evaluation research content at home and abroad, this paper proposes a systematic cost-benefit evaluation index system and evaluation method for BIM technology; the evaluation indicators include finance, product, management, organization and strategy. Due to the difference in project types, the results of BIM technology application benefit calculations are definitely different. Therefore, there are still many ideas worthy of further discussion on the evaluation of BIM benefits.

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