

Developing a set of smart urban water supply management indicators in the digital transformation orientation for the period of 2026-2035

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Abstract—In the context of globalization and the 4.0 industrial revolution, digital transformation has become an inevitable trend in all fields, including urban water supply. Applying the digital transformation to smart urban water supply management is considered a key and effective solution to solve the current shortcomings of urban water supply management. The Government of Vietnam has been clearly aware of the importance of digital transformation and issued many policies to promote the application of digital technology in urban technical infrastructure management, including urban water supply management. Smart urban technical infrastructure is an essential foundation for the formation and development of smart cities, in which urban water supply plays a very important role. Therefore, proposing to develop a set of smart urban water supply management indicators in the digital transformation orientation for the period of 2026 - 2035 is an important link to accelerate the process of building smart cities in Vietnam.

Index Terms—Index system, smart urban water supply, digital transformation

I. RATIONALE FOR DEVELOPING A SET OF SMART URBAN WATER SUPPLY MANAGEMENT INDICATORS IN THE DIGITAL TRANSFORMATION ORIENTATION FOR THE PERIOD OF 2026 - 2035.

Smart urban water supply is one of the strategic orientations of the urban water supply industry in Vietnam. The core requirement of smart water supply is to apply advanced science and technology, with a high level of automation, saving energy, environmentally friendly, etc. right from the

production, operation, management to water distribution stages. [1] [2] According to the Decision No. 926/QĐ-BXD dated October 11, 2024 of the Ministry of Construction approving the Digital Transformation Scheme for the Construction Sector for the period of 2025 - 2026, with an orientation towards 2035 [3], developing digital infrastructure is investing in constructing synchronous, modern, safe digital infrastructure with the ability to reserve and adapt to future changes, creating a solid foundation for the digital transformation process and developing a Digital Government; improving the capacity and efficiency of connection, sharing, data processing and service provision in the digital environment of the Construction sector. Developing digital data is the study to developing a system for managing and exploiting urban technical infrastructure databases, developing a centralized digital management platform for the Construction sector [3] [4] [5]

Proposing to develop a set of smart urban water supply management indicators in the digital transformation orientation for the period of 2026 - 2035 is to evaluate the operation of a modern urban water supply system in different aspects. Smart urban water supply management indicators need to be proposed in line with the requirements of the 4th industrial revolution to fully utilize the power of digitalization and information technology. [1] [2] [3]

Within the scientific article, the group of authors will propose to develop a set of smart urban water supply management indicators in the digital transformation orientation for the period of 2026 - 2035. The proposed indicators are based on the current legal documents on the 4th Industrial Revolution; the Scheme on

sustainable smart urban development in Vietnam; the Plan on green growth urban development in Vietnam; the Scheme on Digital Transformation of the Construction Sector for the period of 2025-2026, with an orientation towards 2035; the National Target Program for Climate Change Response and Green Growth; Orientation for Water Sector Development; Safe Water Supply Plan, etc. [2] [3] [4] [5] [6] [7] [8] [9] [10] [11].

To proactively seize opportunities, propose practical solutions to maximize the advantages, and at the same time minimize the negative impacts of the 4th Industrial Revolution on Vietnam, the Ministry of Construction, Water Supply and Sewerage enterprises and Vietnam Water Supply and Sewerage Association have carried out many activities to deploy smart water supply management nationwide. The smart water supply management in the digital transformation orientation is a major issue that attracts the attention of the whole society. Despite many positive results, the Vietnamese water sector still faces many limitations, difficulties and inadequacies. In particular, Vietnam is facing many major challenges, including: increasing urban population, limited budget, not good operational management capacity, water pollution and extremes of climate change such as drought, flood, inundation, saltwater intrusion, etc. [10] [11] [12] [13].

Facing with these limitations, difficulties and challenges, the Vietnamese water sector has focused on prioritizing policy innovation, attracting resources for investment, improving the quality of resources, and promoting the application of advanced science and technologies. A number of leading urban water supply enterprises have applied many smart water supply management solutions towards the 4.0 technology revolution. In order to fully understand and gradually implement smart urban water supply activities in the water supply system management of water supply companies, the proposal to develop a set of smart urban water supply management indicators in the digital transformation orientation for the period of 2026 - 2035 is very essential. The list of proposed indicators will be the initial measure and one of the tools to assess the level of smart urban water supply management in the digital transformation orientation of enterprises at present and to make plan for future application. [1] [2] [3] [4] [5]

II. PROPOSAL ON A LIST OF SMART URBAN WATER SUPPLY MANAGEMENT INDICATORS IN THE DIGITAL TRANSFORMATION ORIENTATION FOR THE PERIOD OF 2026 - 2035.

2.1. Viewpoints and principles for proposing a set of indicators

Based on the results of reviewing, evaluating and analyzing the current status of urban water supply management; collecting and using relevant legal documents (listed in the list of references); referring to a number of indicators on urban water supply; smart urban water supply management indicators are proposed based on the following viewpoints and principles: [7] [8] [9]

a. Viewpoints on proposed indicators

1. Smart urban water supply management indicators in the digital transformation orientation need to accurately reflect the current situation of urban water supply management in the direction of information technology approach.

2. Smart urban water supply management indicators are developed in accordance with the current legal documents on smart urban water supply management in the digital transformation orientation.

3. The proposed smart urban water supply management indicators in the digital transformation orientation have been referred to international and Vietnamese urban indicators related to urban water supply management.

4. Smart urban water supply management indicators in the digital transformation orientation must ensure scientific nature, using information technology in the management of the entire system and each stage of the urban water supply system.

5. Smart urban water supply management indicators in the digital transformation orientation need to increase initiative and coordination between sectors and stakeholders in automatically managing stages of the urban water supply system.

b. Principles for determining indicators. [7] [8] [9] [10] [11]. [12] [13].

1. The selected indicators need to reflect the major management content of each stage of the water supply system, to properly assess the application of information technology in urban water supply management under the professional management

authority of water supply companies in the 4th Industrial Revolution.

2. The selected indicators need to ensure availability, feasibility and inter-sectoral coordination. Therefore, it is necessary to consider inheriting available indicators, prioritizing the indicators that are of interest and used by many domestic and international agencies and organizations.

3. The selected indicators need to comply with the Water Sector Development Orientation, the National Program and Strategy on Smart Urban Development of Vietnam, the Scheme on Digital Transformation of the Construction Sector for the period of 2025-2026, with an orientation towards 2035, at the same time, consider learning from the international indicators.

4. The selected indicators must ensure that the information sources may be collected and ensure the necessary reliability according to the requirements for data quality and sustainable data connectivity.

5. The selected indicators are all quantitative ones, calculated as a rate of each indicator to easily monitor the level of application to smart urban water supply management of each Water Supply Company and to compare companies with the same function nationwide.

6. The list of smart urban water supply management indicators in the digital transformation orientation

helps the relevant central and local state management agencies have enough updated information and a basis to effectively direct management and investment.

2.2. Basis for proposing indicator groups and subgroups

a. Basis for proposing

The division of groups and subgroups of indicators is based on the following three important requirements:

1. Each indicator group and subgroup must reflect a basic content of urban water supply management.
2. Each indicator group and subgroup must fully cover its important contents, including operation and management contents.
3. Each selected indicator group and subgroup must be capable of applying information technology in smart urban water supply management in the digital transformation orientation.

b. Proposed indicator groups and subgroups

Based on the above-mentioned requirements, groups and subgroups of smart urban water supply management indicators in the digital transformation orientation is proposed to include 04 groups and 08 subgroups. Specific groups and subgroups of indicators are shown in Table 2.1. [7] [8] [9] [10] [11]. [12] [13].

Table 2.1. Proposed groups and subgroups of smart urban water supply management indicators in the digital transformation orientation

No.	Indicator groups	Indicator subgroups
	<i>01. Water source monitoring and management</i>	
1		1.1. Water source monitoring
2		1.2. Water source management
	<i>02. Water plant management</i>	
3		2.1. Operation management
4		2.2. Post-treatment water quality management
	<i>03. Management of network and works on water supply network</i>	
5		3.1. Operation management
6		3.2. Water network loss prevention management
	<i>04. Customer care and management</i>	
7		4.1. Customer care
8		4.2. Customer management
	<i>Total: 4 groups</i>	<i>8 subgroups</i>

2.3. Basis for proposing indicators

a. Selection of indicators

When considering the selection of indicators in the indicator groups, it is necessary to comply with the following 3 criteria:

Criteria 1. The set of indicators must cover all 04 groups of indicators and be the basic contents of smart urban water supply management in the digital transformation orientation.

Criteria 2. The popular, available, easy-to-collect indicators from Water Supply Companies are prioritized.

Criteria 3. The indicators that are periodically summarized are prioritized so that periodic information may be collected from Water Supply Companies.

b. Number of selected indicators in groups

Based on the proposed criteria, 14 indicators are selected as shown in Table 2.2.

Table 2.2. Number of selected indicators

No.	Name of indicator groups	Quantity
1	Water source monitoring and management	3
2	Water plant management	2
3	Management of network and works on the network	5
4	Customer care and management	4
	Total	14

2.4. Proposed list of smart urban water supply management indicators in the digital transformation orientation

According to the Law on Statistics No. 01/2021/QH15 amending and supplementing a number of articles of the Law on Statistics No. 89/2015/QH13, the list of

indicators includes codes, groups and names of indicators. The list of smart urban water supply management indicators in the digital transformation orientation in the period of 2026 - 2035 is shown in Table 2.3 [4] [5] [6] [7] [8] [9] [10] [11] [12] [13]

Table 2.3: List of smart urban water supply management indicators in the digital transformation orientation

Indicator groups	No.	Code	Subgroups and indicators
1. Water source monitoring and management			<i>1.1. Water source monitoring</i>
	1	CN 0101	The ratio of water sources supplied to urban areas that have invested in building water quality monitoring systems and are automatically managed according to the approved planning (%)
			<i>1.2. Water source management</i>
	2	CN 0102	The ratio of automation of updating and declaring water supply quality data for timely control and handling (%)
	3	CN 0103	The automatic warning ratio when a monitoring sample's parameters exceed the set threshold; the system will automatically send a warning to the responsible person (%).
2. Water plant management			<i>2.1. Operation management</i>
	4	CN 0201	The ratio of chemical mixing and dosing facilities and water treatment facilities that are automated in operation management (%)
			<i>2.2. Post-treatment water quality management</i>

Indicator groups	No.	Code	Subgroups and indicators
	5	CN 0202	The automation ratio of providing full post-treatment water quality indicators (after the clean water tank) as prescribed in the current national technical regulations on drinking water quality (%).
3. Management of network and works on the water supply network			<i>3.1. Operation management</i>
	6	CN 0301	The ratio of providing pressure and water flow parameters in the form of area maps from the company's SCADA data (%).
	7	CN 0302	The ratio of valves on the level I and level II pipeline network operating in automatic control mode (%)
			<i>3.2. Water network loss prevention management</i>
	8	CN 0303	The ratio of block meters, master meters and sub-meters in the block that is managed and controlled by specialized software (%).
	9	CN 0304	Water loss ratio that is automatically calculated based on the consumption data by meter, region and the whole network (%)
	10	CN 0305	The ratio of automation of updating and declaring water quality data at locations on the network (%).
4. Customer care and management			<i>4.1. Customer care</i>
	11	CN 0401	The ratio of water customers connected to the electronic billing and payment system (%)
	12	CN 0402	The ratio of water customers who can look up their electronic bills on the water companies' websites (%)
			<i>4.2. Customer management</i>
	13	CN 0403	The ratio of customer feedback via phone number (hotline) received and processed promptly by the company's specialized department (%)
	14	CN 0404	The ratio of information on water customer care situation summarized and made public on the websites of the water supply companies (%)

2.5. Steps to implement the proposed list of smart urban water supply indicators in the digital transformation orientation

To propose feasible and usable smart urban water supply management indicators and assess the overall picture of the implementation of the 4th Industrial Revolution in the urban water supply sector in Vietnam, it is required to follow the following steps: [7] [8] [9]

1. Investigating and surveying the implementation of smart urban water supply at some water supply companies.

2. Setting a scientific basis for developing smart urban water supply indicators in the digital transformation orientation for the period of 2026 - 2035.

3. Proposing a set of smart urban water supply indicators in the digital transformation orientation for the period of 2026 - 2035.

4. Guiding the method of calculating the smart urban water supply indicators in the digital transformation orientation for the period of 2026 - 2035.

5. Conducting a pilot survey at some water supply companies.

6. Preparing a Handbook on methods of calculating the smart urban water supply indicators in the digital transformation orientation for the period of 2026 - 2035.

However, within the scientific article, the group of authors has just proposed a list of smart urban water supply management indicators. The remaining work will be carried out and published in the coming time.

Proposing the contents of the set of smart urban water supply management indicators in the digital transformation orientation for the period of 2026 - 2035, especially preparing the Handbook on methods for calculating the smart urban water supply indicators in the digital transformation orientation for the period of 2026 - 2035 will be an effective tool to:

1. Serve the assessment of the level and ability to implement smart urban water supply activities at water supply companies;
2. Help the Ministry of Construction, the governing body, have a database to assess the implementation of smart water supply in urban areas in Vietnam;
3. Help water supply companies have a basis to assess their achievements in smart urban water supply according to the general level and make plans to invest in new technologies and apply information technology in managing smart water supply systems for the next phase;
4. Contribute to supplementing the database in training work of the water supply and sewerage sector in Vietnam.

III. CONCLUSION

Smart urban technical infrastructure is an essential foundation for forming and developing smart cities, in which urban water supply plays a very important role. To strengthen the ability to access the 4th Industrial Revolution, including the smart urban water supply, it is necessary to gradually apply information technology and automate the operation and management of urban water supply systems in a synchronous manner.

The important content of the 4th Industrial Revolution is the use of information and communication technology (ICT) support tools and other means to contribute to promoting competitiveness, innovation, creativity, transparency, streamlining, effectiveness and efficiency of urban governments' management, enhancing the land,

energy and development resource use efficiency, improving and enhancing the quality of urban living environment, stimulating economic and social growth and development, ensuring consistency and optimizing existing technical and ICT infrastructure based on the ICT Reference Framework for Smart City Development, technical standards and norms to ensure interoperability and synchronous operation of smart cities as well as among smart cities [2], [3];

During the past time, the Party and the State have had many policies and guidelines to promote the application, development of science and technology and digital transformation, as reflected in resolutions, laws, decrees, guiding circulars and documents of authorities at all levels. The Resolution No. 57-NQ/TW is on breakthroughs in the development of science and technology, innovation and national digital transformation. [7]. Guiding viewpoints: Developing science and technology, innovation and national digital transformation is the top important breakthrough, the main force to quickly develop modern production forces, perfect production relations, innovate national governance methods, develop socio-economy, prevent the risk of falling behind, bring the country to breakthrough development and prosperity in the new era; Modernizing and professionalizing water source management towards national water source management on the digital technology platform. The Resolution No. 03/NQ-CP: Promulgating the Government's Action Program to implement the Resolution 57-NQ/TW of the Politburo on breakthrough development of science, technology, innovation and national digital transformation.

The use of key indicators to evaluate the performance of smart cities in general and the smart urban water supply sector in particular is extremely necessary. The investment participation and socialization in developing smart urban water supply is encouraged based on the principle of correctly and fully calculating costs and risks, harmonizing the interests of relevant parties and encouraging the use of domestic products and services. Thus, proposing a list of smart urban water supply management indicators in the digital transformation orientation for the period of 2026 - 2035 is an important link to accelerate the process of building smart cities in Vietnam. [1] [2] [3] [4] [5] [6] [7] [8] [9]

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REFERENCES

- [1] Decision No. 950/QD-TTg dated August 01, 2018 of the Prime Minister approving the Scheme on Sustainable Smart Urban Development in Vietnam for the period of 2019 - 2026 and with an orientation towards 2035;
- [2] Decision No. 84/QD-TTg dated January 19, 2018 of the Prime Minister approving the Plan on green growth urban development in Vietnam until 2035;
- [3] Decision No. 926/QD-BXD dated October 11, 2024 of the Ministry of Construction approving the Scheme on Digital Transformation of the Construction Sector for the period of 2025-2026, with an orientation towards 2030; Directive No. 16/CT-TTg dated October 04, 2017 of the Prime Minister on the strengthening of the ability to access the 4th Industrial Revolution;
- [4] Decision No. 749/QD-TTg approving the National Digital Transformation Program until 2026, with an orientation towards 2030.
- [5] Decree No. 47/2020/ND-CP of the Government: Management, connection and sharing of digital data of state agencies.
- [6] Resolution No. 57-NQ/TW on breakthroughs in the development of science, technology, innovation, and national digital transformation
- [7] Law on Statistics No. 01/2021/QH15 amending and supplementing a number of articles of Law on Statistics No. 89/2015/QH13.
- [8] Decision No. 922/QD-BTTTT of the Ministry of Information and Communications: Approving the Scheme “Identifying the set of indicators for digital transformation of ministries, ministerial-level agencies, government agencies, provinces, centrally-run cities and the country”, vol. 922/QD-BTTTT.
- [9] Decision No. 2502/2016/QD-TTg dated December 22, 2016 approving the adjustment of the orientation for the development of water supply in urban areas and industrial parks in Vietnam until 2026, with a vision to 2050.
- [10] Decision No. 408/QD-TTg dated April 03, 2017 establishing the Steering Committee for the National Program to ensure safe water supply and prevent water and water revenue loss in the period of 2016-2026.
- [11] Decision No. 1566/QD-TTg dated August 09, 2016 approving the National Program for safe water supply for the period of 2016-2026.
- [12] Circular No. 08/2012/TT-BXD dated November 21, 2012 guiding the implementation of safe water supply.
- [13] Circular No. 52/2025/TT-BNNMT (Issued on August 25, 2025): regulating water resource monitoring techniques and water resource warning and forecasting, vol. 52/2025/TT-BNNMT