



Research on the Overall Scheme of Urban Water Affairs Management Informatization

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Abstract. Urban water affairs management requires strong support from information technology. This paper focuses on two major businesses of urban drainage and water environment, summarizes and proposes the informatization requirements for the entire "Design-Construction-Maintenance" lifecycle of urban water affairs management, and an overall framework for an urban water affairs management informatization platform, including information infrastructure, information platform, business applications, as well as security and guarantee systems. Functional modules such as urban water affairs IoT perception, data interaction, intelligent analysis, knowledge base, and business applications are also outlined, forming a complete set of solutions for the urban water affairs management informatization platform. The research results can guide the construction of informatization platforms for urban drainage and water environment businesses, thereby enhancing the level of urban water governance.

Keywords: Urban Water Affairs Management; Informatization Requirements; Overall Framework; Functional Modules

1 Introduction

Water is a core element of urban development resources and a fundamental support for urban construction and development [1]. Influenced by extreme weather and high-intensity urban development, various water issues such as urban flooding and deterioration of water ecological environment are becoming increasingly prominent in China [2-3]. In recent years, China have attached great importance to urban water affairs management, issuing a series of policies such as the Yangtze River Great Protection, Ecological Civilization Construction, and Water Logging Control, promoting the implementation of numerous urban drainage and water environment management projects. From the practical perspective, urban water affairs management projects involve the multi-element control, the entire project lifecycle management, and various water business applications, urgently requiring strong support from urban water affairs management informatization technology.

Chinese researchers have conducted some exploratory research on urban water informatization schemes. For example, Nan Zhang et al. [4] proposed a conceptual method to evaluate the smart water system based on fit-for-purpose concept. Tian Yuan

[5] proposed an overall solution for the integration and sharing of Tianjin water informatization resources. Meng Ying et al. [6] analyzed the difficulties and problems restricting the "Smart Water" informatization construction in Jining City and proposed a construction plan. In general, a relatively complete solution for the urban water affairs management informatization platform has not yet been formed to guide platform construction, resulting in disparate platforms built in various locations, which does not meet the requirements for high-quality development in the industry.

Therefore, this paper focuses on two major businesses of urban drainage and water environment, adopting the technical route of "conducting demand analysis – proposing an overall framework – proposing functional modules" to research the overall scheme of urban water affairs management informatization, aiming to guide the construction of informatization platforms for drainage and water environment management and enhance the level of urban water governance.

2 Analysis of Informatization Requirements for Urban Water Affairs Management

Taking typical cities like Chongqing, Wuhan, and Gong'an as research objects, this study investigates and sorts out the current status and existing problems of urban water affairs informatization, analyzes the water affairs informatization and collaboration needs of different departments and related enterprises. From two major businesses of urban drainage and water environment, this paper summarizes and proposes the informatization requirements for the entire "Design-Construction-Maintenance" lifecycle of urban water affairs management, mainly including business requirements, function requirements, data requirements, performance requirements, and security requirements.

(1) Business Requirements

For the entire "Design-Construction-Maintenance" lifecycle, following the principle of "vertical thoroughness and horizontal coverage", business requirements are analyzed and summarized. Urban Drainage Business mainly includes drainage simulation, early warning, and operation, project construction and maintenance, plan management, etc. Water Environment Business mainly includes pollution source management, water environment simulation, early warning and operation, project construction and maintenance, plan management, etc.

(2) Function Requirements

Information Services include various basic information services, monitoring information services, information sharing services, and information fusion services, greatly enriching urban water data resources and providing foundation for data applications and application systems.

Function requirements determine the functional architecture of the smart water application layer. To meet the business management needs of urban drainage and water environment management, function requirements are analyzed according to "thematic business, project construction and project maintenance", as shown in Table 1.

Decision Support is the "intelligence" core of the platform. Based on integrated multi-source data, it conducts deep mining and analysis of big data and applies

professional model services, applying analysis scenarios to the urban drainage and water environment businesses to ultimately achieve decision support for smart applications.

Table 1. Function Requirements for Business Management

Business Category	Sub-category	Specific Business	Function Requirements
Thematic Business	Data Management	Basic Data Management	Manage vector data, image data, elevation model data, geographic entity data, address data, 3D model data
		Water Facility Management	Manage water facilities like rivers, lakes, pipelines, sewage plants, gates/pumps, storage tanks, outfalls
		Monitoring Data Management	Manage monitoring data such as flow, water level, water quality, video surveillance for hydrology, meteorology, and water facilities
		Plan Management	Manage plans of urban drainage and water environment
		Comprehensive Display	GIS-based "One Map"
	Urban Drainage Management	Drainage Simulation	Simulate flow/water level in rivers, drainage networks under different rainfall scenarios using monitoring and forecast data; assess facility operation status and urban waterlogging distribution, depth, duration and risk
		Waterlogging Early Warning	Issue graded warnings based on simulated waterlogging distribution, depth and duration
		Drainage Operation	Display real-time precipitation, typhoon, flood forecasts; real-time water levels, warning levels at key river sections, reservoirs, video; track disaster development, display disaster statistics
	Water Environment Management	Water Environment Simulation	Simulate and predict water quality in sewers, plants, rivers/lakes, and outfall pollution based on pollutant sources, rainfall, water conditions, engineering, forecasts
		Water Environment Early Warning	Issue graded warnings for abnormal influent/effluent quality at plants, river/lake quality, outfall pollution levels
		Water Environment Operation	Simulate water environment under different operation schemes based on monitoring/simulation results, generate optimal integrated plant-network-river-lake-bank dispatch plans,

			manage feedback, guide stable/efficient sewer system operation
Project Construction	"Four Control" Management	Investment Management	Investment progress, vs. plan analysis
		Schedule Management	Link actual progress to schedule model, track/compare actual vs. plan, progress warning, variance analysis, schedule adjustment
		Quality Management	Link quality info to model elements, quality inspection/evaluation, assessment, accident management, supervision, analysis/traceability
		Safety Management	Link hazards/hidden dangers to data baseline, manage on-site hazards, accident management, safety assessment
Project Maintenance	Daily Inspection	Daily Inspection	Plan inspection routes/schemes integrated with GIS, track location/results in real-time, report/manage results
	Facility Maintenance	Facility Maintenance	Manage maintenance plans/records for pipelines, gates/pumps, tanks, etc.; issue work orders to maintenance teams/personnel
	Maintenance Performance	Maintenance Performance Evaluation	Assess maintenance performance for control of urban drainage and water environment

(3) Data Requirements

Data types for the urban water affairs management informatization platform can be divided into basic spatiotemporal data and IoT real-time perception data, requiring multi-source data integration, database construction, and mining analysis.

Multi-source Data Integration and DataBase Construction: Standardize format, consistency, and spatial processing for structured/unstructured spatiotemporal data; organize various data resources according to national standards and specifications to build a unified standard database.

Data Mining and Analysis: Integrate various data resources, use big data analysis models and professional models to assist decision management, truly "let the data speak," and support the two major business applications.

(4) Performance Requirements

Performance requirements include monitoring data meeting accuracy requirements, rapid data collection and management, stable and reliable platform operation, high model computation performance, and high smart application performance.

(5) Security Requirements

Considering network security, data security, application system security, etc., uniformly, to provide an effective security management mechanism and system for business applications.

3 Overall Framework of Urban Water Affairs Management Informatization Platform

Drawing on the framework for digital twin construction in the water resources industry, and based on the inherent requirements of urban water affairs management for informatization, an urban water affairs management informatization platform is researched and constructed from an overall perspective, integrating technologies such as IoT, cloud computing, big data, and GIS.,which aims to transform the previous human-centric governance model into a more scientific, standardized, quantitative, and intelligent mode. The overall framework includes information infrastructure, information platform, business applications, as well as security and guarantee systems.

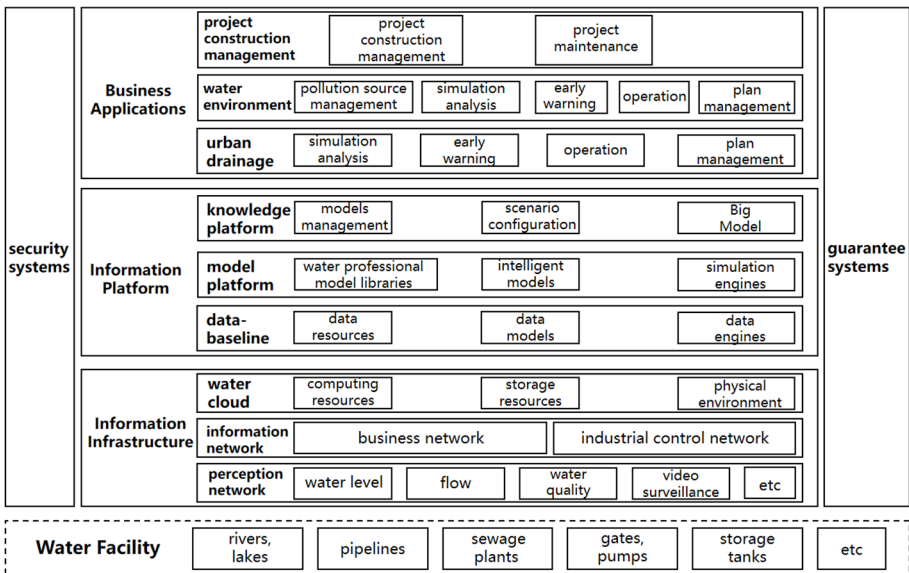


Fig. 1. Overall Framework of Urban Water Affairs Management Informatization Platform

As show in figure 1. Information Infrastructure mainly includes the water perception network, water information network, and water cloud. The perception network includes monitoring elements like water level, flow, water quality, and video surveillance. The information network includes the business network and industrial control network. The water cloud includes computing resources, storage resources, and physical environment.

Information Platform mainly includes the databaseline, model platform, and knowledge platform. The databaseline includes data resources, data models, and data engines, providing calculation data for the model platform and knowledge platform. The model platform includes water professional model libraries, intelligent models, and simulation engines, providing algorithms for business applications. The knowledge platform collects historical water knowledge, simulation results from the model

platform, and relevant data from the databaseline, processed by the water knowledge engine to form knowledge graphs to meet business application needs.

Business Applications mainly include urban drainage, water environment, and project construction management business. The urban drainage business mainly includes simulation analysis, early warning, operation, and plan management. The water environment business mainly includes pollution source management, simulation analysis, early warning, operation, and plan management. The project construction management business includes project construction management and maintenance, uniformly providing these functions for the two businesses.

Security System is the foundation for ensuring secure system application, including physical security, data security, network security, and security management.

Guarantee System includes organizational mechanisms, scientific research, and standards and specifications.

4 Main Functional Modules of the Platform

(1) Urban Water IoT Perception

Based on integrated monitoring technology combining water quantity and quality monitoring, manual and online automated monitoring, it conducts timely, comprehensive, and accurate monitoring and integration of links involved in urban drainage and water environment businesses, achieving IoT perception with full information coverage, full process penetration, and all-weather monitoring.

(2) Data Interaction

This module includes functions for data collection and aggregation, processing and integration, storage and indexing, and data updating.

(3) Intelligent Analysis

This module integrates new-generation intelligent technologies such as numerical simulation, cloud computing, and AI to build an "intelligent brain" for urban water analysis, providing decision-makers with tools for problem analysis and scenario simulation, supporting management decisions for urban drainage and water environment management. Functions include waterlogging assessment analysis, river/lake hydrodynamic assessment analysis, water quality evaluation analysis, combined hydraulic-water quality dispatch, pipeline network capacity and operational status assessment, pollutant source tracing analysis, etc.

(4) Knowledge Base

To meet the needs of smart urban water management, knowledge graphs and Big Model are built, strengthening their integration to further enhance analysis, prediction, optimization capabilities and efficiency.

(5) Business Applications

This module mainly includes urban drainage, water environment, and project construction management business. The urban drainage business mainly includes simulation analysis, early warning, operation, and plan management. The water environment business mainly includes pollution source management, simulation analysis, early warning, operation, and plan management. The project construction management

business includes project construction management and maintenance, uniformly providing these functions for the two businesses.

5 Conclusion and Discussion

Through comprehensive summary and analysis, the informatization requirements for the entire "Design-Construction-Maintenance" lifecycle of urban water affairs management are proposed, to support the transformation from traditional water management to "smart water". Focusing on the overall perspective of informatization for two major businesses of urban drainage and water environment, the overall framework and function modules of the urban water affairs management informatization platform are innovatively proposed, forming a complete set of solutions that can guide the construction of such platforms.

Informatization platform can make the water management components intelligence, for example, Abdennabi Morchid et al.[7] developed an IoT-based smart irrigation management system to enhance agricultural water security using embedded systems, telemetry data, and cloud computing. In the future, based on the research results of this overall scheme, key technologies for urban water affairs management informatization will be further studied in depth, and the informatization platform will be developed to provide scientific and technological support for improving the efficiency of urban water governance.

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