

Research on Construction Quality Acceptance and Digital Archive Management System Based on BIM

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Abstract—By analyzing the existing problems and causes of the construction quality acceptance assessment of engineering projects, the idea of BIM-based construction quality inspection and assessment system architecture was proposed. Through the operation of the system, digital and paperless management of construction project archives was realized while the construction quality inspection and assessment was proceeded. Then it also analyzed the advantages of this system and put forward countermeasures to the possible problems during the operation process.

1 INTRODUCTION

"Complete technical files and construction management materials" is one of the necessary conditions to judge whether the quality of construction works meets the design requirements and functional requirements. As an important part of the construction project archives, the quality of various construction quality acceptance forms and reports directly affects the final quality and function of the project, and is also an important data to trace the quality of the construction process in the later period. At present, in engineering construction archives management, due to the large number of participating units involved, complex archive datum and long formation time, various degrees of problems exist that paying attention to the construction of engineering entity while neglecting the management of archives and the poor validity and authenticity of engineering archives. With the layout of the Development Strategy driven by intellectualization and digitalization, the pace of development of the engineering construction industry towards smart and intelligent construction is accelerating. Taking Chongqing as an example, in March 2020, Chongqing Municipal Housing and Urban-Rural Construction Commission issued the "Chongqing City 2020 "Smart Site" Construction Work Plan", proposing to vigorously promote the construction of "Smart Site" and the transformation and upgrading of construction industry with big data intelligence, also to improve quality and efficiency. Through the establishment of the "Smart Site" Information Management Platform Project Quality

Acceptance Management Subsystem, the technical standard of "intelligent application" was proposed to achieve effective dynamic supervision and intelligent management of the acceptance process of project important nodes.

In the "Code for the Management of Construction Project Archives" promulgated by the National Archives Administration, some requirements are placed on the management of project electronic files and electronic archives, but more emphasis on the classification of electronic documents, archival management and digital processing of electronic files. In the construction process, though digital and intelligent directly formation the construction project files are not involved. In particular, the project quality inspection acceptance form is completed after the inspection finished. Through some data management software printed and signed, which is prone to inaccurate data, time lag in the formation of the inspection form and missing seals.

In recent years, with the continuous development of BIM technology and smart construction site technology, the digitization and paperless process of quality acceptance data archiving is accelerated. Although some engineering data management software attempts to integrate with BIM models, most software functions are still limited to format data entry and report printing and archiving. The functions of intelligent engineering quality acceptance functions, such as automatic comparison and discrimination of BIM models, electronic signature approval and automatic form generation are rarely involved. In this paper, by constructing a BIM-based construction quality acceptance and digital archive

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management system, BIM technology was applied to this management system, to further improve the current construction quality inspection and evaluation archive management mode, and to achieve the digitalization of engineering project archives and paperless management.

2 PROBLEMS AND CAUSES OF CONSTRUCTION QUALITY ACCEPTANCE ASSESSMENT SYSTEM

At present, the basic function of some construction quality acceptance assessment systems or software is mainly to check the generation of assessment forms. In the process of generating such tables, there are four following problems:

2.1 Time lag in the formation of quality inspection and assessment data files

As one of the important components of the construction project file, the project quality inspection and assessment data are required to be completed simultaneously with the project construction process. At present, in the construction of some projects, the formation time of quality inspection and evaluation data is lagging, and even the quality inspection and evaluation data of many engineering projects have only been compiled and perfected at the completion stage. The integrality and authenticity of some evaluation data need to be investigated [1]. On the one hand, the reason for this problem is the design defect of the engineering quality inspection and assessment management system (software). On the other hand, the formation of data files in the quality inspection and assessment management mode is out of touch with the construction process.

2.2 The standardization of the quality inspection and assessment data is not high

Some construction projects completed the on-site quality inspection on the spot and returned to the office for computer data entry. In addition to the aforementioned time lag problem. As a result, the problems such as the discrepancy between the original inspection form and the construction content, the contradiction and omission of the data, the random modification and the random input of the words of the inspection conclusion are easy to appear when the quality inspection evaluation data is filled in. The main reason is that the existing construction quality inspection and evaluation system or software cannot input the inspection data in real time during the on-site inspection and acceptance of the site. After inputting the data, the inspection results cannot be intelligently judged, and an accurate and standardized evaluation conclusion cannot be formed.

2.3 The implementation of engineering quality acceptance procedures is not rigorous

The current engineering quality inspection and acceptance specifications stipulate that the construction unit fills in

the on-site inspection results in a timely, objective and truthful manner in the quality assessment form within the specified time, and submits the inspection in advance on the basis of self-inspection. After supervision personnel on-site inspection and acceptance of qualified enable input the next link of construction [2]. However, due to unreasonable design or inadequate implementation of quality acceptance procedures for some projects, the above-mentioned inspection procedures are often not strictly implemented. During the project quality acceptance, the quality assessment table cannot truly reflect the site acceptance situation. Especially, once the supervision site inspection fails, the rectification needs to fill in the relevant quality evaluation form again. As a result, the management efficiency is low, the process tracking inspection is difficult and the workload of engineering archives management staff increases.

2.4 The problem of signing the quality inspection and acceptance assessment data is prominent

At present, the quality inspection and assessment forms of most projects are entered through the system. After that, they are printed it as paper documents, which require to sign in sequence including the construction unit, supervision unit, proprietor unit, and quality supervision department. It takes a long time and there are many problems with signatures, which are mainly manifested as missing signatures, replacement signatures and supplementary signatures that do not meet the requirements of the current quality acceptance regulations [3]. The main reason is that the documents and materials that need to be signed are complicated, and the responsible personnel with the signing authority can't complete it in time, and the signatures can be renewed afterwards, and even the archives management personnel can sign on behalf of them, which brings hidden dangers to the archives management work.

3 BIM-BASED CONSTRUCTION QUALITY ACCEPTANCE AND DIGITAL FILE MANAGEMENT SYSTEM FUNCTION DESIGN

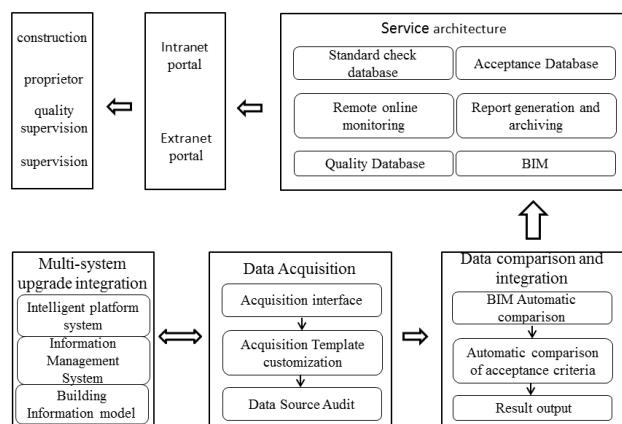


Figure 1. Construction quality acceptance and digital archive management system based on BIM

The construction quality acceptance and digital archive management system based on BIM technology is centered on engineering quality inspection and acceptance related specifications and construction project archive management specifications, etc., to meet the requirements of quality inspection and assessment archives, construction unit, proprietor unit and supervision unit. The functional requirements of users such as quality supervision agencies are taken as the starting point to achieve the functions of full control of construction quality inspection and evaluation, data interaction sharing, traceability of process traces, electronic signature of the whole process, direct export of file information system, etc. The system function design is shown in Figure 1.

3.1 Real-time input and automatic comparison of construction process quality data

Based on the existing engineering data management software, a BIM-based construction quality acceptance data real-time entry and automatic comparison module is designed. During the inspection and evaluation process on the construction site, the quality inspectors can directly input the original data of the inspection and evaluation through the mobile phone or iPad and other mobile terminals. At the same time, they can upload some pictures and videos in the inspection and evaluation process in real time through the system as evidence. According to the entered inspection data, the system will compare with the associated BIM model to automatically determine whether the construction quality of the process meets the design requirements and compares the results. If it is qualified, the next step of the operation can be carried out. If not, the system will issue an early warning according to the quality standards set in advance by the BIM model. Forming a warning point, and automatically send the warning point inspection to the set superior management personnel with management authority, and enter the process of tracking and monitoring process quality issues.

3.2 Initiation and tracking of construction quality acceptance process

Before the formal launch of the acceptance process, process tracking for any previous self-check findings or warning points that are inconsistent with pre-set quality standards in the system, and the rectification process is re-examined and evaluated. All the inspection points of the construction units of partial projects are self-inspected. After entering the basic acceptance data in the system, the responsible person can initiate multiple units to participate in the inspection and acceptance process through the system. According to different project quality acceptance authorities, the system will push the acceptance process to the responsible person of each participating unit, who can review and check the self-inspection records and data of the construction unit, or agree to go to the construction site for re-inspection and evaluation. At the same time, according to the authority of different responsible persons, the existing inspection and evaluation records in the

system shall be modified and supplemented. If the acceptance fails, the unqualified data and rectification list will be generated, and the system will automatically issue instructions to the responsible person to enter the quality acceptance rectification process. After the rectification is completed, the responsible person will resubmit the rectification results through the system and enter the second acceptance until the final acceptance.

3.3 Electronic signature and inspection of inspection and assessment forms

The quality inspection and acceptance of the partial projects should conform to the current quality acceptance specifications. The responsible persons of the participating units conduct electronic signature confirmation in sequence through the system terminal according to the acceptance authority. The system will automatically generate an inspection and evaluation form that conforms to the current quality acceptance standards and project construction file management. It can be viewed and exported at any time, which is convenient for real-time process tracking, remote online signature and directly generating digital quality acceptance files for construction projects that meet the requirements of urban construction file management.

3.4 Statistics and application of quality management data

During the operation of the system, an analysis chart is automatically generated based on the daily fill-in information. At each stage of construction, the statistical analysis of the quality problems in the construction process is carried out for the location of the problem, for example, person responsible for the problem and the improvement process and the severity, etc. Therefore, facilitate Managers take timely measures to carry out precise management. After the project is completed, the use authorization of the project data is obtained. When the authorized data reaches a certain level, a complete and comprehensive engineering quality problem database will be formed, which can provide data support for the application of big data and artificial intelligence technology in the quality management system in the future.

4 ADVANTAGES OF BIM-BASED CONSTRUCTION QUALITY ACCEPTANCE AND DIGITAL FILE MANAGEMENT SYSTEM

4.1 Double comparison of quality inspection assessment data

This system is based on BIM technology and smart construction site management system. It double-contrasts the construction quality inspection and evaluation with the relevant quality information preset by the BIM model and the current project quality acceptance standards. The data

acquisition and recording of quality inspection and evaluation will be more convenient, and the authenticity and timeliness of the data will be significantly improved.

4.2 Quality inspection and evaluation problems can be traced

By inputting the quality inspection and assessment data of different stages and different parts, the construction process information can be completely recorded in the system, the process inspection results can be checked, thus establishing the whole process quality problem database. For unqualified items, the system will automatically issue an early warning, and the person in charge can track the quality problem rectification process throughout the process, so as to realize the whole process of quality inspection and assessment and quality problem rectification.

4.3 Digital delivery of construction project files

Compared with the digital delivery of micro-scanning of paper files for construction projects in some cities, the construction quality acceptance and digital file management system based on BIM adopts digital and paperless methods from the early stage of data formation. When delivering archives, it is no longer necessary to scan and hand over paper archives. In each link in the formation of engineering project archives, all responsible units will establish digital archives through the system to achieve true digital and paperless archive management. Therefore, it can realize the transformation of engineering archive management from paper archive management to digital archive management^[4].

5 POSSIBLE PROBLEMS AND COUNTERMEASURES IN THE SYSTEM OPERATION

The digital files should have the consistency of the currently quality acceptance requirements. Now, part of the construction data management software has realized the digitization of the acceptance forms, which can be implanted in the system in advance to meet the detailed quality acceptance specifications. During the acceptance process, the inspection data only needs to be input to automatically compare and check whether it is qualified, and an archive form conforming to the quality acceptance standards can be generated.

The validity of electronic signature in digital files archives. The "Electronic Signature Law of the People's Republic of China" has clarified the legality of electronic signatures: "Reliable electronic signatures have the same legal effect as handwritten signatures or stamps". It provides a legal basis for the adoption of electronic signature in all acceptance documents generated by the system, and the electronic signature in the system can be verified by such technical means as hash check to ensure its authenticity^[5].

Security issues of digital acceptance archive carrier and process data. According to different management levels, system permissions are set. Once committed to the next process, it cannot be changed at will. Special processing functions shall be set in the system, and shall be approved by the manager with the highest authority when really need to be modified. During the entire acceptance and archiving process, the system will automatically leave marks when inputting data and electronic signature, and the background will monitor the inputting and modification marks.

Issues related to the generation and access of archival data. The system meets the requirements of urban construction archives for construction archives by unifying the format and parameters of digital construction project files. The digital archives can be permanently saved and interactively called at any time to make up for the defects of electronic production and preservation of paper archives.

Issues related to the transmission of file data in remote receiving. When the system is checked and accepted on the construction site, data needs to be input and transmitted in real time with a stable network. With the popularization of 5G technology and the continuous development of traffic aggregation technology, eliminated the technical barriers for the comprehensive application and promotion of this system have been eliminated.

6 CONCLUSION

The Internet era has brought huge opportunities for archive data management of digital and paperless construction projects. Deep integration of the industry's emerging BIM technology and Internet technology to achieve construction quality acceptance and digital file management is the general trend of the development of the engineering construction industry. Currently, the intelligent site system is relatively mature. In this paper, a subsystem of the intelligent construction site management platform is proposed basing on BIM construction quality acceptance and digital file management system, which can realize the deep correlation between construction quality acceptance and BIM model, improve the efficiency and accuracy of construction quality acceptance and guarantee the authenticity, completeness and reliability of digital engineering acceptance files to the greatest extent. It also indicates a feasible direction for the development of traditional construction acceptance files towards digitalization and paperless. It will bring greater convenience to the transmission and delivery of engineering project archives and achieve an effective enhancement of the value of construction project archives management if the function of this system is further optimized and improved.

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