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Study on Performance Evaluation System of Municipal Sewage System Comprehensive Management

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Abstract: *With continuous urbanization, the position of the urban sewage system as a stable social development and environmental protection is becoming more prominent. However, due to the effect of sewage system reconstruction of light pipes, some cities find it difficult for the system to continue to function normally. Simultaneously, a systematic, objective, effective, and highly targeted comprehensive management performance evaluation system is yet to be formed to measure the perfection of urban sewage system management. Therefore, based on a comprehensive summary and analysis of the evaluation research, evaluation criteria, and statistical analysis of the comprehensive management of urban sewage system, this paper constructed the performance evaluation system of the comprehensive management of urban sewage system based on the analytic Hierarchy Process (AHP) and fuzzy evaluation theory. This system selected 25 index factors from 5 aspects, such as quality evaluation, economic evaluation, environmental evaluation, management evaluation, and social evaluation. At the same time, the index calculation method and scoring criteria were proposed. The evaluation system evaluated the comprehensive management performance of the municipal sewage system in G province. The assessment results are consistent with the performance of cities in G Province in relevant assessments. The results show that the evaluation system has a certain reliability in analyzing the comprehensive management of urban sewage systems and can provide a reference for decision-makers to evaluate the comprehensive management of urban sewage systems, improve the efficiency of municipal sewage system through evaluation.*

Keywords: *urban sewage system; comprehensive management performance; evaluation system; economic effect*

1. Introduction

The urban sewage system, as an essential component of municipal infrastructure, is in charge of source collection, halfway transfer, terminal treatment, and recycling of urban sewage. It is closely related to the city's development, health and safety, water ecological environment, flood control, and drainage. Along with the development of the urban economy, the constant update and improvement of sewage systems plays a vital role in urban public health, water environmental regulation, water resource regeneration and utilization, and many other problems. The Chinese urban sewage system is yet to be managed, and urban development is not synchronized. Sewage network construction seriously lags behind urban development, urban villages, old and old urban areas, and rural-urban fringe. There are many blank areas in the pipe network, resulting in some domestic direct sewage discharge and black water odor. The number of sewage collecting and treatment facilities is huge, the space network structure is complex, and updating the old pipe network system is challenging. Fine management is lacking, and the sewage pipe network's administration and operating mechanisms are fragmented. There are pipe network deterioration and dislocation issues, misconnection and mixed connections, severe siltation, groundwater, and rainwater infiltration. As a result, sewage collection and treatment facilities are inefficient and difficult to perform their functions. According to the characteristics of urban sewage system development at the current stage, the state proposes to promote high-quality urban development and improve the living environment, initiate the work of improving the quality and efficiency of urban sewage treatment, accelerate the improvement of domestic sewage collection and treatment facilities, fight the battle of pollution prevention and control, and systematically improve the efficiency of the urban sewage system. However, in promoting the quality and efficiency of sewage treatment across the country, it is found that most cities focus on the construction progress of relevant facilities but neglect to supervise the construction quality and subsequent operation and maintenance management. The relevant management mechanism and system are imperfect, and the lack of an effective and scientific performance management index system results in the management situation not being accurately assessed. This influences the decision-makers to maximize using limited human, financial, and other resources.

Recently, some researchers have begun to conduct research in constructing the status evaluation system of urban sewage facilities and have put forward many evaluation index systems with great practical engineering value [1]. Most studies focus on engineering construction quality, facility operation efficiency, planning scheme preparation, and other schemes. For example, Tang Bo [2] evaluated the operation efficiency of two sewage treatment plants in Mianyang City by building an evaluation system for urban sewage treatment plants and an evaluation model based on the triangular fuzzy number. Then, they evaluated their actual operating conditions on a macro scale. Qiu Zhan [3] proposed a structured and systematic risk assessment method considering the complex operation and management of urban sewage treatment plants and a large amount of information. The risk evaluation system of an urban sewage treatment plant was established by classifying risk possibility and consequence severity with a four-color method. Jiang Lei [4] tried to adopt an analytic hierarchy process, established the design management evaluation index system, and evaluated sewage collection and renovation projects implemented by S Municipal Government. Further improvement of urban sewage system planning evaluation scientifically guides the layout and construction of urban sewage systems from the top level. Leng Xue [5] adopted the analytic hierarchy process (AHP) in strict accordance with the primary index, screening index, and final selection of evaluation index, constructed the evaluation index system of the operation efficiency of the urban drainage pipe network system, and determined the evaluation standard and evaluation model of the operation efficiency of the urban drainage pipe network system. Based on the operation data of a county-level urban sewage treatment plant in Guizhou Province, Dong Chuanqiang et al. [6] adopted the three-level fuzzy comprehensive evaluation method to comprehensively evaluate the four processes of oxidation ditch, A/O (anoxic and aerobic activated sludge denitrification system), HASN (anaerobic and aerobic secondary biological contact oxidation process), and IBR (continuous flow integrated batch biological reaction treatment device). Meanwhile, some foreign researchers, such as Ortiz M et al., have also applied the life cycle evaluation method [7,8] to evaluate sewage treatment[9]. However, there are few studies on the evaluation of sewage system management,in addition the spillover effects of sewage system management on economy, society and environment have not been studied.

Currently, under the background of the rapid development of urbanization in China and the existing business environment, urban sewage management is faced with many and complex problems, the management of sewage systems is generally evaluated by the higher-level government's management department based on the daily work situation, which is subjective and difficult to evaluate objectively, quantitatively, and effectively based on the management situation of different cities. Therefore, the establishment of an effective, reasonable, and scientific performance evaluation system for the comprehensive management of urban sewage systems can provide a significant reference value for improving the urban sewage system management, fully understanding the status quo and existing problems of urban sewage system management, and unified quantitative comparative analysis of management level between cities. At the same time, the management of urban sewage system has been continuously optimized and improved, and its external economic effects have gradually appeared, specifically include the improvement of urban sewage system brings about the rise in the prices of surrounding real estate and commercial institutions; The improvement of urban quality promotes the development of trade and tourism; The improvement of urban living environment reduces the health care cost of residents' physical and mental health; The comprehensive development and treatment of sewage systems improve the business environment, reduce the cost of water treatment industry in the downstream basin and a series of environmental, social and economic spillover effects outside of sewage management work.

In this paper, based on the current management and development of urban sewage system in China, the external economic effect of sewage management is considered, we construct the performance evaluation system of urban sewage system integrated management, using five aspects: quality evaluation, economic evaluation, environmental evaluation, management evaluation, and social evaluation, and use G province as an example to carry out the comprehensive evaluation. This is useful to guide the construction and management of urban sewage systems. This will dramatically reduce the urban sewage system's operating cost, save resources, and promote the circular economy's development.

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2. Evaluation index system

The evaluation index is the key factor of evaluation result credibility. Establishing a scientific and reasonable comprehensive evaluation index system for managing urban sewage systems should follow the basic systematic, hierarchical, dynamic, scientific, comprehensive, and directional principles. Data gathering and literature evaluation of domestic and foreign urban drainage systems and long-term monitoring analysis of G Province sewage system's development, operation, and management were conducted. The analysis method and the index attribute method were used to analyze and determine 25 evaluation indicators from five aspects: quality evaluation, economic evaluation, environmental evaluation, management evaluation, and social evaluation. The index system was established accordingly. The index system was divided into target, criterion, and index layers, as shown in Figure 1.

Quality evaluation is mainly manifested in the collection of pollutants in the sewage system, using five targets: water inlet BOD of sewage treatment plant, water inlet B/C of sewage treatment plant, water inlet C/N of sewage treatment plant, urban sewage centralized collection rate, and frequency of sewage overflow in dry days.

Economic evaluation is mainly manifested in the saving effect of funds, resources and energy in the whole life cycle process of sewage system management and efficient operation, using three targets: ewage treatment fees, sewage network operation and maintenance fees, pollutant removal cost of sewage treatment plant.

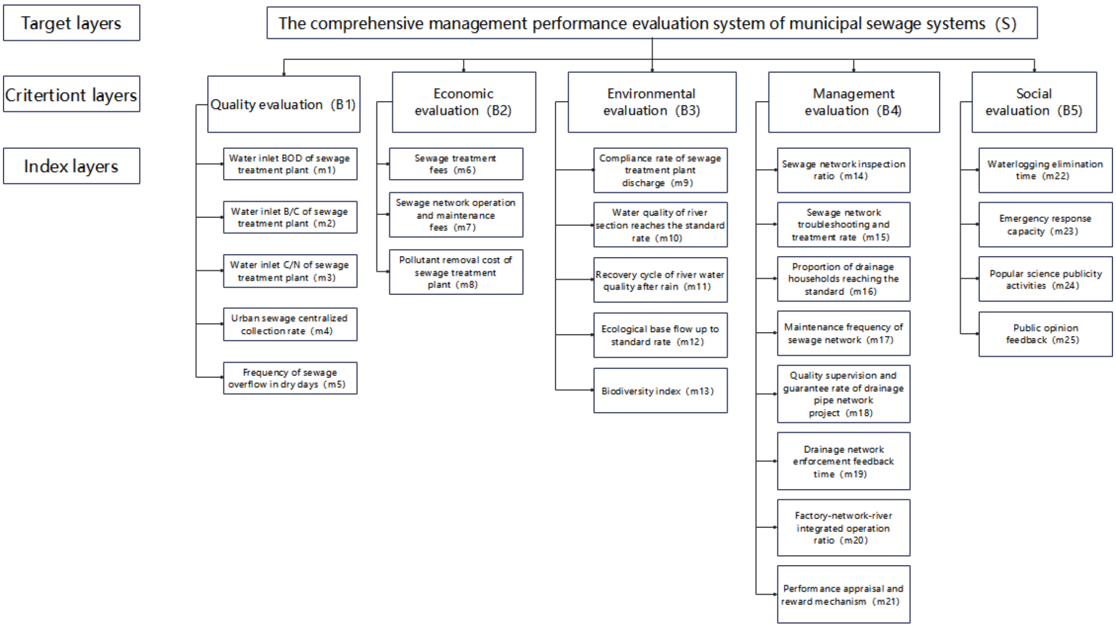

Figure 1: The comprehensive management performance evaluation system of municipal sewage systems.

Environmental evaluation is mainly manifested in the reduction of the risk of pollutant spillover and the improvement of water environment and water ecology by efficient use of water resources. Using five targets: discharge rate of sewage plant, water quality rate of cross section, water quality recovery period after rain, ecological base flow rate, biodiversity index.

Management evaluation is mainly manifested in the unified management and scheduling of the sewage system, the elimination of barriers between various elements and facilities, the realization of the comprehensive efficiency of the sewage system to maximize the overall improvement of urban drainage facilities in the safe operation of the city, flood control and drainage, water environment management and other aspects of the systematic service guarantee ability, using eight targets: sewage network troubleshooting frequency, sewage network troubleshooting and treatment rate, drainage household standard ratio, drainage network operation and maintenance management frequency, drainage network engineering quality supervision and guarantee rate, drainage network law enforcement feedback time, plant network and river integration operation ratio, performance assessment and reward.

Social evaluation is mainly manifested in the improvement of the safety, convenience and service performance of urban human settlements after the transformation of sewage system structure to

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toughness, using five targets: waterlogging elimination time, emergency response capacity, popular science publicity activities and public opinion feedback.

In addition, in the process of indicator screening, the river form index, unit construction cost of pipe network, unit income of water resource reuse, unit construction cost of sewage treatment plant, unit length of sewage collection pipe network, operation and maintenance fee of sewage facilities, pollutant collection rate of sewage system, mass satisfaction, coverage rate of public interactive platform and other indicators were considered. However, due to poor data availability and high correlation with existing indicators, the relevant contents of these indicators can be basically covered by the final 25 evaluation indicators.

3. Construction of a comprehensive evaluation system

3.1 Comprehensive evaluation method

To objectively reflect the contribution degree and importance of each evaluation index to the overall objective in the system, this paper adopts a qualitative and quantitative scientific analysis method -- Analytic Hierarchy Process (" AHP ", similarly below) to calculate the weight of the index. This method has been successfully applied in the decision-making and evaluation of various engineering systems, such as integrated pipeline corridor planning and water purification treatment technology [10-12].

3.2 Weight of evaluation index

3.2.1 Weight of first-level evaluation index

The 5-order square matrix was created and solved with quality, economical, environmental, managerial, and social evaluation as the first-level evaluation matrix in consideration. Next, the weight value of each criterion layer index was calculated. Finally, after the consistency test, the weight value of the index relative to the upper level was obtained. The details are shown in Table 1.

Table 1: Calculation of the Index Weight of First—Level Evaluation Factor

Comparative item	Quality evaluation(B1)	Economical evaluation(B2)	Environmental evaluation(B3)	Managerial evaluation(B4)	Social evaluation(B5)	Weight
Quality evaluation(B1)	1	3	2	2	4	0.356
Economical evaluation(B2)	1/3	1	1/2	1/2	2	0.128
Environmental evaluation(B3)	1/2	2	1	1	3	0.222
Managerial evaluation(B4)	1/2	2	1	1	3	0.222
Social evaluation(B5)	1/4	1/2	1/3	1/3	1	0.071

The corresponding judgment matrix is Formula (1).

$$X=\begin{pmatrix} 1 & 3 & 2 & 2 & 4 \\ 0.33 & 1 & 0.5 & 0.5 & 2 \\ 0.5 & 2 & 1 & 1 & 3 \\ 0.5 & 2 & 1 & 1 & 3 \\ 0.25 & 0.5 & 0.33 & 0.33 & 1 \end{pmatrix} \quad (1)$$

Matlab calculated $\lambda max=5.0331$, and the normalized weight was determined to be 0.356, 0.128, 0.222, 0.222, 0.071. A row consistency test was conducted on the judgment matrix constructed by the above AHP method. $CR=\frac{\lambda_{max}-n}{RI*(n-1)}$=0.007<0.1 (When n=5, the average random consistency index RI was 1.12), with satisfactory consistency.

3.2.2 Weight of second-level evaluation index

Each index under the criterion layer was set as the second-level evaluation matrix, the importance of each factor was compared, the matrix judgment scaling method was combined with the evaluation opinions of experts, and the judgment matrix was obtained by combining the judgment matrix of each index layer and solving the weight by eigenvalue method. The parameters are listed in Tables 2-6.

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Table 2: Weight calculation of quality evaluation index layer.

Comparative item	Water inlet BOD of sewage treatment plant(m_1)	Water inlet B/C of sewage treatment plant(m_2)	Water inlet C/N of sewage treatment plant(m_3)	Urban sewage centralized collection rate(m_4)	Frequency of sewage overflow in dry days(m_5)	Weight
Water inlet BOD of sewage treatment plant(m_1)	1	1	1	0.33	0.5	0.124
Water inlet B/C of sewage treatment plant(m_2)	1	1	1	0.33	0.5	0.124
Water inlet C/N of sewage treatment plant(m_3)	1	1	1	0.33	0.5	0.124
Urban sewage centralized collection rate(m_4)	3	3	3	1	2	0.387
Frequency of sewage overflow in dry days(m_5)	2	2	2	0.5	1	0.242
CR=0.00080, satisfactory consistency						

Table 3: Weight calculation of economic evaluation index layer.

Comparative item	Sewage treatment fees(m_6)	Sewage network operation and maintenance fees(m_7)	Pollutant removal cost of sewage treatment plant(m_8)	Weight
href="javascript:;" Sewage treatment fees(m_6)	1	1	2	0.4
Sewage network operation and maintenance fees(m_7)	1	1	2	0.4
Pollutant removal cost of sewage treatment plant(m_8)	0.5	0.5	1	0.2
CR=0, satisfactory consistency				

Table 4: Weight calculation of environmental assessment index layer.

Comparative item	Compliance rate of sewage treatment plant discharge(m_9)	Water quality of river section reaches the standard rate(m_{10})	Recovery cycle of river water quality after rain(m_{11})	Ecological base flow up to standard rate(m_{12})	Biodiversity index(m_{13})	Weight
Compliance rate of sewage treatment plant discharge(m_9)	1	2	2	3	4	0.356
Water quality of river section reaches the standard rate(m_{10})	0.5	1	1	2	3	0.222
Recovery cycle of river water quality after rain(m_{11})	0.5	1	1	2	3	0.222
Ecological base flow up to standard rate(m_{12})	0.33	0.5	0.5	1	2	0.128
Biodiversity index(m_{13})	0.25	0.33	0.33	0.5	1	0.071
CR=0.0060, satisfactory consistency						

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Table 5: Weight calculation of management layer evaluation index weight calculation.

Comparative item	Sewage network inspection ratio(m_{14})	Sewage network troubleshooting and treatment rate(m_{15})	Proportion of drainage households reaching the standard(m_{16})	Maintenance frequency of sewage network(m_{17})	Quality supervision and guarantee rate of drainage pipe network project(m_{18})	Drainage network enforcement feedback time(m_{19})	Factory-network-river integrated operation ratio(m_{20})	Performance appraisal and reward mechanism (m_{21})	Weight
Sewage network inspection ratio(m_{14})	1	1	1	2	4	4	2	3	0.196
Sewage network troubleshooting and treatment rate(m_{15})	1	1	1	2	4	4	2	3	0.196
Proportion of drainage households reaching the standard(m_{16})	1	1	1	2	4	4	2	3	0.196
Maintenance frequency of sewage network(m_{17})	0.5	0.5	0.5	1	3	3	1	2	0.125
Quality supervision and guarantee rate of drainage pipe network project(m_{18})	0.25	0.25	0.25	0.33	1	1	0.33	0.5	0.043
Drainage network enforcement feedback time(m_{19})	0.25	0.25	0.25	0.33	1	1	0.33	0.5	0.043
Factory-network-river integrated operation ratio(m_{20})	0.5	0.5	0.5	1	3	3	1	2	0.125
Performance appraisal and reward mechanism (m_{21})	0.33	0.33	0.33	0.5	2	2	0.5	1	0.076
CR=0.0051, satisfactory consistency									

Table 6: Weight calculation of the social evaluation index layer.

Comparative item	Waterlogging elimination time(m_{22})	Emergency response capacity(m_{23})	Popular science publicity activities(m_{24})	Public opinion feedback(m_{25})	Weight
Waterlogging elimination time(m_{22})	1	2	3	3	0.446
Emergency response capacity(m_{23})	0.5	1	2	2	0.273
Popular science publicity activities(m_{24})	0.33	0.5	1	1	0.140
Public opinion feedback(m_{25})	0.33	0.5	1	1	0.140
CR=0.0029, satisfactory consistency					

The matrix operation and consistency calculation were expanded based on Table 2-6. The total index weights of the evaluation system between the criterion layer and the target layer, between the criterion layer and the criterion layer, and between the index layer and the target layer were finally obtained, as shown in Table 7.

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Table 7: The calculation result of the performance evaluation system index of municipal sewage system comprehensive management.

Target layers		Index layers		
criterion layers	Weight	Index	Relative criterion layer weight	Relative target layer weight
Quality evaluation(B_1)	0.356	Water inlet BOD of sewage treatment plant	0.124	0.044
		Water inlet B/C of sewage treatment plant	0.124	0.044
		Water inlet C/N of sewage treatment plant	0.124	0.044
		Urban sewage centralized collection rate	0.387	0.138
		Frequency of sewage overflow in dry days	0.242	0.086
Economic evaluation(B_2)	0.128	Sewage treatment fee	0.400	0.051
		Sewage network operation and maintenance fees	0.400	0.051
		Pollutant removal cost of sewage treatment plant	0.200	0.026
Environmental evaluation(B_3)	0.222	Compliance rate of sewage treatment plant discharge	0.356	0.078
		Water quality of river section reaches the standard rate	0.222	0.049
		Recovery cycle of river water quality after rain	0.222	0.049
		Ecological base flow up to standard rate	0.128	0.028
		Biodiversity index	0.071	0.016
Management evaluation(B_4)	0.222	Sewage network inspection ratio	0.196	0.044
		Sewage network troubleshooting and treatment rate	0.196	0.044
		Proportion of drainage households reaching the standard	0.196	0.044
		Maintenance frequency of sewage network	0.125	0.028
		Quality supervision and guarantee rate of drainage pipe network project	0.043	0.010
		Drainage network enforcement feedback time	0.043	0.010
		Factory-network-river integrated operation ratio	0.125	0.028
		Performance appraisal and reward mechanism	0.076	0.017
Social evaluation(B_5)	0.071	Waterlogging elimination time	0.446	0.032
		Emergency response capacity	0.273	0.019
		Popular science publicity activities	0.140	0.010
		Public opinion feedback	0.140	0.010

From the above analysis results, it can be concluded that the centralized collection rate of polluted urban domestic sewage, the frequency of sewage overflow on dry days, the impact on surrounding water bodies, other environmental impacts, and other indicators have a significant impact on the performance evaluation results of the whole urban sewage system management. In the existing sewage system management process, the project construction progress and sewage treatment facility capacity are highly valued, and the sewage system collection and pipe network operation and maintenance management level are relatively ignored. According to our analysis, indicators such as the centralized collection rate of sewage treatment and the operation and maintenance level of the sewage network should be paid more attention to as the prevailing conditions for evaluating the sewage system management level.

3.3 Criteria for the comprehensive evaluation system

The comprehensive management performance evaluation system of municipal sewage systems involves many quantitative and qualitative indexes. This paper adopted a fuzzy comprehensive evaluation method. First, the principles of fuzzy mathematics were utilized to analyze and define the difficult indicators to be quantitatively analyzed in 25 indicator layers according to their membership levels. Then, the objects' attributes were evaluated quantitatively through qualitative and quantitative analysis [13-14].

To obtain accurate evaluation results, all kinds of index values of the comprehensive evaluation

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system of urban sewage system comprehensive management performance were sorted out, analyzed, and screened. First, the corresponding index scoring standards were determined qualitatively and quantitatively. Then, the score values of each index were obtained. Finally, the weight set W (percentage system) was multiplied with the index score m to calculate and determine the final evaluation score value S of the municipal sewage system's comprehensive management and finally get the result based on the score value.

$$S=W*m \tag{2}$$

Where W= (w1, w2,..., W25), Wi is the weight value of the ith evaluation index; R= (m1,m2...,m25) T, mi is the score value of the ith evaluation index.

Table 8: Evaluation standard of performance evaluation system of municipal sewage system integrated management.

Target	Score	Scale of marks		
		100	50	0
Water inlet BOD of sewage treatment plant	4	>120mg/L	90-120mg/L	<90mg/L
Water inlet B/C of sewage treatment plant	4	0.3-0.5	0.2-0.3;0.5-0.6	<0.2; >0.6
Water inlet C/N of sewage treatment plant	4	4-5	3-4; 5-6	<3; >6
Urban sewage centralized collection rate	14	>=75%	75%–60%	<60%
Frequency of sewage overflow in dry days	9	0	0-5	>=5
Sewage treatment fee	5	>=0.95yuan/m^3	-	>0.95yuan/m^3
Sewage network operation and maintenance fees	5	>=75yuan/m·year	45-75yuan/m·year	<45yuan/m·year
Pollutant removal cost of sewage treatment plant	8	＜0.2yuan/m^3	0.2-0.5yuan/m^3	>0.4yuan/m^3
Compliance rate of sewage treatment plant discharge	5	100%	96%-100%	＜96%
Water quality of river section reaches the standard rate	5	100%	98%-100%-	＜98%
Recovery cycle of river water quality after rain	3	＜1day	1-5days	>5days
Ecological base flow up to standard rate	2	100%	90%-100%	＜90%
Biodiversity index	4	Up	Fair	Down
Sewage network inspection ratio	4	>95%	70%-95%	＜70%
Sewage network troubleshooting and treatment rate	4	>95%	70%-95%	＜70%
Proportion of drainage households reaching the standard	3	>75%	50%-75%	＜50%
Maintenance frequency of sewage network	1	One day each time	Two weeks each time	More than two weeks each time
Quality supervision and guarantee rate of drainage pipe network project	1	100%	95%	＜95%
Drainage network enforcement feedback time	3	<12h	24-12h	>24h
Factory-network-river integrated operation ratio	2	100%	70%-100%	＜70%
Performance appraisal and reward mechanism	3	Details	Normal	None
Waterlogging elimination time	4	48 hours	48-120 hours	>120 hours
Emergency response capacity	4	Excellent	Average	Poor
Popular science publicity activities	14	Frequently	Occasionally	Never
Public opinion feedback	9	Positive	Conventional	Delay

Based on the classification of comprehensive evaluation grades of refuse treatment, urban drainage, waterlogging prevention, and other treatment facilities, the characteristics of the fuzzy mathematics evaluation method and the characteristics of urban sewage system management were combined, and the management grades of urban sewage system were divided into four levels, as shown in Table 9.

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Table 9: Urban sewage system management evaluation grade division.

Grade	Score value	Description
Excellent	≥90	Urban sewage system management level is high
Good	75~89	Urban sewage system management level is good
Average	60~75	Urban sewage system management level is average
Poor	≤59	Urban sewage system management level is poor

4. Performance evaluation of sewage system management in G Province

The essential data from 21 cities in G Province were collected and statistically analyzed. Each city was scored according to the established evaluation system and index evaluation criteria. The details are as follows.

(1) There is a specific correlation between urban economic conditions and performance evaluation results of sewage system management. However, the correlation is not significant. Therefore, more attention should be paid to the subsequent centralized sewage collection rate, water environment impact, and management mechanism as essential factors in the performance evaluation of sewage system management.

(2) Among 21 cities in G province, 10 cities have established GIS information dynamic updating systems, related sewage treatment systems, and sewage pipe network operation and maintenance fund guarantee schemes. Moreover, 19 cities have a structural and functional pipe network testing and troubleshooting system or annual testing and troubleshooting records for more than two consecutive years.

(3) In 10 cities, no sewage pipe network project quality supervision system or supervision ledger exists. Nearly half of the urban undrained pipes entered the market quality supervision system and random check ledger, indicating that the coordination between urban housing and construction departments and other departments such as the price bureau is insufficient. However, the follow-up still needs to be strengthened.

(4) Only 2 cities in G province have not established special sewage network management units. Of the remaining 19 cities, 6 cities are maintained by the government or subordinate institutions, 5 cities by non-professional companies, 4 by a mixture of government and professional companies, and only 5 cities are managed by professional drainage companies.

(5) Cities 1, 2, and 3 have performed well in assessing the chief river system and environmental protection supervision, etc., and have been commended by relevant national and provincial departments many times. Cities 14, 23, and 24 have repeatedly given feedback on sewage treatment-related problems in environmental protection supervision. The evaluation system is representative since the outcomes are consistent with the actual scenario.

Figure 2: Performance evaluation of comprehensive management of sewage system in G Province.

(6) No black and smelly water bodies were found in the cities rated as excellent, and no obvious serious waterlogging problems were found. Therefore, the evaluation results can represent the urban sewage system management level to a certain extent.

(7)City 3 Use the comprehensive management performance evaluation system to assess the urban

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sewage management work, find out the shortcomings of management work through assessment, innovate the operation and maintenance working mechanism, strengthen the operation and maintenance guarantee of pipe network, improve the relevant laws and policies of drainage management, improve the pipe network construction and quality assurance mechanism, strengthen supervision and assessment, strengthen scientific and technological support and other policies and measures. In 2022, the average concentration of BOD in the city reached 116mg/L, an increase of nearly 32% compared with 2018, and the centralized collection rate of urban sewage increased from 69.8% to 89.7%. Remarkable results have been achieved in improving the quality and efficiency of sewage treatment. Therefore, the integrated management performance evaluation system can not only evaluate the effectiveness of urban sewage management, but also effectively promote the function improvement of urban sewage system.

5. Conclusion

Based on the analysis of relevant domestic standards and assessment methods, a performance evaluation system for the comprehensive management of urban sewage systems has been constructed, and the calculation method and scoring standard of the evaluation index have been put forward. In addition, the evaluation system evaluates the performance of the systematic collection and treatment of sewage in G province to find out the shortcomings in the management level and management work of each city. The evaluation of G province found that the cities lacking management and insufficient attention have poor evaluation results and management work. On the other hand, the cities with better water ecological environments and fewer drainage and waterlogging problems have excellent evaluation results. The evaluation results are consistent with the actual management status, indicating that the system is reliable and can provide a reference for the performance evaluation of urban sewage system management in other provinces and cities.

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