Principles and Practice of Electronic Document Management in Construction Engineering

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Abstract

[Objective] This paper aims to explore common operational principles for the practical organization and management of electronic documents in construction projects, to remedy the insufficiency of guidance in existing national standards regarding routine practices such as catalog operations and version control, and to enhance the systematicness, security, and traceability of electronic document management. [Methods] Using the project of Plot 40-04 in Jinhui Town, Fengxian District, Shanghai as a case study, and drawing on national standards such as the "Specifications for the Management of Construction Electronic Documents and Electronic Archives," this paper analyzes their limitations in practical application and proposes operational recommendations suitable for daily project management, including carrier backup, version control, classification logic, and file naming systems. [Results] The study proposes principles for multiple backups of storage media, encryption, and access control for electronic document storage; establishes version control methods such as the "369 version number"; clarifies classification principles such as "no duplication and no omission" and "frequently used files near the root directory"; designs a "5+5 quantity" directory structure and standardized naming system; and provides concrete operational examples for the organization of completion documents and electronic as-built drawings. [Limitations] The research is based on the practice of a single construction project, and some principles and methods need to be adjusted according to actual conditions when extended across projects and regions; in-depth discussion has not yet been conducted on the deep integration of new technologies (such as blockchain and BIM platforms) with electronic document management. [Conclusions] Electronic document management in construction projects should balance standardization, practicality, and security. Through a scientific classification system, strict version control, and reasonable backup strategies, it is possible to achieve efficient organization and long-term preservation of electronic data, thereby providing reliable support for daily project management.

Full Text

Principles and Practices of Electronic Document Management in Construction Engineering

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Abstract

[**Objective**] This paper aims to explore common operational principles for organizing and managing electronic documents in construction engineering, addressing gaps in existing national standards regarding daily practices such as directory operations and version control, with the goal of enhancing the systematicity, security, and traceability of electronic document management.

[**Methods**] Based on the practical case of the 40-04 Block Project in Jinhui Town, Fengxian District, Shanghai, and referencing national standards such as CJJ/T 117-2017, this study analyzes the limitations of these standards in practical application and proposes operational recommendations suitable for daily project management, including carrier backup strategies, version control methods, classification logic, and file naming systems.

[**Results**] The study proposes principles for electronic document storage, including multi-backup, encryption, and access control. A "369 version numbering" method is established for version control. Classification principles such as "no duplication, no omission" and "frequently used files closer to the root directory" are defined. A "5+5 quantity" directory structure and a standardized naming system are designed, with practical examples provided for organizing completion documents and electronic as-built drawings.

[**Limitations**] The study is based on a single project case, and some principles may require adaptation when applied to different projects or regions. The deep integration of emerging technologies (e.g., blockchain, BIM platforms) with electronic document management has not been thoroughly explored.

Conclusion Electronic document management in construction engineering should balance standardization, practicality, and security. Through a scientific classification system, strict version control, and reasonable backup strategies, efficient organization and long-term preservation of electronic materials can be achieved, providing reliable support for daily project management.

Keywords: Construction Engineering; Electronic Documents; Archives Management; Directory Operations; Version Control

Introduction

The Ministry of Housing and Urban-Rural Development's *Standard for Management of Construction Electronic Documents and Archives* (CJJ/T 117-2017) provides detailed provisions on archival file formats, verification, transfer, storage, and backup, with Section 4.2 on file classification being particularly instructive. The national standard *Specification for Filing Construction Project Documents* (GB/T 50328-2019, partially revised) specifies specific archival types for engineering categories, while *Specification for Electronic Document Filing and Electronic Archives Management* (GB/T 18894-2016) addresses archival metadata types, scope, appraisal work, and requirements for different metadata categories. Although these standards extensively describe the final form of electronic documents, they offer limited guidance on routine computer operations such as directory management and file overwriting/replacement, which are more commonly used in practice. This paper describes principles and implementation examples for such operations, with specific recommendations for completion documents and electronic as-built drawings.

1.1 Project Overview

The 40-04 Block Project in Jinhui Town, Fengxian District, Shanghai (excluding pile foundations) includes residential buildings 1-7, KT/PT stations 8-12, waste sorting collection stations, underground garage #13, perimeter walls, and other structures. The project covers a total land area of approximately 22,000 m^2 and a total construction area of approximately 72,000 m^2. The project received the Shanghai Municipal Construction Engineering Quality Structure Award for two buildings and the East China Six Provinces and One City Safety Standardization Site Award. Project document management encompasses three critical milestones: group planning key nodes, annual nodes, and completion nodes. The project department strictly adhered to the aforementioned document principles, implementing geographically distributed multi-backup on physical carriers while simultaneously backing up some files on the network.

1.2 Literature Foundation

Xu Yongjun [1] highlights the role of archives in solidifying tacit knowledge, controlling endogenous explicit knowledge, and acquiring external explicit knowledge. Wei Jing [2] emphasizes the necessity of front-end control in the integrated document management system. Zhao Yi [3] discusses the impact of anti-tampering technologies for electronic files—including file solidification, hash value verification, digital signatures, and blockchain—on archives management. Guan Xianhai et al. [4] explore management models of dual-system (simultaneously retaining both electronic and paper versions) and single-system approaches. Yan Peng et al. [5] propose BIM (Building Information Modeling) information platform technology for large construction projects, which enables synchronous generation, organization, collection, and archiving of electronic files. Cai Yingfang [6] summarizes experiences from the 13th and 14th Five-Year Plan

periods regarding enterprise archival technology expansion, digital transformation, and archival development. Xiao Qiuhui et al. [7] conduct forward-looking research on the evidentiary status and legal validity of electronic files.

2.1 Carrier Management Principles

Geographically distributed multi-backup of electronic file carriers is an effective strategy against data loss from local hardware failures, natural disasters, or human error. Therefore, at least three complete copies should be stored in different geographical locations with regular backup verification. Encrypted storage on computers (or at least on specific disk partitions) is crucial for preventing sensitive information leakage, ensuring file security even if devices are lost or accessed without authorization. Long-term storage must balance original formats (which provide legal validity and basis for subsequent editing) with exchange formats (which mitigate obsolescence risks). Coexistence of both formats enables persistent value of digital assets. Files should implement necessary access control, setting appropriate permissions for collaborative documents based on roles and business requirements.

2.2 Version Control Principles

Maintaining necessary backups preserves room for version rollback while controlling storage capacity, representing a key strategy for balancing file integrity with system efficiency. During file generation, important versions should be retained while planning the number of archived versions to ensure resources remain healthy and accessible. During backup operations, a "current complete set" document representing the latest status should always be saved, alongside a "comprehensive complete set" containing historical files. This separation of "working set" and "archive repository" satisfies both daily needs and historical completeness. Regarding backup discipline, the principle of "except for extremely unimportant drafts, only move/copy, never delete" should be enforced. This transforms file management from "deciding what to keep or discard" to "classifying and placing items,"reducing irreversible risks from human negligence.

The "369 version numbering" method is an important approach for controlling display and archiving. For general files, version numbers 11-29 represent self-edited versions, version 30 represents the first submission for leadership review or upload, versions 31-59 represent revisions and responses to that review, version 60 represents the second submission for review, and so on. This systematic numbering enables clear identification of document status and revision history.

2.3 Classification Principles

Classification should follow the "no duplication, no omission" principle, which forms the foundation of a clear and reliable electronic file system. This principle eliminates "information silos" and "data garbage," ensuring the integrity and authoritative organization of the "current complete set" collection—a method

commonly employed by McKinsey and other organizations. Another classification principle states that "the more frequently used files (folders) should be closer to the root directory," which optimizes access efficiency and improves workflow. This usage-frequency-oriented structural planning essentially represents optimal allocation of operational attention. A further balancing principle suggests matching directory sizes and file counts where possible. For example, "supervision meeting minutes" could belong to communication categories (corresponding to drawing categories, plan categories, etc.), organizational categories (corresponding to owner files, design files, project department general/subcontractor files, etc.), or could be a separate meeting category (containing internal project meetings, superior meetings, etc.). These classifications vary by individual and project, but once established, they must be implemented consistently throughout the file system to avoid problems of finding files in category B when they were placed in category A. Similarly, organizational sequence, time sequence, and other classification methods should be applied consistently.

2.4 Display Principles

The "5+5 quantity" principle for directories suggests that from the root directory onward, each directory should contain approximately five subdirectories and five files. This limitation is not absolute but aims to prevent browsing confusion and access difficulties, drawing on psychological principles of information processing to establish a structure that is neither excessively flat nor overly nested. Planning initial letters for directory and file names is an effective technique for automatic, logical sorting, establishing a stable and consistent visual order that improves file location efficiency. Establishing a standardized file naming system is fundamental to efficient electronic file system operation. For example, a system like "Date_{Project} Number_{Responsible} Person_{Content} Description-Version Number" facilitates precise searching and batch operations. Implementing the principle of "the more important the component, the shorter its name" optimizes information hierarchy and accelerates identification speed, ensuring that the most critical information is obtained within limited screen space.

3.1 Operation Process Example

Initial State (Day 1 Comprehensive Complete Set):
[Structure diagram showing root directory with subdirectories and files]

Day 2 Current Complete Set:
[Structure diagram showing updated files]

Day 3 Comprehensive Complete Set:
[Structure diagram showing merged structure]

Operation Explanation: When copying Day 2' s current complete set to Day 1' s comprehensive complete set, two issues arise. First, file AA1 in the Jia-Jia directory lacks an updated version number (despite different dates), which is

not recommended. Second, the Jia-Jia-Yi directory changes from a subdirectory of Jia-Jia to a subdirectory of Jia, resulting in two identical copies of file AB1-1. The solution is to update version numbers for all modifications, enabling overwrite protection during directory moves, then manually align Day 3' s comprehensive files with Day 2' s complete set through overwriting.

3.2 Practical Application

In the electronic as-built drawing preparation for the Huacao 206E Block Project, the aforementioned technologies were applied, including dual-system retention of both paper and scanned copies, knowledge solidification through archive distribution and preservation, geographically distributed multi-backup, file encryption, and authorization controls. Through the efforts of relevant personnel, all documents were successfully transferred to archives.

Conclusion

This paper systematically organizes operational principles and practical methods for electronic file management in construction engineering based on actual project experience. Building upon relevant national standards, it specifically addresses common issues in daily work such as directory overwriting, version iteration, classification logic, and file naming, proposing concrete and feasible operational recommendations. The paper emphasizes that electronic file management should balance standardization, practicality, and security. Through scientific classification systems, strict version control, and reasonable backup strategies, efficient organization and long-term preservation of electronic materials can be achieved, providing reliable support for daily project management.

References

[1] Xu Yongjun. From Archives Collection to Knowledge Accumulation[J]. Shanxi Archives, 2009(2): 13-17.
[2] Wei Jing. Document Control in Engineering Projects from the Perspective of Integrated Document Management[J]. Archives Science Study, 2008(05): 19-22.
[3] Zhao Yi. Impact and Implications of Anti-Tampering Technology Development for Electronic Files on Archives Management[J]. Archives Science Study, 2019(6): 77-85.
[4] Guan Xianhai, He Siyuan, Wu Mengya. Exploration of Electronic File Archiving Management Models[J]. Archives Management, 2017(6): 37-41.
[5] Yan Peng, Shu Zhongmei. Collaborative Management of Electronic Archives for Large Construction Projects Based on BIM Technology[J]. Beijing Archives, 2021(7).
[6] Cai Yingfang. Innovation and Development of Enterprise Archives Work[J]. Archives Science Bulletin, 2021(01): 16-20.
[7] Xiao Qiuhui, Duan Binbin. Research on Legislation of Evidentiary Sta-

tus and Validity of Electronic Files in China[J]. Library and Information Knowledge, 2018(1): 58-65.

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Note: Figure translations are in progress. See original paper for figures.