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Architectural Design Technology Management: The Key Path to Improving Design Quality

Weihua Yuan*

Shenzhen 518000, China

**Author to whom correspondence should be addressed.*

Abstract: Architectural design technology management covers multiple aspects, including the formulation of technical standards, method selection, etc. It plays a key role in design quality, such as establishing a closed-loop management mechanism for the entire process and utilizing BIM collaborative platforms. It also introduces the application of techniques such as parametric design and the construction of quality prediction models. Simultaneously elaborating on the formulation of enterprise standards and other related content, this paper finally proposes an integrated solution while pointing out development bottlenecks and prospects.

Keywords: Architectural design; Technical management; Design quality

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1. Introduction

Architectural design technology management is crucial for improving the quality of architectural design. With the development of the construction industry, relevant policies are constantly improving, such as the *Opinions on Promoting Green Development of Urban and Rural Construction* released in 2021, which emphasizes the importance of building quality and sustainable development. Architectural design technology management covers various aspects such as the formulation and implementation of design technology standards, the selection and optimization of design technology methods, and has an impact on multiple fields such as building functional layout and structural selection. It drives the improvement of design quality through key links such as standardizing design processes, applying technical standards, and introducing new technologies. At the same time, BIM collaborative platform, parametric design technology, etc., play an important role in it. The establishment of a full process closed-loop management mechanism, comprehensive evaluation system, and quality performance assessment system also provides guarantees for improving design quality. However, it also faces some development bottlenecks, and digital twin technology may be able to break through in the future.

2. Theoretical framework of architectural design technology management

2.1. The core connotation of technical management

Architectural design technology management is a series of activities that systematically plan, organize, coordinate, and control various technical elements involved in the architectural design process [1]. Its connotation includes the formulation and implementation of design technical standards, ensuring that the design complies with relevant specifications and industry requirements. At the same time, it involves the selection and optimization of design techniques and methods to improve design efficiency and quality. In terms of scope, it covers multiple aspects such as functional layout, structural selection, material selection, and equipment configuration of buildings. It has a strategic positioning in quality control, by strictly controlling technical processes, preventing and reducing design defects, ensuring the safety, applicability, and durability of buildings, and thereby improving the overall quality of building design.

2.2. Analysis of quality-driven mechanism

Architectural design technology management plays a key driving role in design quality. Technical management covers multiple aspects, including the standardization of design processes, the application of technical standards, and the introduction and integration of new technologies. These aspects are interrelated and jointly affect the quality of design. For example, a standardized design process can ensure an effective connection between each link and avoid quality issues caused by poor communication or chaotic processes. The strict implementation of technical standards can ensure that the design meets basic quality requirements and provide a basic guarantee for high-quality design. At the same time, the reasonable introduction of new technologies and effective integration can stimulate innovative thinking, enhancing the competitiveness and quality level of design [2]. By deeply analyzing the correlation between these elements and their impact on design quality, a model of the role of technical management and design quality can be constructed, providing theoretical support for architectural design technical management.

3. Optimization of the design process and technical control

3.1. Full-cycle quality control system

Establishing a closed-loop management mechanism for the entire process of scheme design, construction drawing deepening, and technical disclosure is the key to improving the quality of architectural design. In the design phase, it is necessary to comprehensively consider various factors such as building function, aesthetics, and environment to ensure the scientific and rational nature of the design concept. In the process of deepening construction drawings, attention should be paid to details, relevant specifications and standards should be strictly followed, and detailed coordination and integration should be carried out for various disciplines such as structure, water, and electricity. The technical disclosure process should ensure that the construction team accurately understands the design intent and provides detailed explanations of key technical points and quality control requirements [3]. Through this closed-loop management of the entire process, design errors can be effectively avoided, design quality can be improved, and the smooth implementation of construction projects can be guaranteed.

3.2. Construction of collaborative design platform

The BIM collaborative platform plays an important role in the management of architectural design technology. In terms of professional collaboration, by creating a unified 3D information model, designers from various disciplines can carry out design work on the same platform, achieving real-time information sharing and interaction, and improving design efficiency and accuracy. For example, structural designers can obtain timely spatial layout information from architects and carry out reasonable structural design [4]. In terms of conflict detection, BIM platforms can automatically detect collision conflicts between different professions, such as collisions between pipelines and structural components. Designers can adjust the design in a timely manner based on the test results to avoid rework and resource waste during the construction phase, effectively improving the quality of the design.

4. Digital technology empowers innovative practices

4.1. Application of parametric design technology

4.1.1. Algorithm generation design optimization

The algorithm-generated design optimization in parametric design technology is of great significance in the field of architecture. Through algorithms, design schemes can be rapidly iterated and optimized. For example, genetic algorithms can simulate the process of biological evolution and optimize various aspects of building form, structure, etc., to achieve better performance goals, such as lighting, ventilation, etc. [5]. Meanwhile, algorithms based on physical rules can simulate mechanical principles and optimize the stability and safety of building structures. In practical applications, tools such as Grasshopper provide a convenient platform for algorithm-generated design optimization. Designers can combine design intent with optimization goals by writing algorithm scripts, quickly generate multiple design solutions, and select the optimal solution through comparative analysis, thereby improving the quality and innovation of architectural design.

4.1.2. Performance-oriented design validation

Digital technology plays a crucial role in performance-oriented design validation. Taking the integration of energy consumption simulation and structural calculation technology as an example, through parametric design technology, various building parameters can be input into relevant software for accurate energy consumption simulation and structural calculation. This can not only evaluate the performance of the building in the early stages of design, but also optimize the design scheme by continuously adjusting parameters to achieve better energy-saving and structural safety effects [6]. This integration method enables designers to consider the performance requirements of buildings more comprehensively, avoiding potential omissions and irrationalities in traditional design methods, thereby improving the quality and feasibility of architectural design and providing strong support for the sustainable development of buildings.

4.2. AI-assisted design decision-making

4.2.1. Prediction of machine learning quality

Building a building design quality prediction model based on historical data is a key aspect of machine learning quality prediction in AI-assisted design decision-making. By collecting a large amount of historical architectural design data, including design parameters, construction results, usage feedback, etc., machine learning algorithms are used to mine potential patterns and patterns in the data. These algorithms can analyze the impact of different design factors on the final quality and establish predictive models accordingly. This model can predict potential quality issues in new design projects based on input design scheme-related data. This helps the designer to adjust the design scheme in advance, avoid potential quality risks, improve the design quality and the success rate of the project, and provide strong support for the technical management of architectural design [7].

4.2.2. Development of an intelligent drawing review system

Image recognition technology plays an important role in the standardized verification of intelligent image review systems. Its implementation logic is based on the digital processing of architectural design drawings, converting drawing information into a computer-readable data form. Analyze these data through algorithms and compare them with preset standards. For example, precise identification and judgment of the dimensions, positional relationships, and annotation information of building components. This technology can quickly and accurately identify non-compliant areas, greatly improving the efficiency and quality of drawing review, reducing potential omissions and errors in manual drawing review, and providing strong technical support for quality control in architectural design [8].

5. The path of standardization system construction

5.1. Preparation of enterprise technical standards

5.1.1. Development of a standardized construction atlas

The preparation of enterprise technical standards should pay attention to scientificity and practicality. The scope and key indicators of the standards should be determined based on the actual needs of architectural design and industry development trends. During the preparation process, fully consider the characteristics and differences of different projects to ensure the universality and flexibility of the standards. At the same time, we should actively learn from international advanced standards and experiences, and enhance the internationalization level of enterprise technical standards. For the development of standardized construction drawings, it is necessary to systematically organize and classify them based on enterprise technical standards. The atlas should include common architectural construction forms and node practices, accompanied by detailed diagrams and explanations, for the convenience of designers to refer to and use. By utilizing digital technology, dynamic updates and maintenance of the atlas can be achieved to ensure its timeliness and accuracy. This not only helps to improve design efficiency but also enhances design quality, providing strong support for architectural design technology management [9].

5.1.2. Development of quality control checklist

Establishing a comprehensive design achievement inspection index system covering all specialties requires starting from multiple aspects, such as standardization system construction path, enterprise technical standard preparation, and quality control checklist formulation. In terms of the standardized system construction path, it is necessary to clarify the standards for each process to ensure the standardization and uniformity of the design process. The preparation of enterprise technical standards should be based on industry standards and practical experience, covering key elements such as design methods and material selection, to provide technical guidance for design. The development of a quality control checklist should focus on various aspects of the design results, including the accuracy of drawings, compliance with specifications, etc., and provide detailed inspection points to ensure that the design quality can be effectively controlled, thereby improving the overall quality of architectural design [10].

5.2. Talent echelon training mechanism

5.2.1. Capability model for technical leaders

It is crucial to establish a comprehensive evaluation system that includes professional skills and management abilities in architectural design technology management. For the construction path of the standardization system, it is necessary to clarify the standards of each process to ensure that the design complies with the specifications. In terms of talent development mechanisms, emphasis should be placed on hierarchical training, with corresponding growth paths for beginners to senior designers. For the ability model of technical leaders, they should have solid professional knowledge, including architectural design principles, various specifications, etc. At the same time, one should have excellent management skills, be able to arrange teamwork reasonably, and control project progress. Innovation ability is also required to respond to constantly changing market demands and design concepts. In addition, communication and coordination skills are also indispensable. It is necessary to be able to effectively communicate with all parties to ensure the smooth progress of the project.

5.2.2. Development of continuing education curriculum

In the path of standardization system construction, it is necessary to closely integrate the development of talent development mechanisms and continuing education courses with the forefront of the industry. For the field of BIM application, courses covering BIM software basic operations, collaborative design processes, and BIM application throughout the project lifecycle should be developed. Enable designers to master BIM technology from beginner to proficient, and improve design efficiency and quality. In terms of green building, course modules such as green building concepts, evaluation standards, energy-saving design strategies, and renewable energy utilization are set up. By combining theory with case studies, students can gain a deeper understanding of the key points of green building design. At the same time, the curriculum should focus on practical operations and simulation projects, cultivate students' ability to solve practical problems, ensure that they can apply the knowledge they have learned to actual design projects, and improve the overall quality of architectural design.

5.3. Quality performance evaluation system

5.3.1. Design of multidimensional evaluation indicators

Establish a three-dimensional assessment model for quality outcomes, technological innovation, and team collaboration. The dimensions of quality outcomes cover indicators such as design compliance with specifications, accuracy and completeness of drawings, and timely project delivery, ensuring that design outcomes meet high-quality standards. The dimension of technological innovation focuses on the application of new technologies, innovative design methods, and the ability to solve complex problems, motivating designers to continuously explore new technologies to enhance their design competitiveness. The team collaboration dimension assesses internal communication efficiency, cross-departmental collaboration effectiveness, knowledge sharing level, etc., to promote the efficient operation of the design team. By comprehensively considering these three dimensions, a comprehensive and objective quality performance evaluation system is formed to provide strong guarantees for improving the quality of architectural design.

5.3.2. Construction of the reward and punishment linkage mechanism

Establishing a quality performance evaluation system and a reward and punishment linkage mechanism requires comprehensive consideration of multiple factors. For performance evaluation, quantitative indicators should be clearly defined, such as the innovation, feasibility, and compliance with standards of the design scheme, while setting reasonable weights. The salary system should be closely linked to performance evaluation results, with high compensation rewards given to outstanding performers to motivate employees to improve design quality. In terms of professional title evaluation, quality performance is taken as an important reference, and employees with outstanding performance are given priority consideration in professional title promotion. For the linkage of rewards and punishments, in addition to salary incentives, reward measures may include honorary titles, promotion opportunities, etc. Punishment measures are targeted at those who fail to meet quality standards, such as salary deductions, restrictions on project participation, and delayed professional title evaluations. Through this linkage mechanism, the quality of architectural design is effectively improved.

6. Conclusion

Architectural design technology management is the key to improving design quality. Through a systematic review of the four major paths of process reengineering, technological innovation, standard construction, and talent cultivation, an integrated solution has been developed. Process reengineering optimizes the design process to improve efficiency; technological innovation drives the updating of design methods; standard construction ensures the standardization of design; talent cultivation provides human resources support for high-quality design. However, there are currently bottlenecks in the development of technology management in areas such as data governance and intelligent decision-making. Looking ahead to the future, digital twin technology has broad application prospects in architectural design quality management and is expected to break through existing bottlenecks, further improve the quality of architectural design, and provide strong guarantees for the sustainable development of the construction industry.

Disclosure statement

The author declares no conflict of interest.

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