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Strategic Planning for Infrastructure of Diyala Governorate: Water Sector

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ABSTRACT

Infrastructure services are closely related to human life and development, as they are an essential indicator of the progress of life in countries. Infrastructure projects including the water sector are indeed the backbone of a country's economic development, providing many social, economic and environmental benefits. This paper aims to study the existing infrastructure (water sector) in Diyala Governorate, analyse the available data, prepare indicators of deficit ratios according to international standards, and propose possible solutions to address the problems in this sector. Data were collected for the water sector, which included the quantities of potable water supplied for the past eleven years. The results showed that the deficit rate in the water sector amounted to 32% in 2021, as evidenced by the deficit rates and the presence of clear deficiencies in the water sector in Diyala Governorate, and this deficiency does not result only from lack of availability, but rather due to a weak planning vision and the absence of future plans that take into account the increase in the governorate population. The results of predicting using simple linear regression using the Spss program version 26 showed that the demand for drinking water will reach 554,354 m³ per day in 2035. Three plans have been proposed to address the current deficit and future demand in the water sector, which is a short-term plan extending from 2022 to 2025, addressing 50% of the current deficit in 2021; A medium-term plan extending from 2022 to 2027 addresses the current deficit once and for all, and a long-term plan extending from 2022 to 2035 addresses the current deficit and future demand in the water sector.

1. Introduction

Strategic planning refers to an organization's future planning, the main and primary goal of implementing strategic planning was to control the entire organization. [1]. A strategic plan is a roadmap for getting an organization from where it is today to where it wants to be in five or 10 years [2]. Strategic planning may assist companies in focusing on making successful decisions and activities that advance the organization's goal [3]. Strategic planning "when done correctly, offers one method for the activation and redirection of the government and also the general service" [4].

Any fundamental system or physical component necessary for societal development may be referred to as "infrastructure." [5]. Projects of Infrastructure are the foundation of a state's economic growth, progress, and well-being [6]. Infrastructure long-term capital facilities are employed in providing specific sorts of services to families as well as those that boost private sector production [7]. It is also argued that human well-being in terms of education and health depends crucially on

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infrastructure services, such as safe drinking water and sanitation to prevent disease, electricity to serve schools and health centers and roads [8]. Infrastructure services are more in demand as a result of population growth, but improved infrastructure services also draw people to a place [9].

The researchers classified the infrastructure into several classifications from this classifications : Physical infrastructure, which includes transportation, energy, water and drainage systems, waste management, information and communication technology (ICT), green infrastructure, which includes rivers, open spaces, and coastlines, as well as community and social infrastructure, which includes public spaces, healthcare, education, and community services, as well as occasionally low-cost housing [10]. Water is one of the basic elements of infrastructure, as it is important and essential for the population especially good water drinking water is important because it is related to human health and its absence causes diseases and epidemics [11]. The most critical issue in water distribution system development and operation is meeting consumer demand, this entails consistently supplying users with high-quality water in sufficient quantities [12].

2. Strategic planning for infrastructure (Water Sector)

There is a consistently growing gap between the demands for ensuring the delivery of utility services and the capacity of the public sector to meet those demands, this capability gap is exacerbated by challenges emerging such as increasing uncertainty in technical and social context conditions, public facilities can determine the abilities to deal with changing circumstances by implementing the processes of suitable formal strategic planning [13]. Awareness of the need for effective strategic planning processes has been rising in the sectors of services and infrastructure-based [14]. A strategic planning approach appropriate for infrastructural projects must specifically take into account their unique characteristics, such as their substantial capital requirements, lengthy relevant time horizons, and the numerous objectives imposed on service delivery, [13]. The characteristics of strategic infrastructure planning can be summarized according to [15] as follows:

1. The objective of strategic infrastructure planning procedures is to improve the quality, cost, and continuity of infrastructure services over the long term.
2. Strategic infrastructure planning would take into account both supply and demand for infrastructure services.
3. It must have a long-term perspective, with a minimum time horizon of 10-15 years and, in certain situations, reaching as far as 30 or 40 years

3. Research aim and objectives

The research aims to study the existing infrastructure for the (water sector) for the Diyala governorate and determine the deficit ratios in the (water sector) and propose solutions to treat the problems in this sector of infrastructure.

4. Research methodology

To achieve the objective, the following research was followed:

4.1 Theoretical aspects

Reviewing the literature about the research topic by summarizing the international studies, including books, papers, and theses.

4.2 Practical aspects

This part included:

4.2.1 Data Collection

Population data were collected for the Diyala governorate for the years 2010 to 2021, as shown in Figure 1, (data collected from the Ministry of Planning - Central Statistical Organization, Diyala Statistics Directorate).

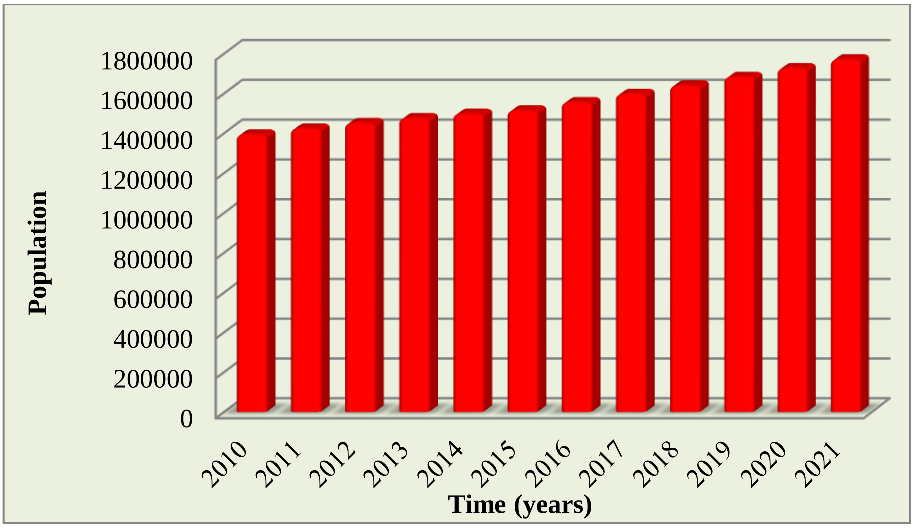

Figure 2. Population growth in Diyala governorate for the years2010 to 2021

The data of the water sector, which included the quantities produced of potable water for the filtration projects and complexes of the Diyala Water Directorate in Diyala Governorate from 2010 to 2021, as shown in Table 1. The data included the total actual capacities of all filtration projects and complexes multiplied by the number of daily operating hours for the projects and complexes for the past eleven years, i.e., what these projects and complexes produced of drinking water. There are 27 projects and 190 complexes in Diyala Governorate in 2021 throughout Diyala Governorate.

Table 1: Data of drinking water service sector

Years	Average quantities of potable water (actual)(m^3/day)
2010	212885
2011	217410
2012	223041
2013	226873
2014	230277
2015	234389
2016	242310
2017	250406
2018	256954
2019	268852
2020	279326
2021	302485

4.2.2 Determine the deficit ratios

Standard of the average per capita share of drinking water (250 liters / person / day) according to the Iraqi Ministry of Planning for the year 2020, according to [16]. Deficit is the difference between demand and actual or supplied.

The demand = number of units x demand per unit….(1) according to (17)
Units u = population

Demand per unit (service level) = quantity of infrastructure service.
Demand for potable water = Population*250*0.001 ……(2) .
250 (liters / person / day) multiplied by 0.001 to convert from liters to cubic meters.

Table 2: The deficit ratios in the water sector in Diyala Governorate for (201٠ to 2021)

Years	Average quantities of potable water (m^3/day) (Demand)	Average quantities of potable water (m^3/day) (Actual)	Deficit ratios
2010	347852	212885	39%
2011	355245	217410	39%
2012	362080	223041	38%
2013	368301	226873	38%
2014	373827	230277	38%
2015	378048	234389	38%
2016	388318	242310	38%
2017	398736	250406	37%
2018	409307	256954	37%
2019	420082	268852	36%
2020	431060	279326	35%
2021	442230	302485	32%

Table 2. shows there was a noticeable deficit in the population's share of potable water in Diyala Governorate.

4-2-3 Predicting the population of Diyala governorate for the year 2035

The reason for the growth in the demand for the service of water is due to the population increase, the population growth of Diyala Governorate was predicted for the period of planning 2035, using the population data from 2010 to 2021 shown in Table (1), using simple linear regression analysis using the SPSS program version 26.

The regression equation is written as follows:

Population (predicted) = 33797.654 (year) - 66560810.077 (3)

The value of beta: 33797.654

Unstandardized Coefficients B (constant) :
-66560810.077

Figure 3. shows the actual population of Diyala Governorate from the year 2010 to the year 2021 and the predicted population of Diyala Governorate for the years 2022 to 2035, where the population of Diyala Governorate was predicted to reach 2,217,41٦ people in the year 2035.

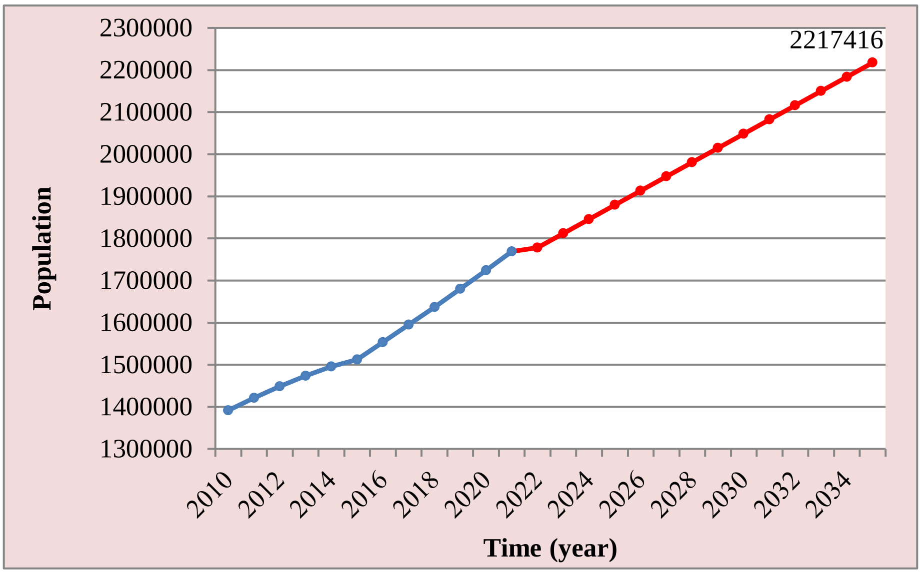

Figure 3. Population growth of Diyala Governorate for 2010 to 2021 and predicted population growth for 2022 to 2035

4.2.4 Predicting the demand for potable water for the year 2035

The demand for potable water was predicted for the year 2035, using the water sector data from the years 2010 to 2021 shown in Table 2, using the simple linear regression analysis, where the population as the independent variable and the demand for potable water as the dependent variable:

The regression equation was as follows:

Demand on the potable water (predicted) = 0.25*populations(predicted)-0.0000000009313 (4)

The value of beta: 0.250
Unstandardized Coefficients B (constant): -0.0000000009313

Figure 3. shows that the demand for potable water will increase in the coming years until it reaches 554354 (m^3/day) in the year 2035.

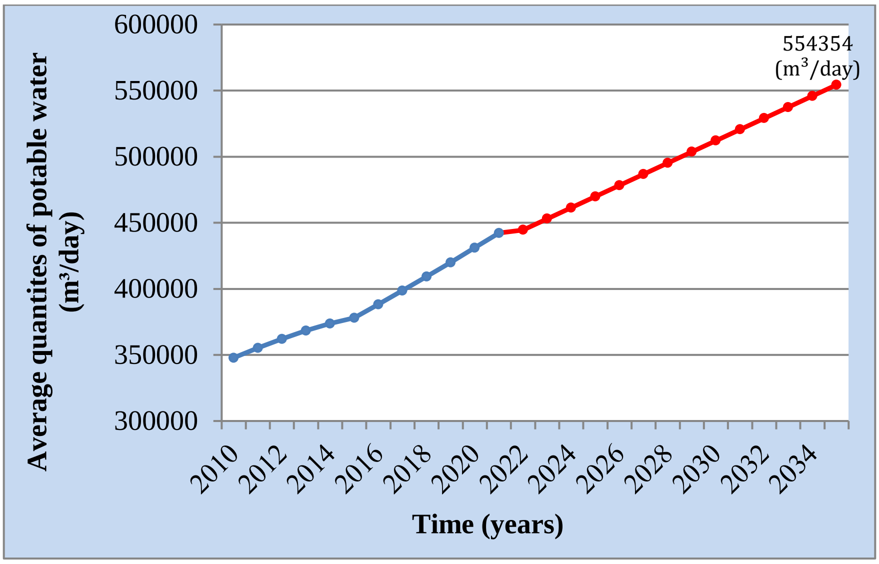

Figure 3. Demand and predicted demand for potable water in Diyala Governorate for the years 2010–2035

4-2-5 Proposed Treatments

Three plans were proposed to treat the current deficit and future demand in the water sector. These plans include: a short-term plan that extends from the year 2022 to 2025, a medium-term plan that extends from the year 2022 to 2027, and a long-term plan that extends from the year 2022 to 2035.

A. Short-Term Plan (2022-2025)

The plan extends from 2022 to 2025 and includes addressing 50% of the current deficit in the water sector in 2021, as shown in table 2, as the deficit for the same year amounted to 139,745 (m^3/day), which requires supplying the governorate with 69,873 (m^3/day) equivalent 50% of 139,745 (m^3/day) during the period (2022-2025). 69873 (m^3/day) divided by 16 hours (complex operating hours in day), which equals 4367 (m^3/hour), which requires the construction of four complexes (1000 m^3/hour) and two complexes (200 m^3/hour).

The total cost of constructing complexes is calculated during the period 2022-2025 as shown in table 3.

The prices are an estimate that includes all the paragraphs of the project based on the opinion of experts specialized in the implementation of these projects in the Diyala Water Directorate.

Table 3. Calculation of the costs of the water sector for a short-term plan

	Type of complex	Cost of one complex (IQD)	Number of complexes	Total cost of construction the complexes (IQD)
	1000 (m^3/hour)	2,500,000,000	4	10000000000
	200 (m^3 /hour)	750,000,000	2	1500000000
Total Cost				11,500,000,000

B. Medium-Term Plan (2022-2027)

The plan extends from the year 2022 to 2027 and includes a complete treatment of the current deficit in the water sector in the year 2021, as shown in table 2, as the deficit for the same year amounted to 139,745 (m^3/day), which requires supplying the governorate with 139,745 (m^3/day) during the period 2022–2027. 139,745 (m^3/day) divided by 16 hours (complex operating hours in a day), which equals (8734 m^3/ hour). which requires the construction of eight complexes (1000 m^3/hour), one complex (500 m^3/hour), one complex (200 m^3/hour) and one complex (50 m^3/hour). The total cost of construction of the complexes during the period 2022–2027 calculates as shown in Table 4.

Table 4. Calculation of the costs of the water sector for a medium-term plan

	Type of complex	Cost of one complex (IQD)	Number of complexes	Total cost of construction the complexes (IQD)
	1000 (m^3/hour)	2500000000	8	20000000000
	500(m^3 / hour)	1500000000	1	1500000000
	200 (m^3 / hour)	750000000	1	750000000
	50 (m^3 / hour)	250,000,000	1	250000000
Total Cost				22,500,000,000

C. Long-Term Plan (2022-2035)

The plan extends from 2022 to 2035 and includes the planning to treat the current deficit in the water sector in 2021 and take into account the expected increase in demand for potable water in the year 2035. The quantities of potable water planned to be available during the period (2022–2035) are equal to demand for potable water in 2035 minus the actual in 2021, which is equal to 251869 (m^3/day). 251869 (m^3/day) divided by 16 hours (complex operating hours in day), which equals (15742 m^3/hour), i.e., providing sufficient quantities of potable water for all residents of Diyala Governorate by 2035. which requires the construction of four projects (2000 m^3/hour), seven complexes (1000 m^3/hour), one complex (500 m^3/hour), one complex (200 m^3/hour), and one complex (50 m^3/hour). The total cost of construction of the projects and complexes of water during the period (2022–2035) calculates as shown in table 5.

Table 5: Calculation of the costs of the water sector for a long-term plan

	Type of project or complex	Cost of one project and complex (IQD)	Number of projects and complexes	Total cost of construction the projects and complexes (IQD)
	2000 (m^3/day)	60,000,000,000	4	240,000,000,000
	1000 (m^3/hour)	2,500,000,000	7	17500000000
	500(m^3 / hour)	1,500,000,000	1	1,500,000,000
	200 (m^3 / hour)	750000000	1	750000000
	50 (m^3 / hour)	250,000,000	1	250,000,000
Total Cost				260,000,000,000

5. Conclusions

Based on the work of the paper, the following conclusions can be drawn:

1. There is a clear deficiency in the volume of infrastructure services for the (water sector) in Diyala Governorate, and this deficiency does not result only from lack of availability, but rather as a result of weak planning vision and the absence of future plans that take into account the increase in the size of the population of the province.
2. The deficit ratio in the water sector reached 32% in 2021, and one of its reasons is that the absorptive capacity of the treatment plants or filtering plants of the drinking water network is not commensurate with population growth and expansions in the study area.
3. Three plans were proposed to address the current deficit and future demand for water sector , where the short-term plan can address 50% of the current deficit in the water sector,, where the cost of this plan amounted to 12 billion ID , the medium-term plan can permanently address the current deficit in the water sector, the cost of the medium-term plan amounted to 23 billion ID, and the long-term plan can address the current deficit and future demand in the water sector, the cost of the long-term plan was 260 billion ID.

References

[1] E. Rezaei, Y. Rostami, M. Ghafouri, A. Fashkhorani, and M. Ahmadi, “The infrastructure attitude to strategic planning of information technology in organizations,” *Mark. Brand. Res.*, vol. 3, pp. 97–108, 2016.

[2] N. E. W. ORLEANS, “Strategic Planning Handbook and Managers Implementation Tools,” 2010.

[3] O. A. M. M. Najati, and A. M. M. Al-Tayab, “The reciprocal relationship between strategic planning and improving the performance of the organizational structure in Iraqi universities.,” Baghdad, 2019.

[4] J. L. Kaufman and H. M. Jacobs, “A public planning perspective on strategic planning,” *J. Am. Plan. Assoc.*, vol. 53, no. 1, pp. 23–33, 1987. https://doi.org/10.1080/01944368708976632

[5] H. C. Demirel, W. Leendertse, and L. Volker, “Mechanisms for protecting returns on private investments in public infrastructure projects,” *Int. J. Proj. Manag.*, vol. 40, no. 3, pp. 155–166, 2022. https://doi.org/10.1016/j.ijproman.2021.11.008

[6] D. Butković, M. S. Klepo, and T. Rastovski, “Infrastructure projects classification–Sustainable development perspective,” in *5th IPMA SENET Project Management Conference (SENET 2019)*, 2019, pp. 68–75. https://dx.doi.org/10.2991/senet-19.2019.12

[7] J. Alm, “Financing urban infrastructure: knowns, unknowns, and a way forward,” *J. Econ. Surv.*, vol. 29, no. 2, pp. 230–262, 2015. https://doi.org/10.1111/joes.12045

[8] G. Datt and M. Ravallion, “Why have some Indian states done better than others at reducing rural poverty?,” *Economica*, vol. 65, no. 257, pp. 17–38, 1998. doi : https://doi.org/10.1111/1468-0335.00112

[9] Thoung, Chris, Rachel Beaven, Chengchao Zuo, Mark Birkin, Peter Tyler, D. O. U. G. L. A. S. Crawford-Brown, Edward J. Oughton, And Scott Kelly. "3 Future demand for infrastructure services." The future of national infrastructure: A system-of-systems approach (2016): 31.

[10] G. Klein, N. Klug, and A. Todes, “Spatial planning, infrastructure and implementation: Implications for planning school curricula,” *T. Reg. Plan.*, vol. 60, pp. 19–30, 2012.

[11] K. . AL Maliki N, “Study of Infrastructure and means of treatment Drinking water network - sewage - wireless communications case study: AL-SHAAB Municipality.,” University of Baghdad, 2013.

[12] B. M. Brentan, E. Luvizotto Jr, M. Herrera, J. Izquierdo, and R. Pérez-García, “Hybrid regression model for near real-time urban water demand forecasting,” *J. Comput. Appl. Math.*, vol. 309, pp. 532–541, 2017. https://doi.org/10.1016/j.cam.2016.02.009

[13] D. Dominguez, H. Worch, J. Markard, B. Truffer, and W. Gujer, “Closing the capability gap: strategic planning for the infrastructure sector,” *Calif. Manage. Rev.*, vol. 51, no. 2, pp. 30–50, 2009.

[14] I. Dyner and E. R. Larsen, “From planning to strategy in the electricity industry,” *Energy*

Policy, vol. 29, no. 13, pp. 1145–1154, 2001. https://doi.org/10.1016/S0301-4215(01)00040-4

[15] S. ALCHIN, T. Worsley, and T. Wickersham, “Developing strategic approaches to infrastructure planning,” 2021.

[16] Ministry of Planning , Department of Regional and Local Development, “Spatial Development Gaps According to Planning Standards for Technical Structures with Economic Activities in the Governorates, Baghdad , Iraq.” 2020.

[17] M. Neuman, “Infrastructure planning for sustainable cities,” Geographica Helvetica., vol. 66, no. 2, pp.100-107, 2012