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A COORDINATED FRAMEWORK FOR REAL ESTATE LIFECYCLE MANAGEMENT USING PARCEL-BASED DATA LINKAGE

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Abstract: This article explores the issues existing in traditional real estate management, such as information silos, repeated material submissions, difficulties in data sharing, and insufficient inter-departmental coordination. It studies the "one-code linkage" governance model in the full life-cycle management of real estate and summarizes the typical local "one-code linkage" practice models. Taking the "one-code land management" reform in Huainan City as a case study, the paper systematically outlines its implementation path from "source coding" to "full-process linkage." Through the "one-code" system, it standardizes, shares, and traces data across the entire life cycle, improving government governance effectiveness. The paper also identifies challenges in data quality, technical support, and inter-departmental coordination efficiency, and proposes targeted strategies, such as strengthening institutional collaboration, accelerating technological upgrades, and enhancing public awareness. This study promotes the digital transformation of three-dimensional real estate and provides theoretical support for constructing full life-cycle governance.
Keywords: Real estate; One-code association; Full life cycle; Real estate unit code

1 INTRODUCTION

The full life cycle management of real estate plays a crucial role in the modernization of natural resource governance, improving government service efficiency and optimizing the business environment. With the continuous advancement of the "Digital China" strategy, issues in traditional real estate management, such as information silos, repeated material submissions, and inefficient inter-departmental coordination, have become increasingly evident and have become key obstacles limiting the improvement of governance capacity. Against this backdrop, the "One-Code Association" mechanism, centered around the "real estate unit code," has emerged, providing a systematic solution to the challenges of managing the full life cycle of real estate through standardized coding, data sharing, and process coordination[1].

In recent years, many regions across the country have launched reforms of "One-Code Land Management," which have enhanced the effectiveness of real estate governance by building a full life cycle data association mechanism. These practices demonstrate that the combination of a standardized coding system and an inter-departmental coordination platform can effectively integrate data flows across various stages, including planning, approval, land supply, construction, inspection, and registration, thereby transforming government services from a fragmented to an integrated approach[2].

This paper uses the "One-Code Land Management" reform in a pilot city as a typical case study, comprehensively analyzes its technical path and implementation results, and extracts universally applicable experiences from the "One-Code Association" model, providing theoretical support and practical references for addressing the fragmentation of real estate governance and promoting the digital transformation of national natural resource governance.

2 THEORETICAL FRAMEWORK AND TECHNICAL SUPPORT

2.1 Core Concept of Spatiotemporal Coupling in Full Life Cycle Management

The full life cycle management of real estate spans the entire process from land planning, development, and construction to eventual decommissioning. Its core lies in the deep integration of process stages and geographical spatial distribution through digital means. The spatiotemporal coupling characteristic of real estate full life cycle management is essentially achieved through the standardization of coding rules (GB/T37346-2019), data platform integration (such as the "One-Code Land Management" system), and inter-departmental coordination mechanisms. This approach enforces rigid constraints on the time series while allowing flexible adaptation to spatial distribution. This coupling not only resolves the issue of information silos in traditional management but also provides a "traceable, verifiable, and predictable" governance framework for digital transformation. It represents an important practical path for the modernization of natural resource governance and serves as the technological foundation for the "One-Code Association" innovative model.

2.2 Technical Architecture Design

2.2.1 Multi-source heterogeneous data fusion mechanism

The multi-source heterogeneous data fusion mechanism for real estate integrates and shares real estate data across departments, levels, and business sectors through the "One-Code Association" technical system. The fusion mechanism proposed in this study consists of three key technical steps: First, in the data preprocessing stage, a unified real estate data dictionary and metadata standards are established to perform structured conversion and semantic alignment of multi-source data from housing construction, natural resources, tax authorities, and other sources. Second, in the association matching stage, real estate unit codes are used as the unified index for various spatial data, and a knowledge graph is constructed to form a network of associations between spatial data in different forms, thereby enabling precise linking of real estate entities from different sources[3]. Finally, a traceable and up datable real estate holographic data model is built. The entire fusion process follows a closed-loop management model of "collection-cleaning-transformation-association-validation-application," implementing multi-protocol adaptation at the data access layer, using a distributed processing framework to improve efficiency at the computation layer, and providing standardized API interfaces at the service layer to support diverse application scenarios.

2.2.2 Cross-layer platform interaction technology

In the construction of the "One-Code Association" system for real estate, cross-layer platform interaction technology ensures real-time data linkage and business collaboration across platforms at national, provincial, municipal, and county levels through unified coding. This technology addresses challenges such as data standard discrepancies, interface protocol conflicts, and secure, reliable transmission between platforms at different levels. Additionally, it utilizes the One-Code Association technology to enable dynamic integration of full life cycle data. At the technical framework level, the "Real Estate Registration Data Specification" is used as the unified data standard to ensure data interoperability across different levels. For instance, the national-level platform can call the mortgage registration status from local systems via standardized interfaces, and the municipal platform can synchronize completion and acceptance data in real time to the provincial system, supporting the "land transfer equals certificate transfer" process.

3 COMPARISON OF THE "ONE CODE ASSOCIATION" PRACTICE MODEL FOR REAL ESTATE IN CHINA

3.1 Typical Local Practice Models

China's various provinces and cities have carried out numerous explorations in the field of real estate "One Code Association." These explorations are primarily guided by government data sharing, market applications, and real estate financial services. This study reviews relevant materials online and selects the models of Zhejiang Province, Shenzhen City, and Hefei City for analysis, in order to present the practical characteristics and innovative pathways of different regions in terms of "One Code Association."

3.1.1 Zhejiang province "universal code" management model

Zhejiang Province has pioneered the creation of a unified real estate management system through the implementation of the "One Trip for the Most" policy. This system integrates blockchain technology with government data to achieve precise control over real estate information and cross-departmental data sharing. The system adheres to the rules of unified coding by assigning a unique identification code to all real estate units in the province. This unique identifier ensures data consistency, enabling data sharing across departments such as real estate registration, housing, taxation, and finance. By reducing redundant data entry, it has greatly improved office efficiency. The "Universal Code" management model in the province employs blockchain technology, ensuring the security and integrity of data. The system is applied to critical processes such as real estate registration and transactions, significantly improving administrative efficiency. The transaction processing time has been reduced from the original 10 working days to just 5 working days.

3.1.2 Shenzhen city "multi-code integration" reform path

Shenzhen City has implemented the "Multi-Code Integration" innovative reform, which combines core identifiers such as the real estate unit number and property rights number into a unified real estate registration code system. This reform has achieved collaboration with various stakeholders, with the government providing a data-sharing platform to facilitate the exchange of data across 12 departments, including taxation, public security, construction, and more. The city has also actively promoted the use of electronic certificates, resulting in an average simplification of registration materials by 48%. By optimizing processes, the time for mortgage registration has been reduced from five days to just one day, and non-residential property transfer registration can now be processed instantly between businesses. Blockchain technology ensures data security, and an intelligent review system has enhanced the efficiency of document examination. As a result, the efficiency of real estate registration services in Shenzhen has increased by 58.3%, with online processing accounting for up to 92%[4].

3.1.3 Hefei city's "one code for land" application example

Hefei City has innovatively implemented the "One Code for Land" model, which assigns a unique identification code to each piece of land. This system establishes a comprehensive lifecycle management framework that covers land approval, supply, registration, and supervision. By using a unified land coding standard, the model achieves precise location tracking and builds an intelligent monitoring platform to dynamically monitor land use. At the same time, it optimizes business processes, reducing the time required for land title registration from 20 working days to just 8 working days. Following the implementation of this model, land ownership disputes have decreased by 28.7%, and land supervision efficiency has improved by over 40%.

3.2 Common Characteristics and Differentiated Choices

After analyzing the "One-Code Association" practice models in Zhejiang Province, Shenzhen City, and Hefei City, common requirements for standardization construction across regions can be summarized, along with differentiated strategies tailored to local conditions.

3.2.1 Common requirements for standardization construction

While the implementation paths for real estate "association" differ across regions, they all follow several common principles. First, there is an emphasis on establishing a unified coding system. For example, each real estate entity is assigned a unique identifier, similar to an ID number, which enhances data consistency and improves management efficiency. Second, extensive use of blockchain, big data, and GIS (Geographic Information System) technologies ensures data security and traceability. Third, data sharing is promoted between governments, financial institutions, and market participants, such as information sharing between banks and real estate registration departments, to improve business collaboration efficiency. Fourth, reducing data redundancy and optimizing approval processes make real estate registration and transactions more convenient. These principles lay the foundation for innovative real estate management practices across regions.

3.2.2 Regional differentiated implementation strategies

Different regions implement the "One-Code Association" policy with consideration for local economic levels, policy orientation, and market demands, resulting in noticeable regional differentiation. For example, Zhejiang Province focuses on the integration of government data, streamlining diverse data sources to enhance governmental efficiency and optimize approval processes. In Shenzhen, the emphasis is on integrating government and market dynamics, enabling both governmental supervision and the application of real estate data in the property market. Hefei, in terms of real estate management, focuses on controlling land resources, using digital technologies to optimize land rights confirmation and development supervision. The regional implementation of the "One-Code Association" policy highlights the differentiated focus and innovation in real estate management, reflecting the unique characteristics of each region.

4 ANALYSIS OF THE "ONE-CODE LAND MANAGEMENT" PRACTICE PATH IN HUAINAN CITY

4.1 Construction Objectives and Approaches

The overall goal of the construction of the "One-Code Land Management" system in Huainan City is to use the "Real Estate Unit Code" as the primary key, creating an interdepartmental, cross-level "intelligent sharing model" for data across natural resources, taxation, housing construction, courts, and water, electricity, and gas services. This model covers the entire workflow, including project site selection, standard land supply, engineering planning permits, completion inspections, and real estate registration[5]. By implementing "source-based coding and comprehensive coverage," a new mechanism for cadastral investigation throughout the entire life cycle of construction projects is established. This allows for the sharing of internal business data such as planning, approval, land supply, and registration within natural resources, and external interconnection with systems from housing construction, taxation, and other departments[6]. The integration of various stage results data through "codes," enabled by digital technology, reduces the operational costs for market entities, fosters a favorable business environment, and creates an efficient and standardized natural resource management system, promoting high-quality economic and social development. The main approaches include three aspects: platform construction, coding system, and process construction.

(1) Platform Construction

The Huainan Real Estate Registration Center continues to deepen the "One-Code Association, One-Code Land Management" reform. Following the principle of "vertical data connectivity and horizontal association expansion," the system uses the real estate unit code as the "entry point" and relies on the city-county integrated "Huai-Shun Registration" intelligent sharing platform (hereinafter referred to as the "Integrated Platform"). The platform links all business activities at both the city and county levels. It expands into five main functions: "Code Generation," "Code Association," "Code Query," "Code Supervision," and "Code Sharing." By empowering all business and process management in construction projects with information technology and digitization, the system links various business processes in new project management, creating an integrated management system that covers project site selection, standard land supply, engineering planning permits, completion inspections, and real estate registration. It achieves full lifecycle information tracking and management for projects, from "birth" to "disappearance." A unified coding system has been successfully implemented, supporting the continuity and sharing of results. The "One-Code Land Management" comprehensive management platform has integrated with internal systems such as the "One Map," "Multi-Measurement Integration," and "Cadastral Map Visualization Query," as well as external platforms like "Huainan City Construction Project Approval Management," pre-sale management for commercial housing, online signing and filing of commercial housing contracts, stock housing fund supervision, municipal tax, water, electricity, gas services, and judicial control systems, enabling data sharing across platforms. "One-Code" integrates data across stages, supporting project development and construction supervision and monitoring, making it easier for enterprises to query project land information using "One-Code" [7].

(2) Coding System

Strictly following coding standards, each plot of land is assigned a unique "ID number." Source-based coding is implemented during land supply, engineering planning permits, construction planning supervision, and completion inspection stages. If the real estate unit remains unchanged, the code is retained. If changes occur due to planning adjustments, land subdivision, or merging, the code is re-assigned according to the coding rules, ensuring proper mapping and linking between codes. Real estate unit codes include key information such as administrative divisions, plot locations, and land use, ensuring uniqueness, stability, and scalability. Through coding, it is possible to link and share land and housing information across different business systems, providing a solid data foundation for "One-Code Association" work[8].

(3) Process Construction

The "One-Code Land Management" involves eight internal business processes in the Urban Planning and Resources Bureau, including land pre-examination, land approval, land supply, land planning, engineering planning, secondary land market, land supermarket, and cadastral map visualization query. These processes enable the sharing of materials during real estate registration, eliminating the need for paper submissions. Externally, the system links to completion inspections, pre-sale of commercial housing, taxation, court control, and real estate and water/electricity/gas transfer processes. The "One-Code" is recorded on documents such as the "Joint Inspection Opinion," "Completion Inspection Record," and commercial housing contracts (pre-sale, current sale), as well as tax payment certificates, enabling the real estate unit code to be associated with and applied for [9].

4.2 "One Code Association" Application Process

The application process for "One Code Association" primarily involves five key business areas:

(1) "One Code Association" Engineering Planning Acceptance

The project unit initiates the application through the housing and construction "Engineering Modification System". The real estate unit code is linked to the "multi-survey integration" results, and the code is automatically inherited without regeneration. After the system review, the real estate unit code is recorded on the "Construction Engineering Planning Verification Certificate" electronic certificate. Documents such as the planning verification application form, construction completion verification technical report, land grant contract or allocation decision, construction planning permit, completion drawings, stakeout documents, inspection documents, staged planning verification application report, and attribute data are shared with the "One Code Land Management" comprehensive management platform. After joint acceptance and concurrent approval, it is recorded in the "Huainan City Building and Municipal Facilities Foundation Engineering Joint Acceptance Opinion" and shared with the "One Code Land Management" platform for processing the "Acceptance (handover) and Certificate Issuance at the Same Time."

(2) "One Code Association" Pre-sale of Commercial Housing

The project unit initiates the application through the pre-sale management system. The "One Code" retrieves the electronic certificate of the land real estate ownership certificate and the construction planning permit. The city's housing and construction bureau's "intermediate library" links to the real estate unit codes pre-compiled during the engineering planning phase (for natural buildings and units). The real estate unit code (building) is recorded in the "Commercial Housing Pre-sale Permit," and the real estate unit code (unit) is recorded in the "Commercial Housing Sales Contract (Pre-sale or Current Sale)." This process facilitates combined online signing, pre-sale registration, and filing.

(3) "One Code Association" Real Estate, Water, Electricity, and Gas Transfer

The system interfaces with water, electricity, and gas departments. During the real estate transfer registration process, the water, electricity, and gas accounts are linked to the real estate unit code. After registration, the attribute data and electronic certificates containing the real estate unit code are pushed to the water, electricity, and gas departments, which promptly return completion information, achieving "One Code Association[10]."

(4) "One Code Association" Taxation

The system interfaces with the tax authority to push tax information related to the property owner's identity, residence, marital status, contracts, and other relevant tax data through the "One Code Association" to the tax department. After tax payment, the tax payment receipt, including the real estate unit code, is shared with the "City-County Integration" platform.

(5) "One Code Association" Court Search and Control System

The system integrates with the court system, enabling real estate registration and judicial search/control services through the "One Code" process. Courts at all levels can initiate real estate inquiries, sealing, continued sealing, unsealing, and other related matters via the provincial high court's "Judicial Cloud" platform, which is linked to the real estate unit code.

5 CONCLUSION

The current "One Code Linkage" work for real estate faces several challenges:The first challenge is related to data integration, as historical issues exist, with some outdated real estate information being missing or incorrect. A significant amount of human resources is required to clean and update this data. The second challenge is insufficient technical support, as the existing system has gaps in certificate aggregation and has not used the "Real Estate Unit Code" as a key field for linking data. Additionally, the construction approval system and the "One Code Land

Management" platform rely on manual associations, preventing automatic data push. The third challenge is the low efficiency of cross-departmental collaboration, where communication barriers affect the timeliness and accuracy of information sharing. The fourth challenge is the lack of public awareness, with some enterprises and the general public being confused about the functionality and usage process of the "One Code Linkage."

To address these challenges, the following areas should be prioritized:Firstly, establishing a cross-departmental coordination and evaluation mechanism to clarify responsibilities, strengthen supervision, and break down administrative barriers. Secondly, accelerating technological upgrades by promoting the standardization of data field integration between systems, developing automatic coding and data exchange functions, and forming specialized teams to focus on historical data cleaning. Finally, enhancing public awareness and optimizing services by improving social recognition through case studies and operation guides, establishing user feedback channels, and making precise service improvements. The focus should be on real-time data, system intelligence, and inter-departmental collaboration to construct a full lifecycle management loop for the "One Code Linkage."

Therefore, the One-Code Association system, through standardized and unique coding, effectively resolves issues of information fragmentation, lengthy processes, and inefficiency in traditional real estate management. It promotes business integration, data sharing, and the upgrade of social services, ultimately achieving efficiency, transparency, and convenience in real estate management. This is a key aspect of the digital transformation of real estate. This paper explores the governance model of One-Code Association for real estate full life cycle management, summarizes typical local practices, and uses the "One-Code Land Management" in Huainan as a case study. The paper analyzes the implementation path from "source coding" to "full-process association" and proposes strategies to address the existing challenges related to data, technology, and other factors.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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