Study on Framework Design of Smart Water Management System in Shenzhen

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Abstract. Given the current situation and major problems in the development of water affairs informatization in Shenzhen, we put forward the following objectives for construction of a smart water management system – “to see the whole view through one map”, “to know everything through one click”, “to monitor all through one station” and “to manage water-resource affairs through one machine”. To meet these objectives, we proposed an overall framework of the smart water management system consisting of five levels (intelligent sensing, infrastructure, big data of water affairs, intelligence application and intelligence portal), two main sub-systems (standard and information security) and the main construction tasks of “1+3+N”. In the end, we analyzed the expected benefits of the smart water management system in hopes of providing a basis to promote construction of an overall smart system in Shenzhen in an all-round manner.

1. Introduction
With the advent of the third wave of information technology marked by cloud computing and the new generation of mobile networks, the Internet of Things and its applications, which have the basic characteristics of "perception, interconnection and intelligence", have greatly changed the efficiency, ease of use and behavior paradigm of information services in the industry. Water information technology and modernization have its good opportunity [1-3]. The development of smart water conservancy and the construction of a safe, practical, intelligent and efficient water conservancy information system will become a powerful force to comprehensively promote the modernization of water conservancy and rapidly enhance the water management system and governance capacity. Beijing [2], Dalian [4], Zhengzhou [5] and other cities have put forward the idea of smart water management, and actively promote the construction of related fields. As the pioneer of reform and the city of innovation in China, Shenzhen is striving to build a new benchmark for a new type of smart city. As an important part of the construction of a smart city, the smart water management system is one of the important symbols reflecting the level of intellectualization of urban management [6-8]. It is related to the optimization of city resource allocation, the promotion of government functions, and the improvement of public services and other tasks of urban operation. With the continuous advancement of water control strategies such as the river chief system, water quality improvement and the sponge
city construction in Shenzhen, the requirement of refined water management and business coordination is constantly increasing, which leads to higher requirements for smart water management in Shenzhen. It is urgent to build a smart water resource management system in an all-round way.

Based on the analysis of the current situation of water informatization in Shenzhen and in order to meet the overall objectives of smart water-resource management, this paper preliminarily puts forward the overall framework and main construction tasks of building a smart water management system in Shenzhen, with a view to discussing how to develop the smart water management system in Shenzhen and providing a theoretical basis for promoting smart water system construction in Shenzhen in an all-round way.

2. Current situation of water informatization development in Shenzhen

2.1. Current situation of development
The In recent years, Shenzhen Water Bureau has actively promoted the construction of informatization. Shenzhen Water Bureau has achieved rapid development in water information infrastructure, business application system and environment protection through planning and constructing public information platform and promoting the construction of supporting information projects, which has laid a good foundation for Shenzhen Water informatization to change from "digital water" to "smart water". First, the water information infrastructure has been continuously improved. The city water information collection system and network coverage are expanding, with the implementation of sewage online monitoring system and emergency command system of prevention and early warning combating flood, drought and typhoon disasters, and the data center is basically built. Second, the application of water business is gradually deepened. Several business application systems, such as online sewage monitoring, water use planning management, decision-making support platform for disaster prevention, water resources management, water supply information management and water and soil conservation information management, have been gradually built. The supporting capacity of water business application system for water affairs has been continuously enhanced. Third, the information security environment is optimized. It has formulated management methods and information security management system for water informatization project construction, established relatively perfect information security technology measures, regularly carried out information security grade protection, grading and risk assessment work, and initially established information security management system with perfect system, technical measures in place and standardized management.

2.2. Existing problems
Due to the lack of overall planning, there are still some problems to be solved urgently in the construction of water information in Shenzhen, which are mainly reflected in the following aspects: (1) The development of informatization is unbalanced and its functions are not perfect. The existing business application systems involve less applications in water environment and water ecology, especially in water control and quality improvement, engineering regulation and control, and no special support management system has been formed. (2) The lack of in-depth integration and sharing of information resources, and the lack of uniform standards and designs for information collected by various sites such as rainfall, water level and water volume, have led to the scattering of monitoring information in different business departments, resulting in data separation and information isolated islands, and the lack of sharing system with water-related departments at the district level. (3) Business system lacks overall planning, application depth is insufficient, application system has not been unified planning and design, data information processing still stays at the level of acquisition and basic analysis. There is blank in the construction of assistant decision-making systems such as intelligent forecasting, intelligent early warning, intelligent regulation and intelligent decision-making, and new generation information technology such as big data and virtual reality has not yet played a role. The information technology needs to be improved urgently in improving the level of water supervision and optimizing decision-making support ability.
3. Overall objective of smart water management in Shenzhen

The overall objective of smart water construction in Shenzhen is to make full use of the new generation information technology and adopt the loose coupling model to construct three systems of intelligent sensing, data fusion and intelligent application, to realize the whole process of intelligent management and control of water-related affairs sensing, supervision and decision-making, and to realize the objectives of “to see the whole view through one map”, “to know everything through one click”, “to monitor all through one station” and “to manage water-resource affairs through one machine”.

“To see the whole view through one map”: A map composed of points (water sources, water users, sewage outlets, etc.), lines (rivers, water functional areas, water supply and drainage network, etc.) and surface (administrative regions, water resources zoning and groundwater zoning, etc.) will be constructed, and a comprehensive sensing network system of water security, water resources, water environment and water ecology will be established, so as to better sense water basic information and water conditions, water quality, work conditions, disasters, water ecological information by means of information technology.

“To know everything through one click”: Build a supervisory and decision-making assistant system based on big data, information sharing and artificial intelligence. One click can obtain the information service of "water security, water resources, water environment, water ecology, water culture and water affairs", and provide visual decision-making support services such as early warning of urban waterlogging, optimal dispatch of water resources, prediction of water environment quality and evaluation of ecological space suitability.

“To monitor all through one station”: A hierarchical management and control system consisting of local stations, sub-centers and control centers has been built to realize remote monitoring and control of the monitored objects in the systems of source water, water supply, drainage, ecological rivers and lakes and flood control.

“To manage water-resource affairs through one machine”: Build a smartphone mobile application system, realize water business management services available at anytime and anywhere, and build a convenient and efficient application system for urban management and people's livelihood services.

4. Design of smart water technology framework in Shenzhen

According to the overall objectives of building a smart water management system in Shenzhen, the preliminary design of the overall structure of smart water management system in Shenzhen is proposed by combining with the latest information technology, taking into account the future technological development, ensuring the sustainable evolution of technology, making the system has good practicability, advanced, expansibility, portability and openness. The overall framework consists of five layers, i.e. intelligent sensing, infrastructure, water big data (including model services), intelligent application (including application support and display layer) and portal, and two main subsystems, i.e. standard and information security. The overall structure of the smart water management system in Shenzhen is shown in Figure 1.
4.1. Intelligent sensing
Intelligent sensing includes water condition, water quality, work condition and video etc. It mainly provides data support for intelligent application. Based on the space-sky-ground integrated three-dimensional monitoring technology with the combination of surface, underground and remote sensing monitoring, station monitoring and mobile monitoring, a smart water intelligent sensing system is formed to realize the timely, comprehensive, accurate and stable monitoring of natural water cycle process and social water cycle process.

4.2. Infrastructure
Infrastructure includes cloud platform, network engineering, infrastructure environment and information security. It provides information transmission channel and safe infrastructure operation environment (including network environment) for intelligent water affairs. It can expand automatically according to the needs of front-end business, realize failover and automatic operation and maintenance monitoring, etc. The cloud platform mainly centers on the construction of Shenzhen Government Cloud.

4.3. Water big data
Water big data includes big data platform, database, big data service and analysis and model service. The main services are data storage, management and use. On the basis of big data platform of Shenzhen, the basic database, monitoring database and special database are constructed to form water big data.
4.4. Intelligent application
Intelligent application includes application support layer, application layer and display layer, among which application support layer provides public service capabilities needed by intelligent application, such as unified certification, unified reports and process services. Application layer business covers six areas: water resources, water ecology, water security, water environment, water affairs and water culture.

4.5. Portal
Portal is the unified entrance of the whole smart water management platform, including unified PC and mobile portal, providing personalized portal for water management departments, water-related enterprises and the public.

4.6. Standard system
Standards are the important basis for ensuring the coordinated work of all components of the smart water system, ensuring the interconnection of all kinds of information, and ensuring the standardization, order and efficiency of project construction process and operation and maintenance management. By making full use of the existing national standards and industry standards, and referring to the international advanced standards, the necessary standards are built to form the standard system of smart water management.

4.7. Information security system
On the basis of comprehensive analysis and assessment of the value, risk, vulnerability and threats of various elements of smart water management affairs in Shenzhen, and in accordance with the requirements of the "Law of the People's Republic of China on Network Security" and the hierarchical protection system, combined with the reality of water affair Shenzhen, the information security system of smart water management is constructed to ensure the safety and stability of the system.

5. Main construction tasks of smart water management system in Shenzhen
According to the overall objectives of smart water management and the actual situation of water affairs management in Shenzhen, a smart water system is constructed according to the overall framework of "1+3+N", namely, one big data center for water affairs, three types of business (special business, government service, project management), and N application systems. The major construction tasks include:

5.1. Water foundation platform

5.1.1. Public infrastructure and service platform, including intelligent water management and control center, integrated communication command platform, water emergency disposal platform, water management and control mobile platform, backbone transmission network engineering, wireless network engineering, public information security system and other infrastructure.

5.1.2. Water big data center, including water business integrated database, data sharing and exchange system, data management system, water geographic information system, application support platform, system management and monitoring, water big data analysis platform, unified smart water dispatching system and unified smart water coordination system.

5.1.3. Public application system, including water collaborative office system, public service system, application portal and public service portal.

5.2. Special business
It includes three disasters defending command system, flood control and waterlogging management system, water resources and water supply management system, water conservation management
system, drainage management system, water eco-environment management system, water and soil conservation management system, river chief management system, sponge city management system, construction and security supervision management system, hydrology and water quality monitoring management system, water engineering construction and quality supervision management system.

5.3. Government service
It includes human resources management system, planning management system, regulations and administrative licensing management system, water technology management system, water administrative law enforcement management system, financial management system and water project cost management system.

5.4. Project management
It includes river management system, reservoir management system and water diversion project management system.

6. Expected benefit of smart water system construction in Shenzhen

6.1. Social benefits

6.1.1. Improving water security and disaster prevention and reduction capabilities and building resilient cities.
With the construction of smart water affairs, we will promote the refined management of water security and water resources, enhance the ability of water resources allocation, water supply guarantee and the prediction, research, management and control of flood and waterlogging, make the water supply situation and flood disaster visible, knowable and predictable, and support the precise dispatch and scientific decision-making of water resources and floods, so as to comprehensively enhance the urban security resilience in terms of water supply guarantee and water disasters in Shenzhen.

6.1.2. Strengthening the comprehensive management ability of rivers and lakes and improving the quality of urban environment.
By building a smart water management system, we will enhance the comprehensive management ability of rivers and lakes, strengthen the technical ability and means of implementation, supervision and assessment of water control and quality improvement, help build a beautiful Shenzhen with clean water and green coast, and enhance the level of ecological civilization construction in Shenzhen.

6.1.3. Improving the level of water services and industry supervision and optimizing urban public services.
Building a smart water management system can broaden the channels of water information opening and sharing, make the public access to water service information more conveniently and intuitively, enhance the standardization and refinement level of water administrative law enforcement and industry supervision, and make water-related enterprises and other subjects access to guidance and regulatory opinions of water behavior more timely and accurately. We will further optimize the business environment and urban public services to help Shenzhen build a modern, internationalized and innovative city by more fully benefiting enterprises and people.

6.2. Economic benefits

6.2.1. Fully sharing information to enhance the value of data
By building a smart water management system, the relevant standards and processes of collection, transmission, management, sharing, analysis and application of water affair information and data are established to realize the full coverage of information collection, the full sharing of business information among relevant departments and the unified standard of data analysis, eliminate data
isolated islands and information chimneys, promote the integrated management of water affair business, and make water affair management decision more scientific and precise.

6.2.2. Changing work mode, reducing cost and increasing efficiency in management
By building a smart water management system, we can provide standardized and refined daily management tools for water project inspection, water administrative law enforcement and industry supervision. We can change the mode of "human prevention" with human input and manual operation into a "technical prevention" mode which provides agile, efficient, standardized and refined management means through system functions. We can use science and technology to exchange human resources to promote the efficiency and reduce the cost of water management in Shenzhen.

7. Conclusion
Systematically solving the water problem in Shenzhen city and realizing the modernization of water management are inseparable from construction and development of smart water management. By building a smart water management system in Shenzhen, the infrastructure of smart water management in Shenzhen can be improved, the network information security can be more stable and controllable, the information resources can be shared more comprehensively and widely, and the management of water affairs can be more efficient and intelligent, so as to further improve the ability of water security, disaster prevention and reduction, and promote the construction of a safe and resilient city of water resources in Shenzhen. It will also enhance the comprehensive management ability of rivers and lakes, improve the quality of urban environment, improve the level of water services and industry supervision, optimize urban public services, and help to build a modern, international and innovative city. At the same time, the mode of "human prevention" focusing on manpower investment and manual work will be transformed into the mode of "technical prevention" which provides agile, efficient, standardized and refined management means through system functions. Water-related information will be fully shared, data value will be enhanced, and water work mode will be transformed, management cost will be reduced and efficiency will be increased. It has remarkable social and economic benefits.

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